Water Management across Scales in the São Francisco River Basin:

Policy Options and Poverty Consequences

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Embrapa

Choosing the Proper Spatial and Temporal Resolution for Water Management: Don't Forget the 'Invisible' Factors

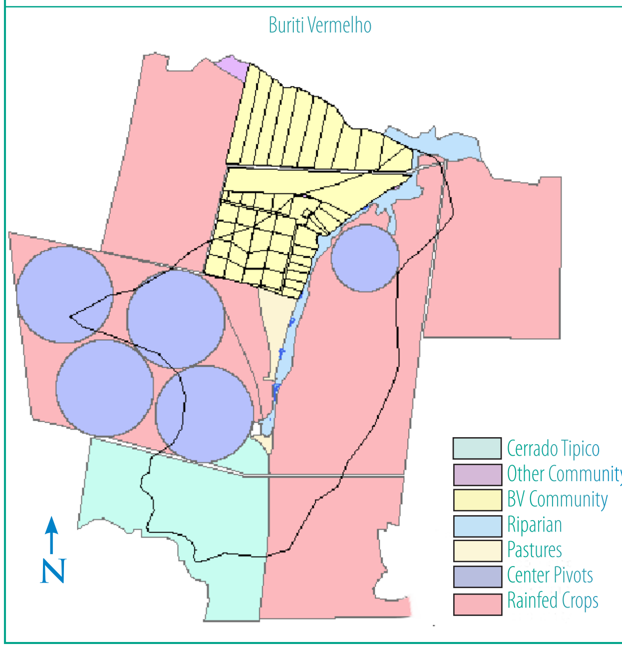
In the search for the proper spatial and temporal resolution at which to manage natural resources, we are generally guided by the flows and stocks of water that we can 'see' – rainfall, flowing water, reservoirs, dams, etc. We use what we observe to identify the socially optimal flows/stocks of water, and then suggest the public policy action required to achieve these results. However, there are also some 'invisible' factors that need to be included in policy discussions related to water management; one important invisible factor is groundwater (the focus of this brief).

The bad news is that groundwater is 'invisible,' hence stocks and flows of it are more difficult to measure. The good news is that we are discovering ways to more cheaply measure groundwater stocks/flows and to predict the spatial and temporal effects of groundwater extraction. The SFRB research team has developed a demonstration model capable of examining these effects, and what follows is derived from simulation experiments using that model in the Buriti Vermelho sub-catchment area located near Brasilia.

The Buriti Vermelho Sub-Catchment Area

The Buriti Vermelho (BV) sub-catchment area is a small watershed comprised of several types and spatial extents of farming activities. Figure 1 depicts the BV site; the precise boundaries of the sub-catchment area are given by the thin black line. Water emerges from about the south-central part of the site, just outside the green patch of *cerrado típico* (savanna forest) and flows from south to north. Blue circles identify the location and size of capital-intensive center-pivot irrigation schemes, while yellow rectangles identify small farms. Large patches of rainfed agriculture remain in the BV and appear as pink in Figure 1.

Figure 1. The Farms and Farming in the Buriti Vermelho Sub-Catchment Area



Spatial Patterns of Invisible Factors

A spatially distributed hydrology model is being developed for the BV to better understand the effects of alternative farming activities and policy actions on the availability and cost to farmers of surface water and groundwater. We used a demonstration version of this model to examine the effects of installing a tube well in the area within the BV site occupied by smallholders (the yellow area). The well was 'installed' in the model and extracted water at a rate of five liters per second. The model simulated the depression in the water table and, hence, its effect on the availability of groundwater both on the farm where the tube well was installed and on neighboring farms.

Figure 2, a 180-degree rotated version of Figure 1, provides our answer. The red area is where the water table is shallow (and pressure head is highest) and cheapest to pump from. As you move to green and yellow areas, the water table is deeper and pumping is more expensive.

The curving blue flow lines around and primarily to the right of the well indicate the well's capture area; farmers in this capture area will pay higher pumping costs because the water table declines. The intersecting straight blue lines locate the well in the BV site. Note that the affected area is not symmetrically distributed around the tube well location; neighbors to the left of the well (downslope) are largely unaffected, but groundwater availability clearly declines for some farmers to the right of the well (upslope).

Knowing the spatial distribution and severity (e.g., how far water tables will fall on a neighbor's farm as a result of pumping) of the effects of groundwater extraction is an important first step in understanding the overall effects of such actions on agriculture and on poverty. The physical effects on this invisible water resource need to be coupled with economic and other factors to fully understand the consequences. For example, we need to know pumping costs and how these change as water tables decline, and the effects of increased pumping costs on farm income and (hence) poverty. But even before this important complementary information is available, we can begin to discuss how to include what we will soon know about this 'invisible' factor into policy dialog.

Policy Action and Invisible Factors

What are some of the possible consequences associated with introducing these 'invisible' factors into policy discussions?

First, new information may be needed to monitor changes in stocks and flows of these invisible factors. In the case of groundwater, monitoring wells may have to be drilled in key aquifers, and groundwater use by farmers and others may have to be measured.

Second, the links between poverty and these invisible factors will need to be explored and understood.

Third, some new policy instruments may be required. For example, regulations on tube well location, depth, diameter, and use may be required to manage groundwater. Scientific information will be required to help establish such regulations.

Fourth, since there is no guarantee that the spatial distribution and the effects of (say) groundwater pumping will match the boundaries of existing policy domains, a new set of policy domains, or new inter-domain collaborative arrangements, may need to be identified and negotiated to ensure proper resource management.

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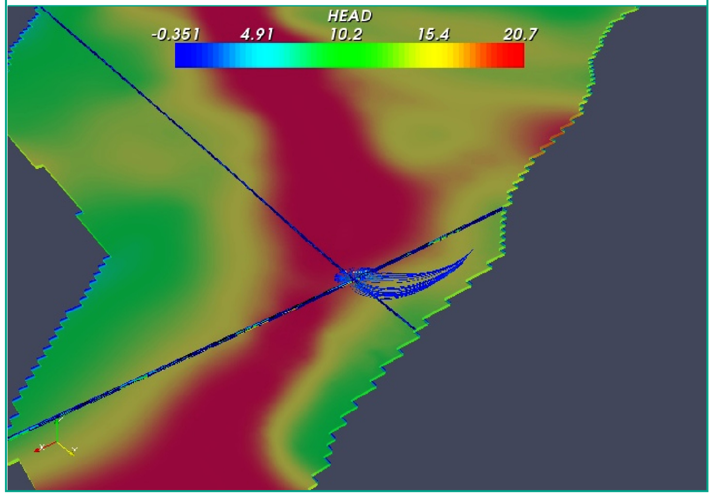
Figure 2. Simulated Effects of Groundwater Extraction on Neighboring Farms



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