

Lecture for World Food Problems: Water Resources Management: An Economist's Overview Oct. 7, 2009

I. Introduction

- A. Most of our water is salt water (97.5%)
- B. Most of our fresh water is frozen (69%)
or nonrenewable groundwater (30%)
 - Lakes, rivers and wetlands (.35%)

II. Sea Water

- A. Serious pollution problems, particularly
in coastal areas
 - Agriculture and industry
 - Shrimp farming
- B. Who enforces international agreements
prohibiting dumping of toxic materials or
use of drift nets?

- C. Open access problem for fisheries and other ocean resources such as oil and minerals
- 230-mile exclusive economic zone
 - How do you draw the line between island countries and the mainland countries?
 - Expansion of territorial water from 3 to 12 miles
 - Many countries can't enforce the rule of law on their extended territory
 - UN is now saying that major commercial fish stocks could collapse due to overfishing, pollution and global warming
 - 2.6 billion people depend on fish for major source of protein

My focus today will be on fresh water

Simple Water Facts

1. Water Requirements

- 4,000 gallons of water produces 1 kilowatt of electric power which lights 100 watt bulb for 10 hours.
- Over four gallons of water to produce one gallon of milk
Eight gallons of water to produce a tomato
- 300 million gallons of water to produce a single days supply of U.S. newsprint
- Three to four gallons to produce a gallon of ethanol.

2. Cost

- In U.S. communities, 1¢ buys 160 eight ounce glasses of water or 4¢ per barrel

- Bottle of water is \$.75/gal to \$8.00 per gal
- Cost of oil is \$65-75/barrel; bottled water is \$30 to \$300/barrel

3. Water Storage

- Australia 4,729 m³ /capita
- Ethiopia 43 m³ /capita

4. Losses Related to Water

- Drought in Zimbabwe caused 60% drop in GNP
- Flooding in Mozambique caused 30% drop in GNP
- 50% of wetlands in world are gone
- 20% of world's freshwater fisheries are endangered or extinct

5. Demands for water

- Very dependent on rainfall, temperature and income per capita.

III. Services and Dis-services Provided by Water

A. Consumptive uses

1. Domestic and industrial water supply
2. Irrigation
3. Nonirrigation agricultural uses (water for livestock, etc.)

B. Nonconsumptive Uses*

1. Hydropower – time of use may be problem
2. Fish culture
3. Recreation
4. Navigation
5. Dilution of waste materials
6. Aquatic habitat
7. Bathing and washing clothes
8. Cooling for buildings and power plants
 - Biggest use in Minnesota

*Can compete with other uses because of time of diversion and release (winter release to generate power vs. summer for irrigation).

C. Dis-service

1. Flooding
2. Disease vector
3. Soil erosion - land productivity is deposited in rivers, lakes, reservoirs, wetlands and oceans.

IV. Fresh Water

- A. Over 5-fold increase in water use since in past 70 years.
- B. 2-4% increase in water use per year in many countries (exceeds population growth)
- C. World consumptive water use*:
 - 1. 69% agriculture
 - 2. 23% industrial uses
 - 3. 8% domestic
- D. In Asia, Africa, and U.S. West agricultural consumptive use is 80 to 85% of total consumptive water use
- E. By the year 2000, 17 of 24 cities (over 10 million in population) were in less developed countries (LDC's), compared to 1 in 1960.

* For agriculture, about 50% of water delivered is not consumed and returns to the environment.

- F. About one-third of the world's food supply comes from irrigated land
1. Food production has grown over 3.0 times since the 1950s
 2. Nearly half of the increase is due to increased irrigation
 3. Cost of new irrigation is going up rapidly including environmental costs
 4. Area of new land that is suited for new irrigation is down – easily irrigated areas irrigated first
 5. Water delivery and use is still very inefficient in public projects – little incentive to do otherwise
 6. Land being lost to water logging and salinity problems and urbanization
 7. Can we allocate more water to irrigation given the demands for domestic and environmental use?

G. Domestic water supplies

1. 1.1 to 1.2 billion people lack water
 - Water scarcity if a country has less than 1,000 m³ per capita annually.
 - Water stress if less than 1,700 m³ but greater than 1,000 m³ per capita annually.
2. 1.7 to 2.5 billion people have poor sanitation
3. 3.8 to 5.0 million people die annually from water-borne diseases
 - 30% of the deaths in LDC's are from unsafe or inadequate water.
4. 1 billion become ill annually from unclean water
 - 80% of the illnesses in LDC's are from unsafe or inadequate water.
5. In Peru cholera caused over a \$billion lost in income over a decade ago
6. Collecting water takes 15% of women's time in many LDC's
7. High cost of new sources of domestic water supply – 2 to 3 times more expensive (figure)

8. UN declared that 2005-2015 is decade to provide "water for life." By 2015 people will have safe drinking water and basic sanitation (this was also tried in the 1980s, but with limited success).
9. Unaccounted for water due to leaks and stealing:
 - a. 58% in Manila
 - b. 40% in Latin American cities
 - c. 40% distribution losses in Algeria
 - d. 50% Cairo, Lagos, Mexico City, Jakarta and Lima
 - e. A reduction of leakage in Jakarta by 30 to 50% would save enough water for 800,000 people for one year (45 million m³)
10. People's willingness to pay for clean water is quite high even in low income areas. Many times they pay private vendors 3 or 4 times the public rate for water and as much as half their income.

- *11. Water “needs” estimate based on food and water “needs” of the growing world population
- a. Sub-Saharan Africa – 3 times more water
 - b. Asia – 2.2 times more water
 - c. Europe – 1.3 times more water
 - d. However, need is not quantity demanded and the demand for water is not completely inelastic. Thus, one needs to be somewhat skeptical of such estimates.

*12. Water for Grain

- a. Sub-Saharan Africa 5,000 m³/ton for wheat
- b. Western Europe, 600 m³/ton for wheat
- c. Rice in Asia 5,500 m³/ton is 2 to 3 times the amount used for wheat or corn in Asia.
- d. Why is the scarcity value of water not reflected in the grain prices?

*13. Minimum stream flows to preserve habitat?

- a. 30% of stream flow in dry season
- b. 50% of stream flow in wet season

14. Is salt water our backstop resource? Have had limited success with salt water irrigation but usually involves mixing with fresh water.

- Desalination is still expensive in terms of dollars and energy required per m^3 .
- However, people keep claiming they have a low cost method.

* From M. Falkenmark's lecture.

V. Central Water Management Problems

- A. Fragmented water resource planning and management – ignore basin-wide impacts and the interconnected nature of water sources, e.g. ground water, wetlands, rivers and lakes.
- B. Excessive reliance on government to provide water services
- C. Failure to decentralize the delivery of water services
- D. Inadequate coordination of international and interstate water resource use and development
- E. Underpricing of water and the lack of cost recovery from users
- F. Inadequate delivery of water and sewage services to the poor
- G. Neglect of water quality, health, and environmental aspects of water resources

VI. World Bank's Lending for Water

- 1947 - 91 \$40 billion
- 1993 - 98 \$18 billion
- Estimated need is between \$600 and \$700 billion
- World Bank has helped, by supplying \$30 billion, to help fund about half of the world's total irrigation infrastructure (\$100-150 billion)
- The big future World Bank investments will likely be in domestic water supply and sanitation
- Will this change in investment hurt irrigation development, particularly in Africa?
- Africa hasn't had the investment in irrigation that has occurred elsewhere.

- VII. What Should Be Done Besides Provide Financial Support?
- A. Change incentives so that management feels it is responsible to serve the users.
 - B. Promote water user groups as part of decentralizing water management
 - C. More emphasis on demand management rather than on increasing supplies
 - D. Where public management is not working, try privatizing water management. Government becomes regulator of service providers and prevents monopoly pricing
 - Unbundle system so public can own system but private sector can management parts of system

- Decide what part of system to privately manage from construction and maintenance to bill collection
- May require providing public access for domestic water needs.
- Irrigation privatization primarily means water users taking on a bigger management role
- Private management may involve establishing a financially autonomous public entity that manages the water.

- E. Encourage water markets where socially feasible (irrigation)
- Water rights and fair method for allocating them
 - Conflict resolution mechanism
 - Mechanism to transfer traded water
 - Management to transfer traded water
- F. Water metering and higher prices (particularly in domestic and industrial uses)
- For domestic water use, average cost pricing is common
 - Volumetric pricing based on volume used
 - Block pricing (increasing or decreasing rate)
 - Charge per acre irrigated (most common for irrigation)
 - Two part pricing (fixed connection charge plus volumetric charge)

- G. Take a basin approach to planning including watershed protection
- H. Basic institutional reform and policy changes may need to precede decentralization, privatization, and water markets
 - Trade policy
 - Agriculture policy
 - Set up legal system
- I. Invest in infrastructure to improve water control and develop low cost irrigation technology
- J. May want to provide subsidies for infrastructure that conserves water in canals, farmers' fields and in households and businesses
- K. Research to reduce crop water requirements and to develop other means to conserve water

Appendix A

The rain is plenteous by God's decree,
Only a third is meant for you and me;
Two thirds are taken by the growing things
Or vanish Heavenward on vapour's wings:
Nor does it mathematically fall
with social equality on one and all.
The population's habit is to grow
In every region where the water's low:
Nature is blamed for failings that are man's,
And well-run rivers have to change their plans.

(Poem "Water" by Sir Alan Herbert)

Appendix B

Summary of market problems that require public and community action.

- A. Externalities – return flows and pumping impacts on other users
- B. Public goods aspects – storage capacity and distribution system
- C. Decreasing costs – monopoly power potential
- D. Lack of information in large systems (principal-agent problem)
 - Managers don't know when and how much water farmers need
 - Managers don't know how much water farmers use or crops they grow
 - Many times farmers don't know when and how much water they will receive
- E. Open access – over pumping of groundwater (marginal user cost and buffer stock value are ignored without property rights) and the stealing of surface water from canals in large systems