Water Management across Scales in the São Francisco River Basin:

Policy Options and Poverty Consequences

UC DAVIS
UNIVERSITY OF CALIFORNIA

An interdisciplinary collaborative project of the University of California, Davis and the Empresa Brasileira de Pesquisa Agropecuária

Embrapa

Water Productivity at Basin Level: Methods, Benefits, and Shortcomings

Water productivity measures are ratios that contain some measure of output in the numerator and some measure of water availability or use in the denominator. There is a broad array of options for both the numerator and the denominator, and depending on the choices made different policy issues can be addressed. In this brief we present a water productivity measure generated for the São Francisco River Basin (SFRB) in Brazil, and then discuss its relative usefulness for addressing policies.

Figure 1 depicts the value of crop production for the SFRB in 2004 for each of the 469 municípios that comprise it. This is the numerator of our water productivity index. The most productive municípios appear in blue and are clustered around the south-west, central-west, and central-north portions of the basin. The least productive municípios are scattered throughout the basin but tend to concentrate in the southern, central-eastern, and north-eastern regions.

The next step is the calculation of a denominator. This is often more challenging than generating estimates of the numerator because less attention is generally paid to water use than to agricultural production.

The SFRB research team generated an estimate of water availability using readily available data on rainfall, slope of terrain, catchment area, and base evapotranspiration. Using this combination of factors, areas with relatively high rainfall, large upstream area, and flat terrain got relatively high scores for water availability (high rainfall in such areas stayed on the farm), while high-rainfall areas with small upstream area and steep slopes got lower scores (high rainfall in such areas ran off the farm). For the same catchment area and base evapotranspiration, low-rainfall areas had less naturally available water to begin with, and their scores were also affected by slope—the lowest scores were for municípios that received small amounts of annual rainfall and were located in hilly areas. Note that no official estimates of water use, water flows, or water stocks are required for this calculation; this is very good news, since such information currently is not available in Brazil. Figure 2 depicts water availability calculated using this method; the 'wettest' municípios appear in dark blue and the 'driest' appear in red.

We are now in a position to generate município-level estimates of water productivity for the entire SFRB. Taking the values of crop production from Figure 1 as our numerators, and the values of the water availability given by our index in Figure 2 as our denominators, we can calculate water productivity. Figure 3 presents these calculations. Municípios with the highest water-productivity measures appear in blue; those with the lowest appear in red.

Juxtaposing Figure 2 and Figure 3 highlights some of the matches and some of the 'mis-matches' between water availability and agricultural water productivity, as we have

Figure 1. Value of Crop Production, by Município, 2004

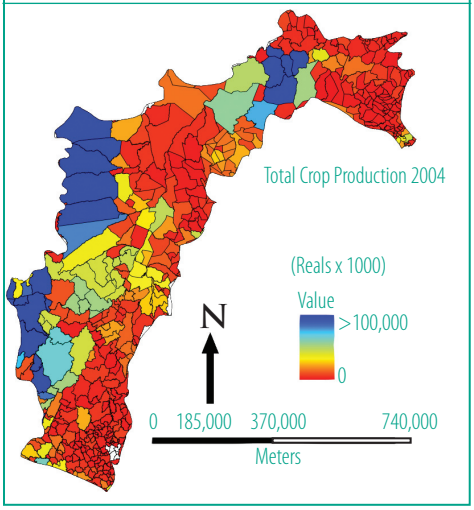
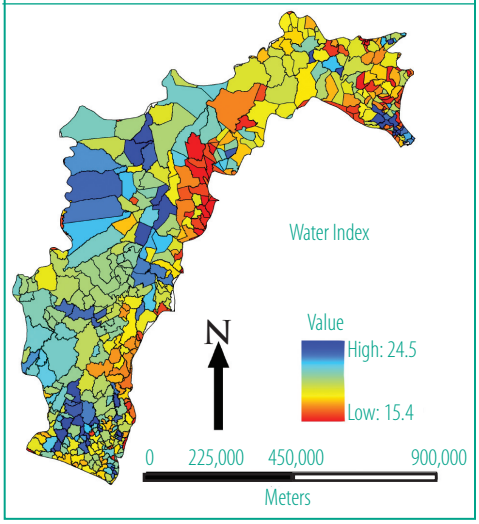


Figure 2. Index of Water Availability, by Município



calculated them. The matches include the 'wetter' central-western and south-western portions of the SFRB, and the drier northeastern region; the former tend to be more productive and the latter less so. But visual inspection also turns up many mis-matches—e.g., areas with relatively little available water but very high measures of crop production. Most of these municípios, such as those in the center-north portion of the basin, owe their successful agriculture to investments in irrigation infrastructure. Likewise, there are some very 'wet' municípios that have failed to generate much in the way of crop production.

Conclusions

What are the take-away messages that one can derive from this exercise?

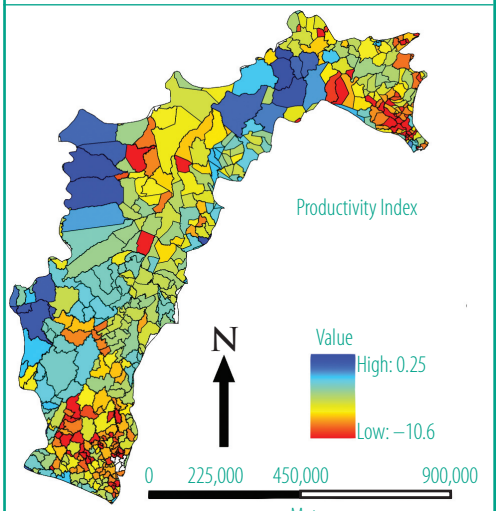
First, let's address the key issue of this session—what is the point of doing this exercise for the entire SFRB? However improbable it might seem, many of the municípios that comprise the very large SFRB are linked in two ways. First, many of these municípios are linked hydrologically—what happens in the hillsides of the southern headwaters of the river basin will eventually affect some downstream users to the north. The degree of effects will, in part, depend on the timing, severity, and extent of hydrological disturbances (e.g., the spread of irrigated agriculture), but these effects can be large and would be lost if the extent of analysis were less than the entire basin. Second, farmers in many of these municípios produce similar products and compete in the same marketplaces; increasing output in one município can affect input and product prices faced by producers in distant municípios. These economic effects are not likely to be large for most products produced in the SFRB, since the national agricultural market dwarfs that of the SFRB. However, perennial tree and vine crops may be important exceptions.

Third, while having more naturally available water might reduce production costs and hence improve the competitive advantage of some municípios over others, the mismatches identified above suggest that abundant water is neither necessary nor sufficient to guarantee high levels of agricultural production. For many municípios, massive investments in large-scale irrigation systems (e.g., center-pivot systems) have effectively tapped relatively scarce 'local' surface water and groundwater supplies for agricultural production.

Fourth, low measures of water productivity, however calculated, need not represent economic inefficiency. At farm level, regardless of the size of the farm, all that economic efficiency requires is that water be used to the point where its marginal contribution to farm profits is equal to its unit cost. If water is free, or nearly free, then farmers should and will use it until the last drop contributes almost nothing to farm profits. Under such circumstances, farmers will use much more water than any hydrologist or agronomist would consider rational.

Finally, and perhaps most importantly, for most of the urgent policy questions in the SFRB, water productivity ratios are not the proper analytical tool. Most policy questions require addressing a series of 'what if?' scenarios—e.g., what will happen to small-scale agriculturalists in water-scarce areas if the price of water increases? What will happen to down-stream water users if gross cropped area under irrigation triples in upstream areas over the next 15 years? Addressing such questions requires the capacity to predict the hydrological effects of such scenarios, and to predict the behavior of farmers and other water users in response to changes in water availability.

Figure 3. Water Productivity for the SFRB, by Município



This research brief was prepared as input into the CPFW's International Forum on Water and Food, Vientiane, Lao PDR, November 12 – 17, 2006.

Contacts

University of California, Davis
Stephen A. Vosti, PhD
email: vosti@primal.ucdavis.edu

Brazil
Marcelo Torres, PhD
email: torres@primal.ucdavis.edu

Contributors

University of California, Davis
Stephen Vosti
Wesley Wallender
Marcelo Torres
Lisa Pfeiffer
Marco Maneta
Richard Howitt
Julie Young
Julie McNamara

Embrapa
Luís Bassoi – Semi-Arid Tropics
Lineu Rodrigues – Cerrados

CGIAR Challenge Program on WATER & FOOD

This research program is part of the CGIAR Challenge Program on Water & Food and is supported by the International Water Management Institute, the Brazilian Enterprise for Agricultural Research (Embrapa), and the Department of Land, Air and Water Resources, the Department of Agricultural and Resource Economics, and the Center for Natural Resources Policy Analysis, all at the University of California, Davis. The views expressed in this research brief need not reflect those of the sponsors.