

# The Sustainability of Water

April 22, 2011

# Millennium Development Goals

## Millennium Development Goals

- MDG
- MDGWater

## Questions

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## Questions

1. Eradicate extreme poverty and hunger

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1. Eradicate extreme poverty and hunger
2. Achieve universal primary education

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8. Develop a global partnership for development

# Water and the Millennium Development Goals

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How many of these goals are intimately related to water?

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# Some Water Questions

Millennium  
Development Goals

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Millennium  
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1. Can we provide clean drinking water to 9 billion people in 2050?

Questions

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## Some Water Questions

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2. Will we be able to produce enough food to feed 9 billion people in 2050?

## Some Water Questions

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Currently 80% of all global water use is in agriculture.

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3. Can we meet all the water needs of agriculture, energy, and industry in 2050?



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  - a) Dead Sea
  - b) Aral Sea
  - c) Yellow River
  - d) Ganges River
  - e) Colorado River
  - f) Ogallala Aquifer

## Some Water Questions

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  - e) Colorado River
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27 percent of the irrigated land in the United States overlies this aquifer system.

6. How many people will die between now and 2050 due to

Questions

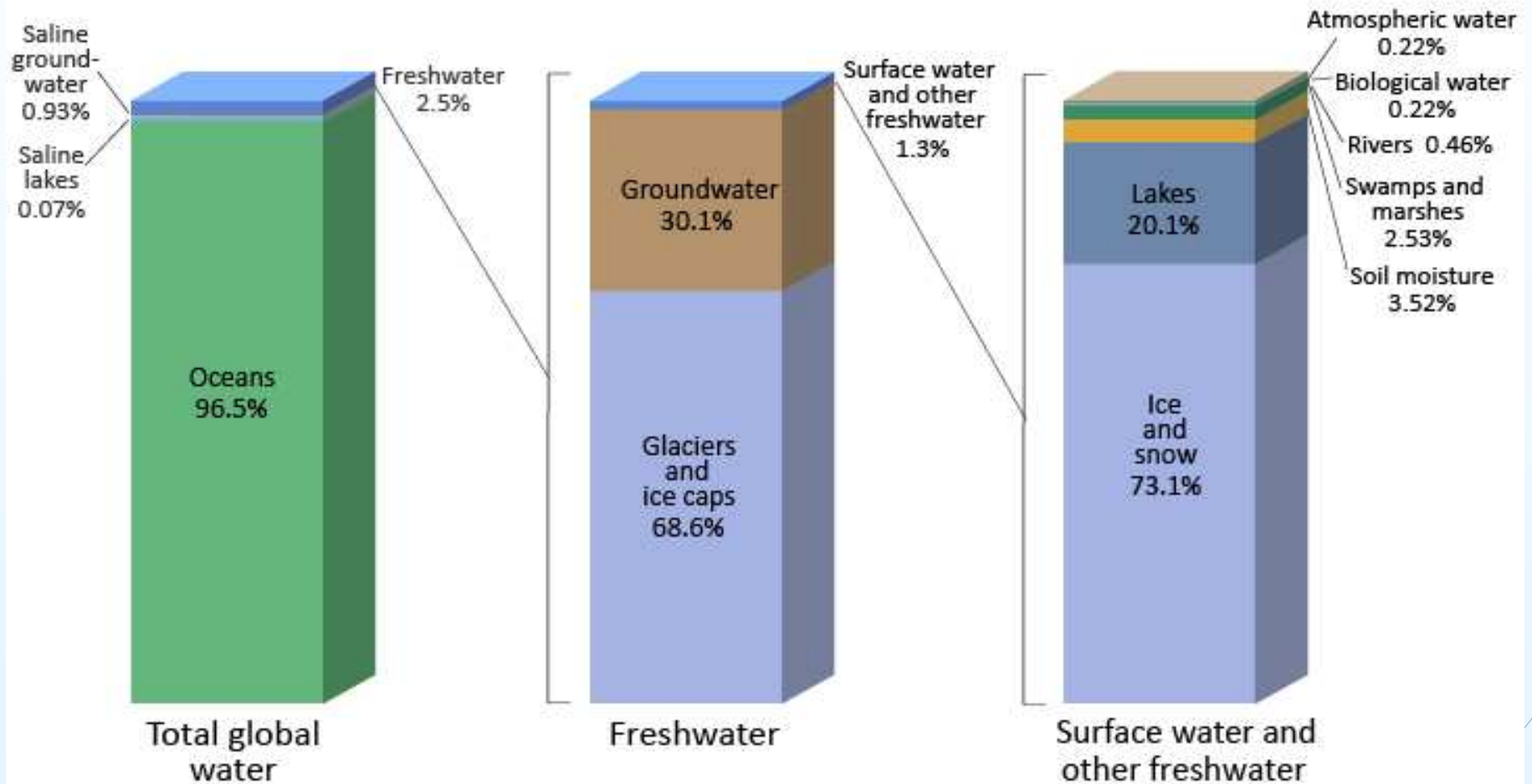
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5. How many more rivers and aquifers will dry up by 2050?
6. How many people will die between now and 2050 due to waterborne diseases?
7. How many more wars will be fought between now and 2050 over water?

## Distribution of Earth's Water



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, *Water in Crisis: A Guide to the World's Fresh Water Resources*.

# 21st Century Water Challenges

Millennium  
Development Goals

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## Questions

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Millennium  
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Questions

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## 1. Climate Change/Global Warming



# 21st Century Water Challenges

Millennium  
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## 1. Climate Change/Global Warming

### a) Rising sea levels

# 21st Century Water Challenges

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## 1. Climate Change/Global Warming

- a) Rising sea levels
- b) Change in evapotranspiration?

# 21st Century Water Challenges

Millennium  
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1. Climate Change/Global Warming
2. Water supplies

# 21st Century Water Challenges

Millennium  
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1. Climate Change/Global Warming
2. Water supplies
3. Water quality

# 21st Century Water Challenges

Millennium  
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1. Climate Change/Global Warming
2. Water supplies
3. Water quality
4. Water conflicts/trans-boundary issues

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1. Climate Change/Global Warming

2. Water supplies

3. Water quality

4. Water conflicts/trans-boundary issues

In 2002, there were 263 trans-boundary basins compared to 214 in 1978.

- Africa: 59
- Asia: 58
- Europe: 73
- Latin America and the Caribbean: 61
- North America: 17
- Oceania: 1

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5. Ecosystems

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2. Water supplies
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4. Water conflicts/trans-boundary issues
5. Ecosystems
6. Waste



# Hydrologic and Physical Attributes of Water

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# Hydrologic and Physical Attributes of Water

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- Water is mobile

# Hydrologic and Physical Attributes of Water

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- Water is mobile



Water has a high exclusion cost

# Hydrologic and Physical Attributes of Water

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- Water is mobile
- Water supplies tend to be highly variable

# Hydrologic and Physical Attributes of Water

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- Water is mobile
- Water supplies tend to be highly variable
- Water is a nearly universal solvent

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- Interdependency among users is pervasive

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## Hydrologic and Physical Attributes of Water

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- Supply facilities exhibit economies of size



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- Water is a nearly universal solvent
- Interdependency among users is pervasive
- Water problems are often site specific
- Supply facilities exhibit economies of size
- Groundwater supplies have distinctive attributes

# Water Demand

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- Commodity Benefits

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- Commodity Benefits

- 
- a) Drinking
  - b) Cooking
  - c) Sanitation
  - d) Agriculture
  - e) Industry

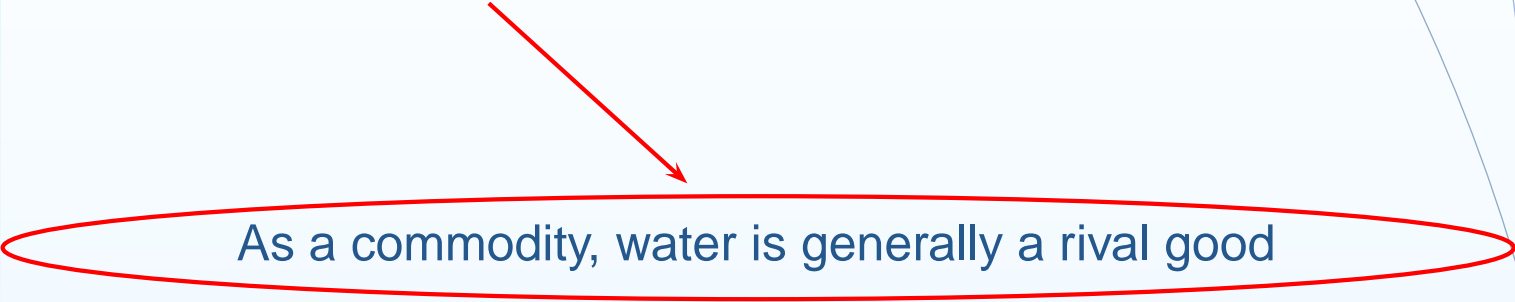
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- Commodity Benefits



As a commodity, water is generally a rival good

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- Commodity Benefits



a) Offstream use

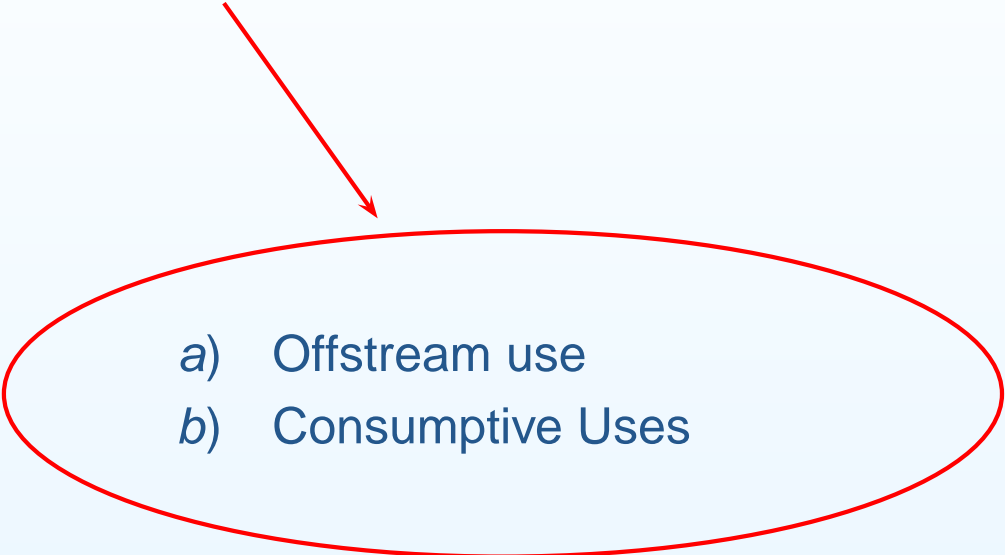
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- Commodity Benefits

- 
- a)* Offstream use
  - b)* Consumptive Uses

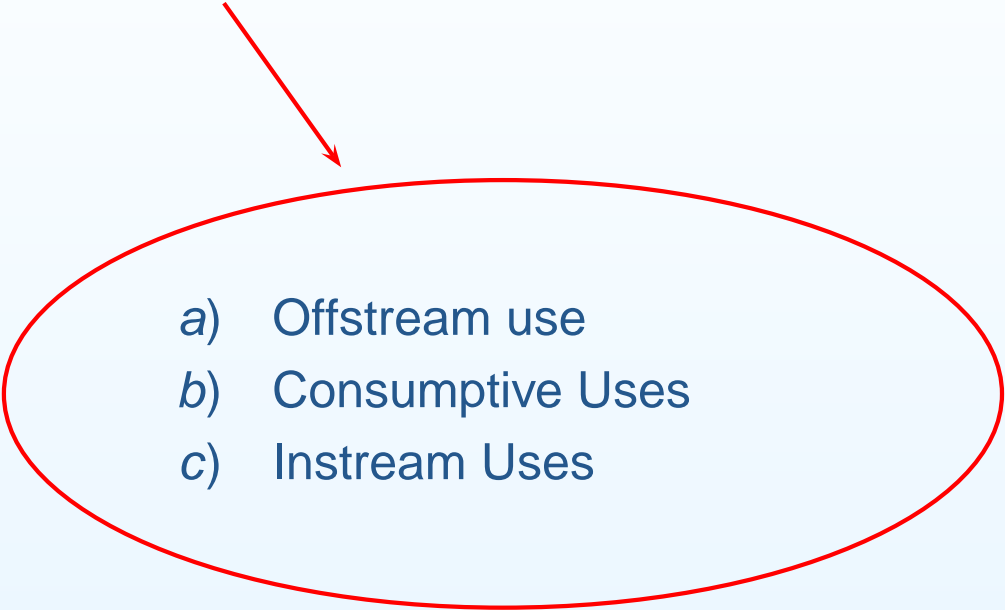
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- a) Offstream use
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  - c) Instream Uses



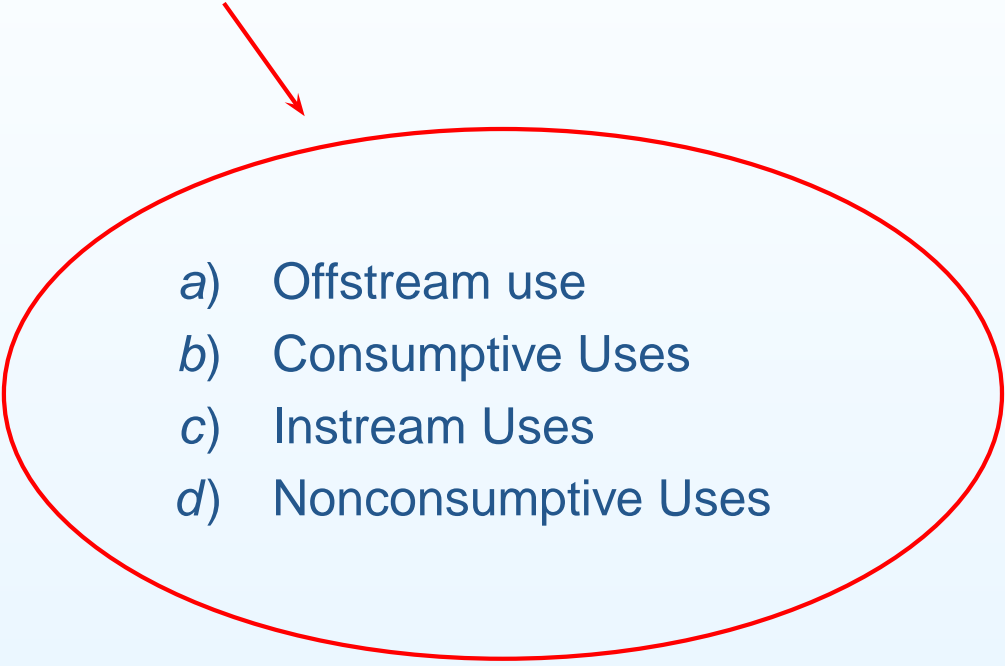
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- a) Offstream use
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  - c) Instream Uses
  - d) Nonconsumptive Uses

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## Water Demand

- Commodity Benefits
- Waste assimilation

Questions

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## Water Demand

- Commodity Benefits
- Waste assimilation
- Aesthetic, recreational, fish and wildlife habitat

Questions

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Public Good or Private Good?

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## Water Demand

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- Biodiversity and ecosystem preservation

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- Biodiversity and ecosystem preservation
- Social and cultural values

# Social Attitudes Towards Water

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## Social Attitudes Towards Water

- “...it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price.”



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## Social Attitudes Towards Water

- “...it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price.”
- For many, water has special cultural, religious and social values.
- ”the sacredness of water as a symbol of ritual purity exempts it somewhat from the dirty rationality of the market.”

# Legal and Political Considerations

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# Legal and Political Considerations

## Transactions Costs

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## Legal and Political Considerations

### Transactions Costs

- Resources required to establish, operate and enforce a resource allocation, management or regulatory system

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## Legal and Political Considerations

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- ICE—Information, Contracting, Enforcing

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## Legal and Political Considerations

### Transactions Costs

- Resources required to establish, operate and enforce a resource allocation, management or regulatory system
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Transactions costs for water tend to be high relative to its value.

# The Tyranny of Small Decisions

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# The Tyranny of Small Decisions

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- Actions of each agent are very small and have almost no impact of aggregate solution.

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## The Tyranny of Small Decisions

- Actions of each agent are very small and have almost no impact of aggregate solution.
- Cumulative effect of all these small decisions can be very large.

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## The Tyranny of Small Decisions

- Actions of each agent are very small and have almost no impact of aggregate solution.
- Cumulative effect of all these small decisions can be very large.
- Individual decisions are difficult to monitor and/or regulate.

Questions

- Questions
- Dist
- Challenges
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- Demand
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  - Fishing

# Water is a Common Pool Resource

## Millennium Development Goals

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# Water is a Common Pool Resource

Millennium  
Development Goals

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- Characteristics of common pool resources

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## Water is a Common Pool Resource

- Characteristics of common pool resources
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- Characteristics of common pool resources
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- Characteristics of common pool resources
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Or exclusion costs are very high

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## Water is a Common Pool Resource

- Characteristics of common pool resources
  - Rival
  - Non-excludable
  - When no one owns a resource, users have no incentive to conserve for the future, or to consider the foregone benefits to others

# Economic Value

Millennium  
Development Goals

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## Economic Value

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- “X” does not have to be a market good;

# Multiple Levels of Water System Management in Agriculture

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## Farm-Level Water Management

### Choices:

- Land Allocation How many acres to each crop?
- Irrigation Should crops be irrigated or not?
- What type of irrigation system (traditional or modern) should be used?



## Regional Conveyance

### Choices:

- How should water be allocated between sectors?
- How much to invest in conveyance structure maintenance?
- How should water be priced to different users?

# Multiple Levels of Water System Management in Agriculture

## Regional Conveyance

### Choices:

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## System Design

### Choices:

- What should be the ratio of groundwater to surface water used (in a conjunctive use system)?
- How much should be invested in a water project?
- What should be the capacity of a new water project?