

Chapter 9 Lecture -Water: A Confluence of Renewable and Depletable Resources

Econ 275 – Environmental Economics

Chapter 9 Lecture - Water: A Confluence of Renewable and Depletable Resources

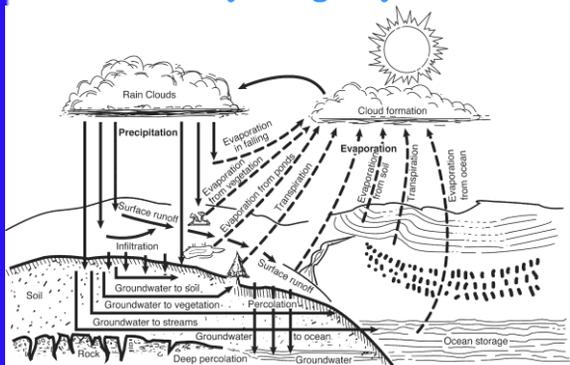


The Potential for Water Scarcity

- **Surface water** is a renewable resource consisting of rivers, lakes, and reservoirs.
- **Groundwater** is water that collects underground in aquifers. Some aquifers are non-recharging and are thus nonrenewable resources.
- In many parts of the world, excess demand for water is causing great stress, for example, fracking.
- Groundwater levels have also been declining in many areas due to intensive pumping.
- Water quality is also a growing problem. Excessive withdrawal from aquifers is a major cause of land subsidence.
- Also a question of allocation.

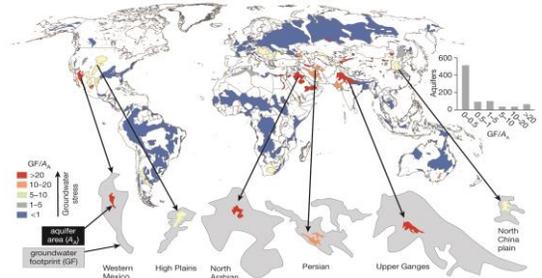
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The Hydrologic Cycle



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Degree to Which Aquifers Important for farming are Under Stress



Groundwater stress measures the ratio of groundwater withdrawal relative to its recharge rate over a given aquifer. Values above one indicate where unsustainable groundwater consumption could affect groundwater availability and groundwater-dependent ecosystems

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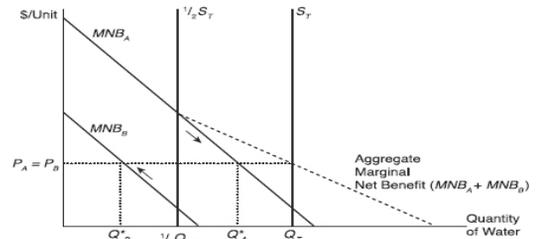
The Efficient Allocation of Scarce Water

Surface Water

- An efficient allocation of surface water must (1) strike a balance among a host of competing users and (2) supply an acceptable means of handling the year-to-year variability in water flow.
- Efficiency in the presence of competing uses implies that the marginal net benefit should be equalized across all users.
- If water were not scarce, scarcity rents would be zero.
- Water is also a highly variable resource in terms of the timing of flows. Thus, a system must be able to deal with interannual variation in flows.

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The Efficient Allocation of Scarce Water

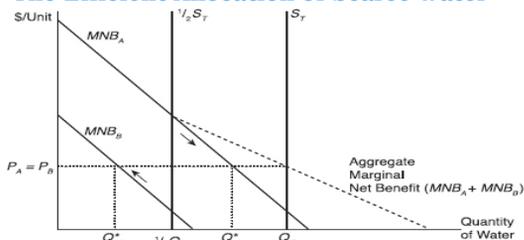


Consider a water supply represented by S_T , where the amount of water available is Q_T . Suppose there are two different users represented by marginal net benefit curve A and marginal net benefit curve B. In this figure, A has higher demand (higher willingness to pay). The total (aggregate) marginal net benefit is the horizontal sum of the two demand curves.

What is the efficient allocation of water across these two users with different marginal values for water?

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The Efficient Allocation of Scarce Water



Suppose instead, however, that the state or water authority decides, for equity or political reasons, to simply divide the available water equally between the two users, giving each an amount $Q_A = Q_B = \frac{1}{2} Q_T$. **Is this efficient?**

Suppose now the total water supply is equal to $\frac{1}{2} S_T$. **How should the lower water supply be efficiently allocated between the two users?**

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The Efficient Allocation of Scarce Water

Groundwater

- For groundwater, there is a marginal user cost reflecting the intertemporal opportunity cost.
- For groundwater sources for which withdrawals exceed recharge, the resource will be mined over time until it is depleted or until the marginal extraction cost reaches a prohibitive level.
- In some regions, groundwater and surface water are not physically separate and management must consider the linkages.

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The Current Allocation System

Riparian and Prior Appropriation Doctrines

- Riparian rights allocate the right to use water to the owner of the land adjacent to the water.
- The prior appropriation doctrine allows the transfer of water away from the stream for beneficial use (“use-it-or-lose-it”).
- Water rights are usufructuary rights which are rights to use, not rights to own.

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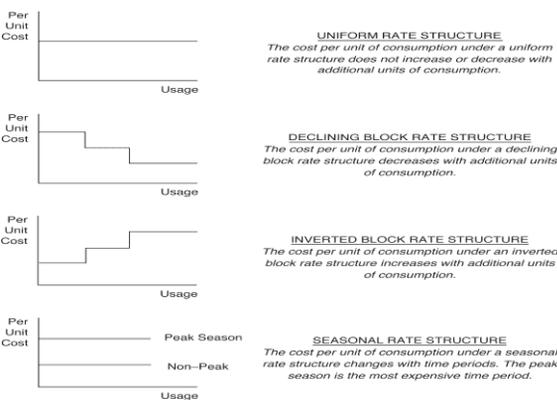
Remedies and Reforms: Water Prices

Municipal Water Pricing

- Water conservation and various charge rate structure



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Remedies and Reforms: Water Prices

Full Cost Recovery Pricing

- Inefficient prices can be adjusted by allowing water utilities to earn more than a normal rate of return by charging a full cost recovery (FCR) price for water services.

- The EU Water Framework Directive

Water Market: Sales, Leases, and Banks

- Relaxing “use-it-or-lose-it” restriction would encourage conservation and allow water to move to higher valued uses by allowing owners to sell conserved water.
- Water markets and water banks are being increasingly utilized to treat both inefficiencies and scarcity in the short term or on a long-term basis.

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Remedies and Reforms: Water Prices

- **Water Market: Sales, Leases, and Banks (contd.)**
 - **Water Markets in Australia**
 - Australia has eight mechanisms for trading water that include posted water markets, auctions, and the 'water exchange' which allows interstate trade and forward contracts.
 - **Environmental Water Transaction**
 - Attempts to protect instream water uses must confront two problems. First, the demand for instream rights will be inefficiently low. Second, their use to protect instream flows may not be considered "beneficial use."

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EXAMPLE 9.6 Moving Rivers or Desalting the Sea? Costly Remedies for Water Shortages

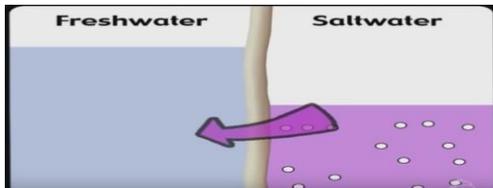
In most of northern China, freshwater is extremely scarce. China has been pursuing immense engineering projects in order to bring new water sources to this desperately dry, yet rapidly growing region. One three-phase project involves the diversion of water from the Yangzi River basin through hundreds of kilometers of canals and pipelines at extraordinary cost (\$34 billion so far). The project is only partially complete. The other is a \$4.1 billion power and desalination plant in the port city of Tianjin. The Beijing Power and Desalination Plant began operating in 2009. The capacity of the desalination plant will satisfy only a small portion of China's demand for water.

As of 2013, water from the plant cost 8 yuan per cubic meter (about \$1.30) to produce. Diverted water from the Yangzi is expected to cost about 10 yuan. Both of these are at least 60 percent higher than what households currently pay, though water rates are rising. Even if higher water prices were imposed on consumers, prices would be unlikely to cover the true cost of either source. Desalination is very energy intensive. In China, that energy comes mainly from burning dirty coal. Diverting water is not without external costs either. Diverting water deprives southern China of the water needed to combat drought. Developing scarcity in a crucial resource like water can force some tough choices!

Source: Removing salt from seawater might help slake some of northern China's thirst, but it comes at a high price. Economist, February 9, 2013.

Remedies and Reforms: Water Prices

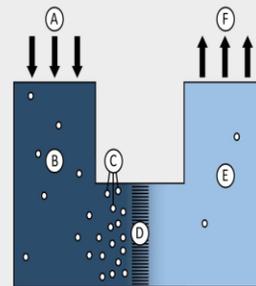
- **Desalination and Wastewater Recycling**
 - **Reverse osmosis: pumping seawater at high pressure through permeable membranes**
 - **Significantly reduced price of desalinated water due to technological advances in reverse osmosis, nanofiltration, and ultrafiltration methods**



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What is Reverse Osmosis?

Reverse osmosis is a process of water purification using an applied pressure to pump water through a semi-permeable membrane that only allows potable water through and leaves ions, molecules and suspended particles behind.



- A. Applied pressure
- B. Seawater or brackish water in
- C. Contaminants
- D. Semi-permeable membrane
- E. Potable water
- F. Potable water outflow and distribution

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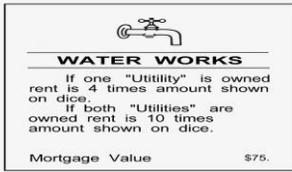
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Remedies and Reforms: Water Prices

• Privatization

- **Privatization of water supplies creates the possibility of monopoly power and excessive rates, but privatization of access rights does not.**
- **Privatization of access rights only establishes specific quantified rights to use the publicly supplied water.**



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Should Water Systems Be Privatized?

Faced with crumbling water supply systems and the financial burden from water subsidies, many urban areas in both industrialized and developing countries have privatized their water systems. Generally this is accomplished by selling the publicly owned water supply and distribution assets to a private company. The impetus behind this movement is the belief that private companies can operate more efficiently (thereby lowering costs and, hence, prices) and do a better job of improving both water quality and access by infusing these systems with new investment.

The problem with this approach is that water suppliers in many areas can act as a monopoly, using their power to raise rates beyond competitive levels, even if those rates are, in principle, subject to regulation. What happened in Cochabamba, Bolivia, illustrates just how serious a problem this can be.

After privatization in Cochabamba, water rates increased immediately, in some cases by 100–200 percent. The poor were especially hard-hit. In January 2000, a 4-day general strike in response to the water privatization brought the city to a total standstill. In February the Bolivian government declared the protests illegal and imposed a military takeover on the city. Despite over 100 injuries and one death, the protests continued until April when the government agreed to terminate the contract.

Is Cochabamba typical? It certainly isn't the only example of privatization failure. Failure (in terms of a prematurely terminated privatization contract) also occurred in Atlanta, Georgia, for example. The evidence is still out on its overall impact in other settings and whether we can begin to extract preconditions for its successful introduction, but it is very clear that privatization of water systems is no panacea and can be a disaster.

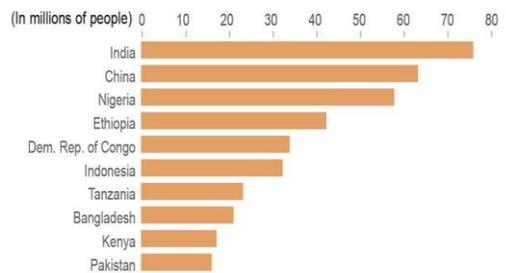
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People living without access to safe water

Top 10 countries with the greatest number of people without access to safe water.



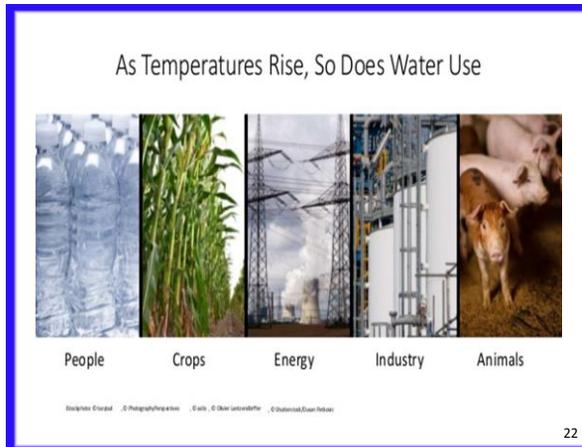
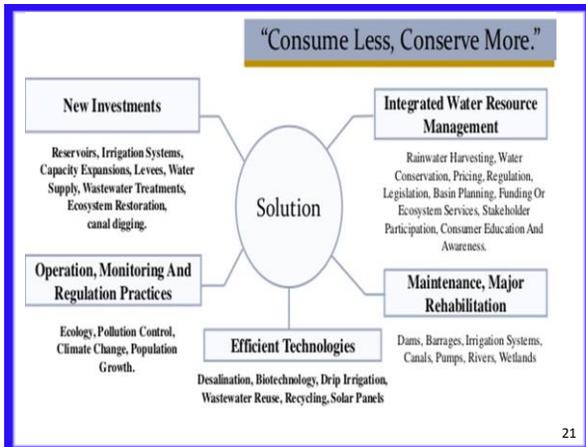
Source: WaterAid

Lorena Elebee / @latimesgraphics

<https://www.chicagotribune.com/la-fg-global-world-water-story.html>

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Climate Change Causes Bigger, Harder Downpours, and Simultaneously Causing Longer and Deeper **DROUGHTS**

- Evaporation from the ocean into the atmosphere increases even **MORE**
- As the air gets even warmer, it can hold even **MORE** water vapor
- Heavy downpours get even heavier, causing **worse flooding**
- Snowpacks melt earlier in the year, leading to more spring flooding, but less water in the heat of summer
- There are longer intervals in drought-stricken areas between downpours, making droughts even worse
- More water also evaporates **MORE QUICKLY** from the soil, making **DROUGHTS** deeper and longer still

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