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Water Police Research

Highlight

Energy Pricing and Supply for Groundwater Demand Management

Lessons from Mexican Agriculture

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Mexico's agriculture is highly groundwater intensive, more than even India and China. Moreover, municipal and industrial demands are also met largely by groundwater. This places aquifer overdraft firmly at the centre of both present and future water management challenges in the country.

Strong legislations and radical institutional innovations have been tried to regulate groundwater use. While the purely regulatory approach has failed in controlling groundwater overexploitation, institutional approaches are still evolving.

Power pricing and supply policy can be used to structure economic incentives to complement the regulatory and participatory approaches to groundwater conservation.

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Energy Pricing and Supply for Groundwater Demand Management: Lessons from Mexican Agriculture[1]

RESEARCH HIGHLIGHT BASED ON A PAPER TITLED:

"ENERGY PRICING AND SUPPLY FOR GROUNDWATER DEMAND MANAGEMENT: LESSONS FROM MEXICAN AGRICULTURE"

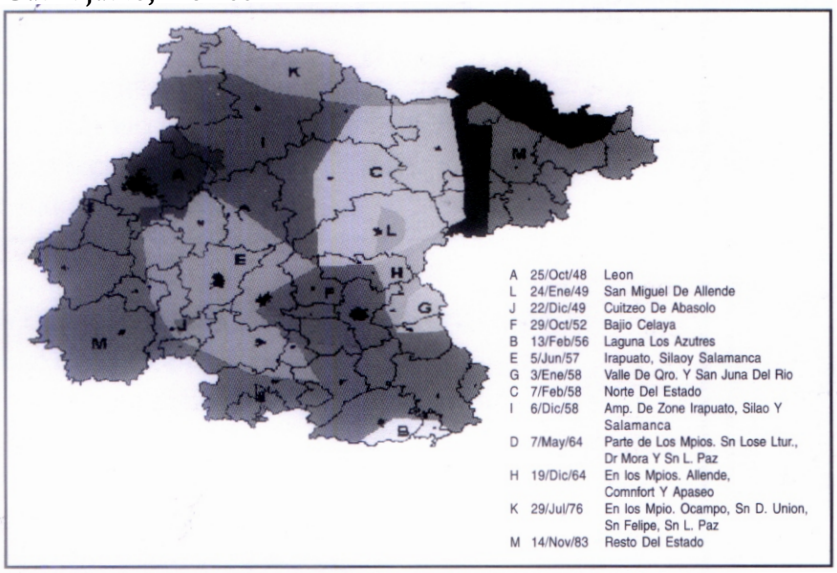
While in absolute terms Mexico's annual groundwater draft of 12 km^3 is modest compared to countries like India (150 km^3), China (90 km^3), and Pakistan (45 km^3), on a per irrigated hectare basis it is nearly twice as high as India's, which explains both Mexico's higher per hectare crop yields and rapid groundwater depletion. Additionally, a significant share of Mexico's municipal and industrial water demand is met from groundwater, placing aquifer overdraft firmly at the centre of both present and future water management challenges.

FAILURE OF THE PURELY REGULATORY APPROACH

Guanajuato state, one of the major consumers of groundwater in the country, has seen an explosion in the number of wells over the past 50 years, driven by a combination of direct (Federal) government support programmes for well drilling and equipment installation and by favourable agricultural production and marketing conditions in the Bajío region of southern Guanajuato. Simultaneously, various strategies to control the expansion of groundwater extraction have been adopted but with little success. Groundwater overdraft is estimated at 1.3 km^3 annually and water table is falling at an average annual rate of 2 m per year in the state. Official bans on new wells have been imposed in different parts of the state since 1948 and these remain in effect even today (Figure1).

Despite the bans, the number of wells continued to increase at an exponential rate until 2000. Official data indicates that since then no new wells were drilled (Figure 2). Unofficial accounts, however, suggest that unregistered wells continue to be sunk. An informal association of well drillers in the state indicates that over a thousand wells were drilled in 2001, while only about 250 of these had official permission to reposition existing wells.

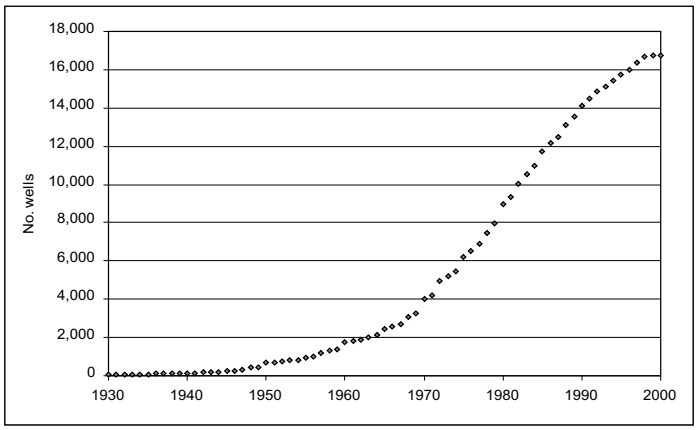
Figure 1: Imposition of Official Bans on New Wells in Guanajuato, Mexico



All groundwater is a national property in Mexico. State regulates construction of new wells and volume of extraction from existing wells. Strong legislations are in place for more than 50 years. Yet the purely legal approach to groundwater regulation has not been successful in checking overexploitation.

[1]The research covered by this IWMI-Tata Research Highlight was carried out with generous support from IWMI. The research paper can be downloaded from the IWMI-Tata Website http://www.iwmi.org/iwmi-tata.

Figure 2: Increase in Number of Groundwater Wells, Guanajuato State, 1930-2000



In Mexico all groundwater is a national property and is administered by the national water commission (CNA, Comisión Nacional de Agua) which awards titles and concessions of all water rights. Renewable concessions are granted for a specified annual volume over the period of the concession, generally ten years for groundwater. Urban and industrial users pay CNA for water rights while agriculture is exempted from payments. However, a process of "regularizing" agricultural rights for groundwater has been set in motion to formalize the concessions of agricultural well owners with a title. In addition to specifying the annual volume concessioned based on the discharge of the well and the area of irrigable land reported, the title spells out the norms regarding repositioning of the well, cessation of rights for unutilized volumes (over three consecutive years), the transfer (sale) of rights, etc. All agricultural users must install a volumetric flow meter and report pumped volumes to CNA. This clause is not enforced; pumped volumes exceed concessioned volumes. In the Silao-Romita aquifer, only one-third of the 1,900 wells are concessioned to pump in excess of 200,000 m^3/year; however, it is estimated that the average pumped volume per agricultural well for this aquifer is 250,000 m^3/year. CNA is understaffed and admits its own incapability to make supervision visits to even a meaningful sample of the nearly 17,000 agricultural wells in the state. Clearly, the purely regulatory approach to groundwater regulation pursued in Mexico has not been successful.

Figure 3: Guanajuato Groundwater Irrigators

INSTITUTIONAL INNOVATIONS IN GROUNDWATER MANAGEMENT

With the regulatory approach failing, the 1990s saw the emergence of participatory approach to groundwater management in Mexico. Efforts have been made to organize water users around the central problem of groundwater overdraft at the aquifer level in form of COTAS (consejos *técnicos de aguas*) (technical water councils) with ambitious objectives for integrated water management based on the representation of multiple sectoral uses in a council structure. Though COTAS have an ambitious agenda to follow, CNA has offered them little scope to assume responsibility for concessioning and titling or for supervision of pumping, drilling (repositioning) of wells, etc. Instead, the COTAS can only extend support to users in the concessioning process, serving as intermediaries to defray the costs of travelling to and from the state CNA office. Even the most advanced of Mexico's COTAS are in a nascent stage today. They are trying to define their role in a way that would let them win their members' affiliation and gain financial and institutional autonomy.

It is apparent that both regulatory and participatory approaches to groundwater management in Mexico are constrained by federal-state-

local institutional relations. While these dynamics are evolving, it is likely to take longer to establish functioning institutional arrangements than the pace of groundwater overdraft in Guanajuato will permit. There is an urgent need to modify the groundwater pumping incentive structure created by the energy pricing and supply regime in Mexico.

ECONOMIC INCENTIVES FOR GROUNDWATER REGULATION

Radical legislations and institutional innovations have been tried out for groundwater regulation in Mexico with limited success. These should be complemented with economic measures to encourage users to accept regulatory controls and affiliate with participatory approaches.

It is our contention that a third element of groundwater demand behaviour must be incorporated in order that users, who hold the ultimate decision of how much to pump, a) accept regulatory controls whether externally mandated on the part of the government, or, are internally devised and imposed on water users associations, aquifer councils, etc. and b) affiliate with participatory approaches.

Farmers' production decisions, and thereby the water demand exerted by the crops planted, are strongly influenced by costs and returns. Because irrigation generally represents a relatively small fraction of the total input costs while it conveys a significant degree of risk mitigation for other factors of production (seed varieties, fertilizers, etc.), the tendency is to irrigate in excess of the crop's water requirement. Attempts to reduce groundwater draft must address farmers' preference for over-irrigation as a risk mitigation strategy.

Following an economic rationale for decision-making, farmers will adopt conservationist behaviour when the cost of water increases to a level close to its marginal value. When costs and returns are not more closely matched, the elasticity of demand remains low and incremental price increases have little or no bearing on demand. This is the case with groundwater in many regions, including Guanajuato where previous IWMI studies have shown that irrigation depths for the same crop irrigated from surface or groundwater sources are essentially the same, despite the fact that groundwater costs approximately three times more than surface water. The limits to the expansion of surface water irrigated area were of course driven by water scarcity resulting in drawn down or depleted surface reservoirs. Groundwater, on the other hand, represents a much larger reservoir and unbounded demand results in increased area under groundwater irrigation and, by extension, overdraft.

A specific behavioural response by groundwater pumpers is set up by the large differential between fixed and recurring costs for a well. In order to recover the high capital investment, the tendency is to maximize the volume pumped. One very real, though often overlooked, outcome of efficiency improvements for groundwater irrigation is that the total area irrigated per well increases as a result of farmers' efforts to recover

their investments. Efficiency improvement accompanied by downsizing of pump capacity (in other words to irrigate the same area at lower recurring pumping costs) and cropping shift to lower water demand are the only ways to reduce groundwater draft through the efficiency approach.

USING ENERGY-IRRIGATION LINKAGES FOR GROUNDWATER MANAGEMENT IN MEXICO

Power pricing and supply policy can provide an effective incentive structure for groundwater conservation in Mexico.

An effective way to instill or provide an incentive structure for water conservation is through energy pricing and supply. The pricing angle was men tioned earlier and requires moving into the elastic range of demand behavior. The supply issue warrants some further discussion: for electrical power, this entails (in order of least to most difficult socially, politically, and technically in the Mexican context) :

a) Restrictions on new connections

b) Caps on capacity or amperage, and

c) Reductions in hours of power supply

New electrical connections for agricultural wells are granted even though the well may be in defiance of existing bans on new wells and hence illegal. However, the illegal wells will not be entitled to subsidized power tariff from October 2002. They will have to pay electricity bill at commercial rates which would more than double their tariff costs. The differential power tariff regime to be applied in such cases may serve as a powerful deterrent for users to apply for new connections. Nevertheless, there is at present no parallel ban on new electrical connections - this appears to be another shortcoming of the regulatory approach to groundwater management.

Amperage caps through limits to transformer capacity have been experimented within Mexico. However, pumps must be sized to meet peak irrigation demand for the land authorized to be watered under the concession title, with the result that idle capacity may be used during non-peak periods to irrigate additional land including through water trading or selling. Additionally, transformer installation is the responsibility of the well owner - transformers are sold by pump distributors - so voluntary capacity upgrades are now possible. Similar to our assessment that not limiting electrical connections is a lost opportunity, allowing well owners to size their own transformers appears to be a lacuna in the regulatory framework.

Finally, reducing the hours of service is an energy supply control being used in countries like India, although there it has more to do with generation and distribution capacity relative to demand than as a conscious regulatory approach. Exercising this option in a country like Mexico would be very difficult socially and politically. Urban areas already command a disproportionate share of public services and further cutbacks, for instance, in rural power supply would cause unrest and spell political doom.

Policy Implications

Groundwater management is a key challenge that requires regulatory and participatory approaches coupled with changes in demand behaviour of water users. Where groundwater use is largely agricultural, cropping changes and water demand may be influenced by commodity prices; however, energy pricing and supply can also be determinants of pumping behaviour. Price must be high enough to be in the elastic range of demand response, while supply options can face social and political challenges. In Mexico, regulatory approaches to groundwater management have been in place - and have been largely unsuccessful - for over 50 years. Nevertheless, the current well concessioning and licensing drive is important and should be continued.

IWMI-Tata Water Policy Program

The IWMI-Tata Water Policy Program was launched in 2000 with the support of Sir Ratan Tata Trust, Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations.

Through this program, IWMI collaborates with a range of partners across India to identify, analyse and document relevant water-management approaches and current practices. These practices are assessed and synthesised for maximum policy impact in the series on Water Policy Research Highlights and IWMI-Tata Comments.

The policy program's website promotes the exchange of knowledge on water-resources management, within the research community and between researchers and policy makers in India.

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