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Efficient Groundwater Pricing, Intergenerational Welfare, and Inter-District Exchange

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Efficient groundwater pricing, intergenerational welfare, and inter-district exchange

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Proposals for marginal cost water pricing have often been found to be politically infeasible, especially where the marginal cost of water groundwater is taken to include the marginal user cost of depleting the aquifer. As a result, inefficient pricing is continued and groundwater is overused by the present generation of consumers, causing early depletion of aquifers and need to use desalination or other high-cost alternative sources of water supply. The present generation is, thus, able to extract large transfers from the future by imposing the burden of premature desalination. Despite the fact that efficiency pricing is potentially Pareto-improving, it cannot be implemented; future consumers have no political weight, other than what may be conferred on them by current altruistic consumers.

We study the four districts of the central Oahu corridor as a case in point to show how efficiency pricing causes small welfare losses for present consumers compared to large gains for future consumers who benefit by deferring high-cost, desalinated water. We show how this potential Pareto improvement can be rendered actually Pareto-improving, and thus politically feasible, by compensating current users with block pricing. The initial block is priced at zero and set at a quantity sufficient to compensate the consumer for paying the full marginal cost, including user cost, for the second block. Revenue shortfalls from this scheme are then made up through deficit finance. This transfers a debt burden to the future, albeit one that is well below the gains to future consumers from deferring high-cost water.

Efficient water management also includes spatial optimization, inclusive of distribution costs. The current pricing system does not differentiate prices across elevations and results in subsidies from low to high elevation users. We categorize users into elevation groups and compute efficiency prices for each elevation category. This requires that users in each elevation category pay their own distribution costs and results in lower efficiency prices for low-elevation users and

higher prices for high-elevation users. As a result, users in the lowest-elevation category actually gain welfare in the current period, as well as in the future.

We divide the central corridor into four zones, each with its own groundwater source(s) and recharged both from the Koʻolau watershed and from adjacent watersheds. Efficient management now requires not only spatial and intertemporal efficiency within zones but between zones as well. If the optimal program includes water transfer from one zone to the next, then the efficiency price from the receiving zone must equal the efficiency price in the source zone plus the cost of transfer. Optimal extraction rates and present values are re-computed for this case, which includes endogenously determined, underground, inter-aquifer flows. We show that, as the dimensions of optimization increase, so does the present value of switching to efficient management. Estimates of waste for continuing current policies are correspondingly higher.

Groundwater in Oahu, as in many other coastal areas, is stored in a Ghyben-Herzberg freshwater lens where freshwater floats on a saltwater layer underneath. If the freshwater is extracted faster than it is recharged (from the watershed), the freshwater head level falls and the saltwater interface rises. This rising interface can ultimately reach the bottom of current well systems that will then begin to pump out saltwater. To make the water management policy more realistic and practicable, we constrain the welfare maximization problem such that the freshwater head must not fall below the level at which wells would begin to turn saline.