Water Economics and Financing

Water Markets in Integrated Water Management

Water Markets and Environmental Flows: Theory and Practice

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Zaragoza, 29 July 2008

Aquasvivas Water Basin

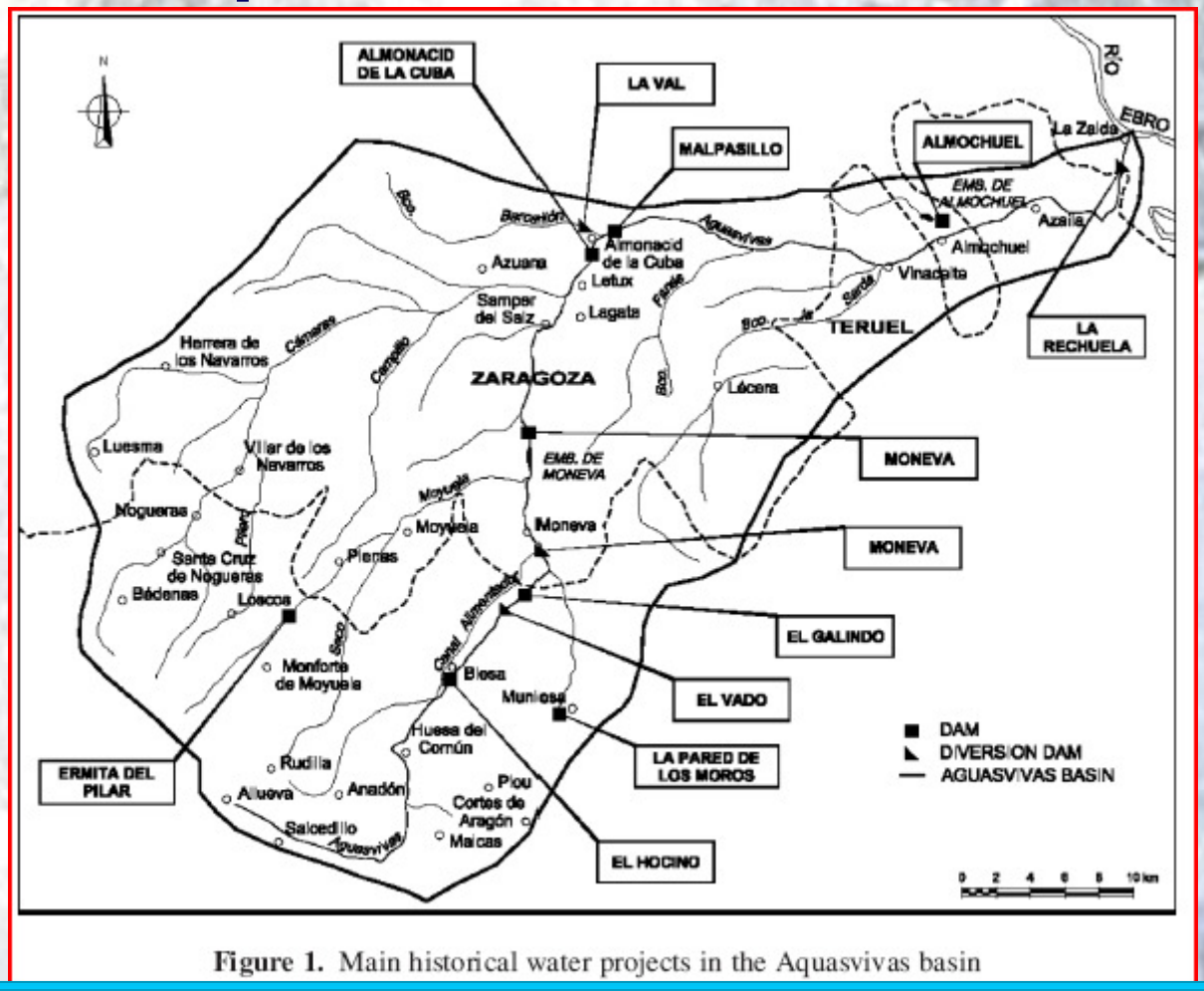

Figure 1. Main historical water projects in the Aquasvivas basin

Source: Arenillas, M. (2007)

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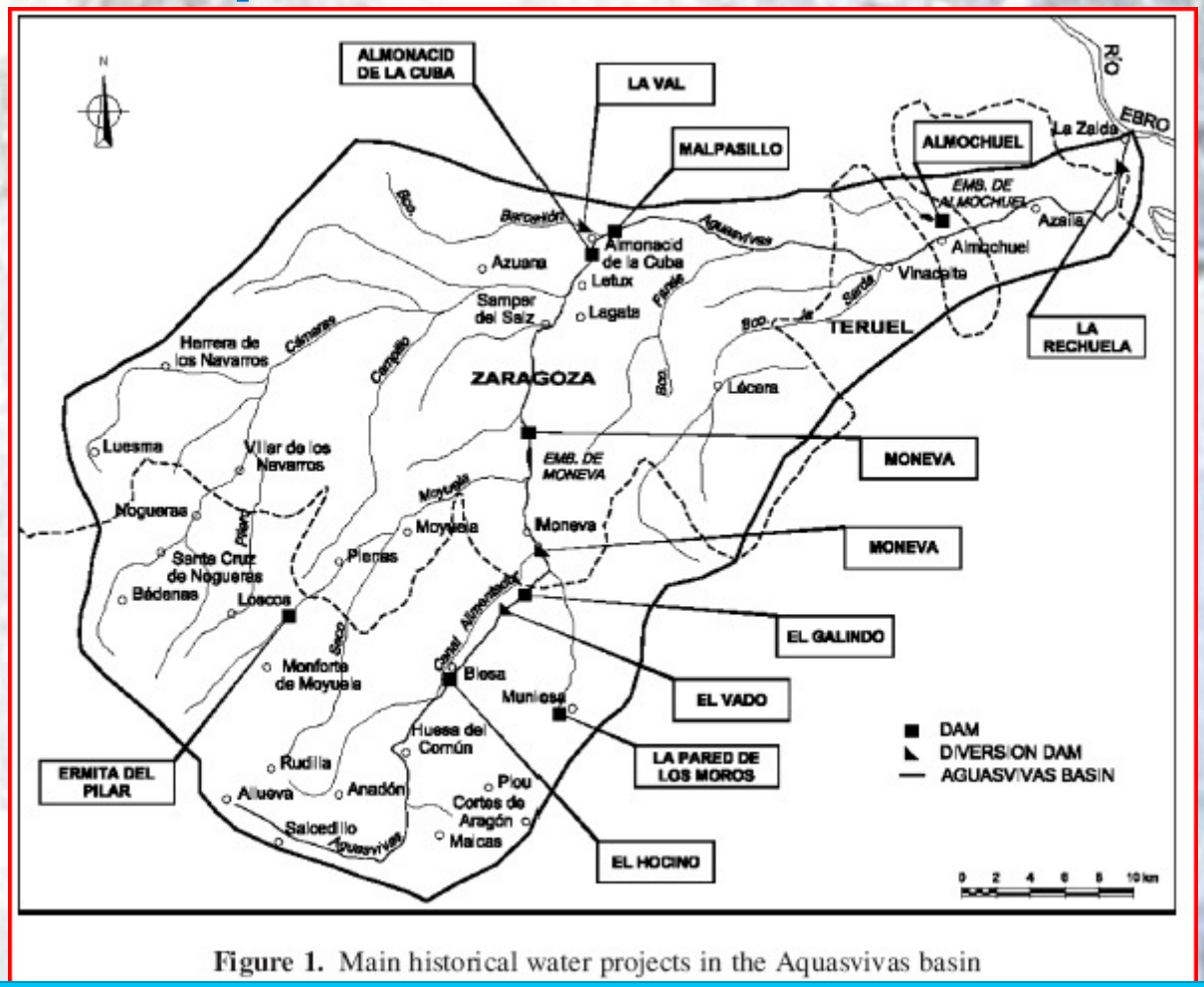
Aquasvivas Water Basin



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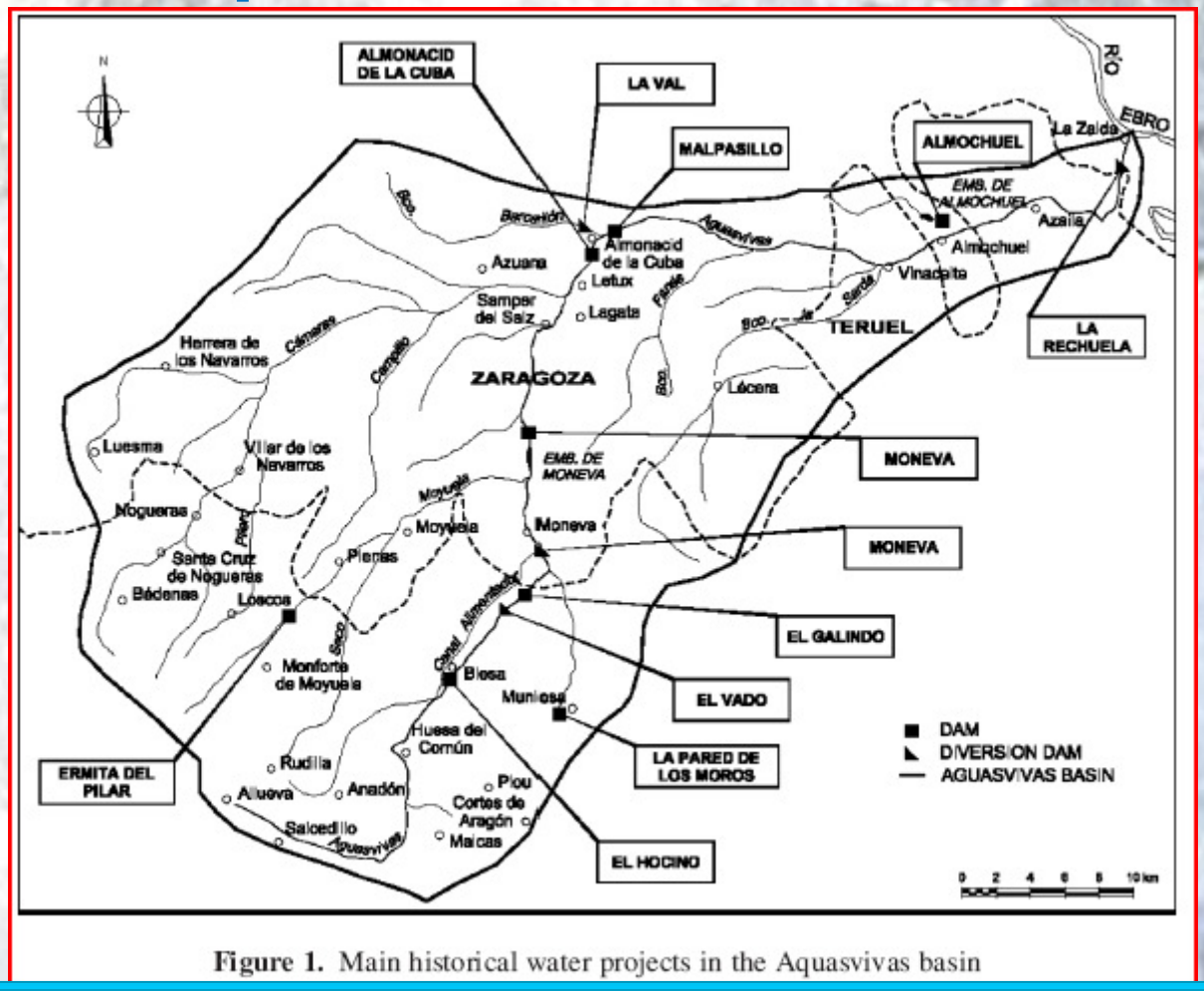

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Presentation Outline

- Brief review of environmental water allocation policies
- Economic models for environmental water allocation & theory of market provision
- Water markets as a tool for environmental water allocation in practice: achievements and obstacles.
- Conclusions

Environmental water allocation policies

- Water left instream often seen as wasted water
- Wetlands seen as unproductive (or counterproductive) use of land
- Instream water often not recognized as beneficial use
- Offstream use often a condition for establishing water rights. (Likewise: development for land rights)
- When instream uses have been recognized, they have often been accorded junior water rights, meaning they are the first to be cut in drought situations.

Past policies have left a legacy of environmental and ecological damage

Fig. 6: **FRESHWATER LIVING PLANET INDEX,** 1970–2003

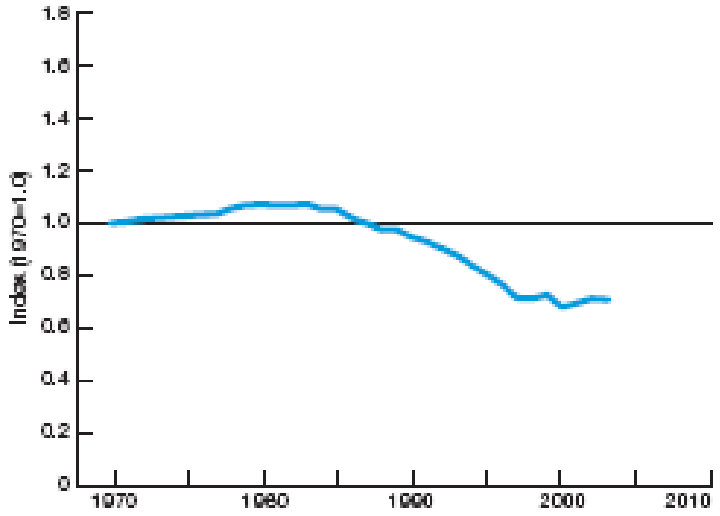
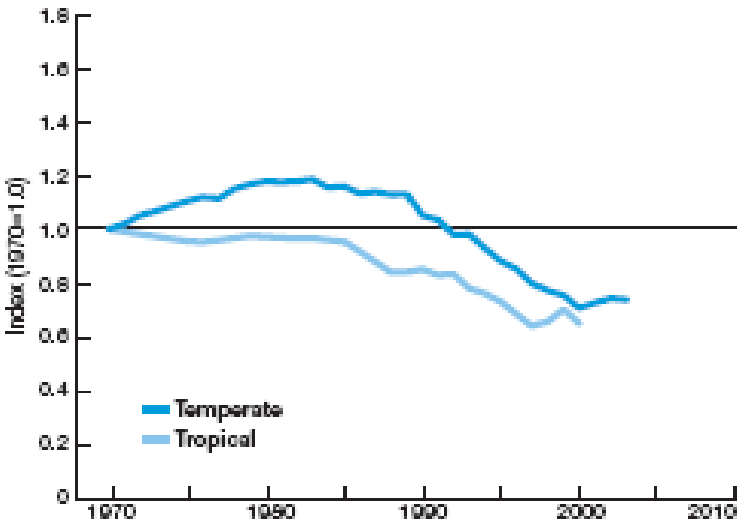


Fig. 8: **TEMPERATE AND TROPICAL FRESHWATER INDICES,** 1970–2003



Source: WWF (2008)

Environmental water allocation policies

Over the last 30 years, there has been a change in perception, with increasing awareness of benefits of environmental and other instream uses of water

in large part due to recognition of economic benefits of environmental services

Original focus of legislation was on water quality, but now quantity is increasingly seen as salient.

Flow has been seen as a master variable for determining aquatic ecological quality (Poff et al, 1997)

Environmental water allocation policies

Instream Flows

- Biodiversity
- Other ecological needs
- Maintenance of environmental services
- Dilution of pollution
- Recreation
- Navigation
- Hydro-power

Environmental water allocation policies

Instream Flows

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} **Environmental Flows**

Numerous Local, National, and International Policy Frameworks for Preserving Environmental Flows

National:

- South African Water Reserves
- Australian Caps
- Swiss minimum flows
- US: ESA & FERC

International:

- UN Convention on non-navigable water uses
- Agenda 21
- EC Framework Directive
- World Commission on Dams
- RAMSAR, CBD
- World Bank lending criteria

Economic models for environmental water allocation

3 common approaches in economic models concerning environmental water allocation

- Environmental Externalities
- Minimum Flows
- Competitive Markets

Economic models for environmental water allocation

Model 1: *Environmental Externalities*

- Water is allocated to non-environmental sectors only.
- Environment receives whatever water is leftover, if any.
- Damage to the environment affects overall utility, but is not included in the objective function.

Eq. (1) $\mathbf{Max\ U(w_1, w_2, \ldots, w_i)\ \ s.t.\ \Sigma\, w_i \leq W_T\ ;}$

$\boldsymbol{but\ actual\ U(w_1, w_2, \ldots, w_i, w_e)}$

U = utility

w = quantity of water allocated to sector i

i = water consuming sectors other than environment

W_T = total amount of water available for all purposes

w_e = quantity of water allocated to the environment

Economic models for environmental water allocation

Model 1: *Environmental Externalities*

Was dominant model in past. Still somewhat common because of difficulties valuating environmental benefits.

Typical Results:
Underallocation of water for environmental purposes leading to environmental degradation.

Resources then expended to mitigate or compensate for damages (or not).

Economic models for environmental water allocation

Model 2: *Minimum Flows*

• Maximizing utility from allocation of water to non-environmental sectors, subject to an overall water constraint and an environmental constraint.

Eq. (2) $\mathbf{Max\ U(w_1, w_2, \ldots, w_i)}$

$$\mathbf{s.t.\ \Sigma\ w_i + w_e \leq W_T \ \ and\ s.t.\ w_e \geq E}$$

E = some minimum environmental flow requirement

Economic models for environmental water allocation

Model 2: *Minimum Flows*

Very common model for compliance with environmental water regulations

Typical Results:
Minimum flow allocation only

Minimum flows are rarely efficient, either economically or ecologically.

Economic models for environmental water allocation

Model 2: *Minimum Flows*

Studies in Idaho demonstrated that optimum flows that balance benefits and costs can be ten times greater than minimum flows.

Loomis 1998

Economic models for environmental water allocation

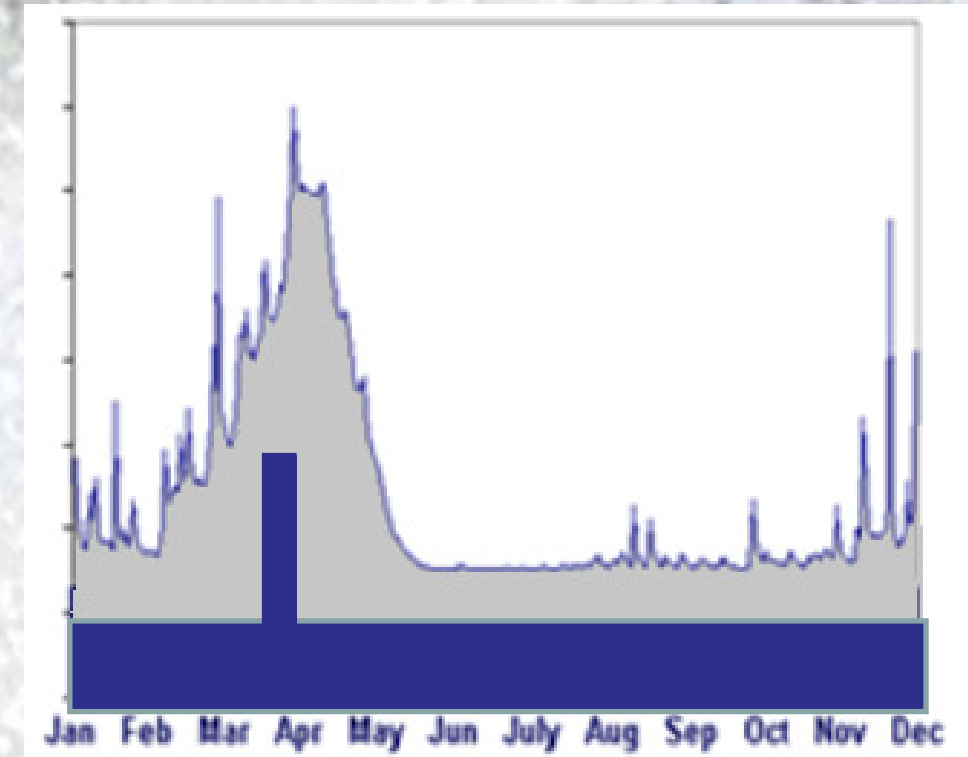
Model 2: *Minimum Flows*

Minimum flows are often requested for policy-making.

Scientific methods for determining minimum flows vary widely.

e.g., Tennant Method, Wetted Perimeter, IFIM, IHA.

Model 2: *Minimum Flows*

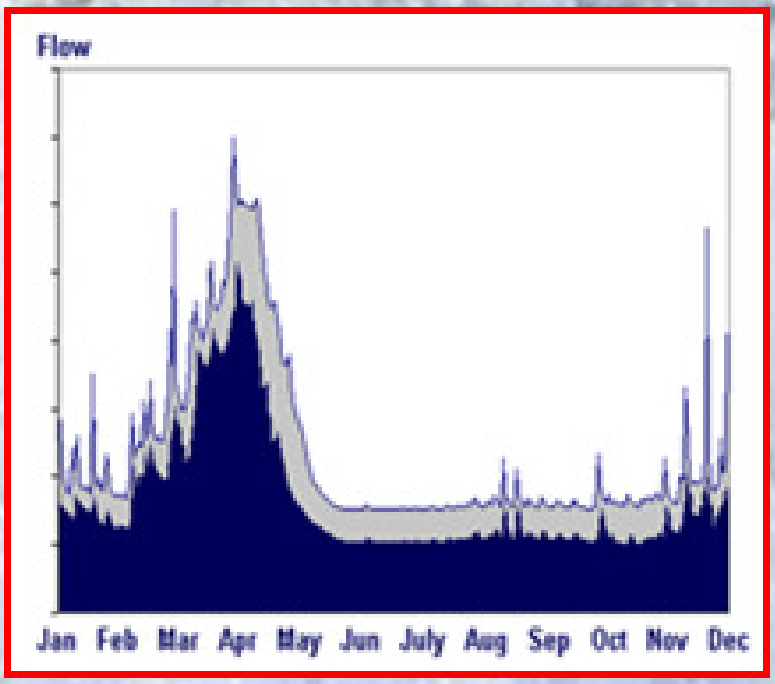


Ecosystems demand more than just quantities for base flow

Components of Flow:

- *Magnitude*
- *Timing*
- *Frequency*
- *Duration*
- *Rate of change*

Richter et al: 1996



Percentage of Flow Reserves

Model 3. *Competitive Market*

Maximizing utility from allocation of water to all sectors including the environment.

Eq. (3) $\text{Max } U(w_1, w_2, \ldots, w_i, w_e)$

$$\text{s.t. } \Sigma w_i + w_e \leq W_T$$

Model 3. *Competitive Market*

Advantages of Market Reallocation

- *Less political opposition than centralized redistribution*
- *Reduced need for information requirements by central administrator*
- *Market indicates true shadow price of water*
- *Allows for temporary reallocations to accommodate droughts or other short term needs*
- *Allows for adaptation to climate change*

Model 3. *Competitive Market*

Obstacles to Efficient Market Reallocation

- Third-Party Effect: Environmental and Instream Flows
- Third-Party Effect: Other Rights Holders
- Socioeconomic Area-of-Origin Effects
- Third-Party Effect: Groundwater-Surfacewater Interaction
- Legal Costs
- Explicit Barriers to Trade
- Infrastructure Costs and Constraints
-Political and Social Barriers

Source: Chong and Sundig 2006

Obstacles to Efficient Market Reallocation

Regulatory Frameworks

- *Trade is not allowed – at all or across sectors*
- *Environment is not a recognized beneficial use*
- *Only government is allowed to hold instream water rights*
- *Temporary transfer might jeopardize permanent rights*

Obstacles to Efficient Market Reallocation

Information

- *Lack of knowledge of true values of water for nature*
  - *relatively few studies done*
  - *science unsure, especially regarding restoration flows*
- *Lack of centralized brokers adds to transaction costs*
- *Lack of knowledge about environmental as an option*

Obstacles to Efficient Market Reallocation

Property Rights / Pubic Goods

- *Underprovision of Public Goods*
  - *Who speaks for the water?*
- *Economic vs. Financial value*
  - *lack of financial returns for many aspects of environmental flows impedes effective market competition. Especially impedes allocation of environmental flows in developing countries, where water development financed by outside loans.*

Obstacles to Efficient Market Reallocation

Third Party & Downstream Impacts

- *A priori direction of impacts are ambiguous*
- *Downstream benefits often mean net improvements of efficiency even exclusive of environmental concerns.*
- *Because environmental flows are non-consumptive, water may be reused downstream, benefiting both environment and other downstream users.*
- *Environment can also gain from transfers to downstream users, but depends on timing and method of transfer.*

Obstacles to Efficient Market Reallocation

Third Party & Downstream Impacts: Responses

- *Limiting the scale of water transfers (e.g. in basin only)*
- *Limiting transfers to consumptive use only*
- *Limiting water transfers to "no harm" transactions*

Limits of Limitations:

- *Reduces the scale of possible efficiency improvements*
- *Difficult to measure consumptive use & not how most property rights are defined*

Water Markets & Environmental Flows in Practice

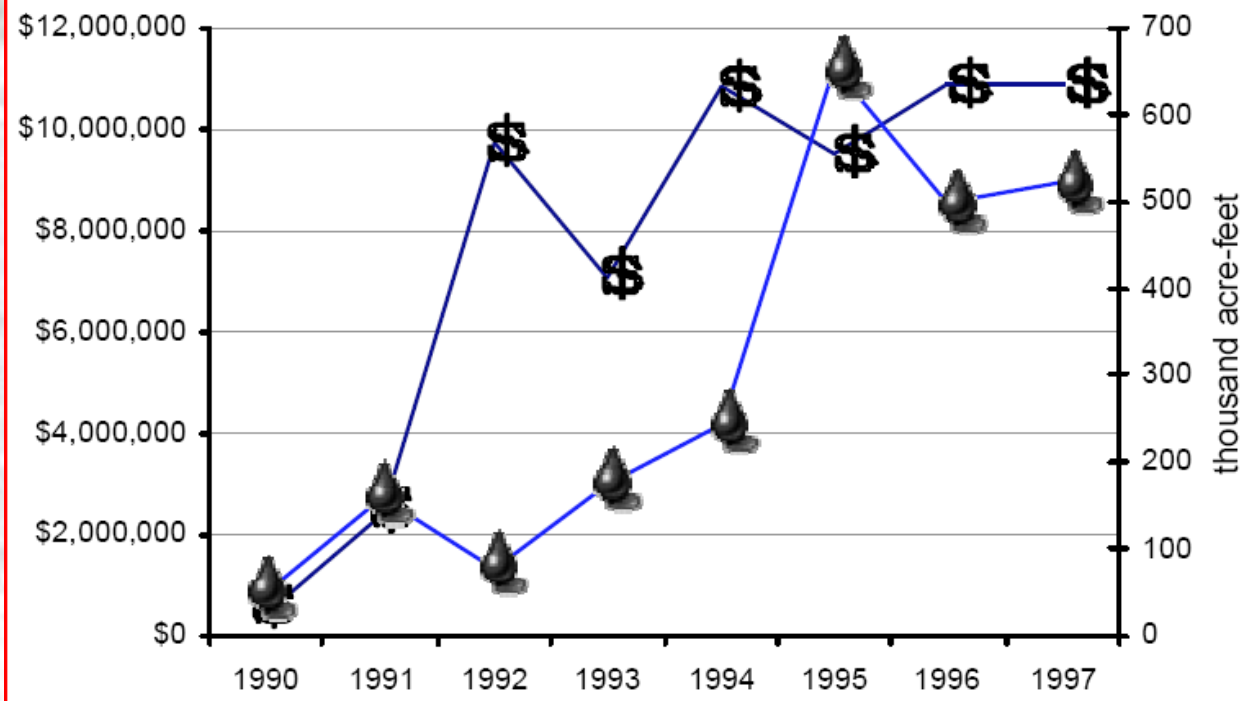
Limited Experience:

USA, Australia, South Africa, & Chile

Relatively little information about experiences with markets for environmental flows in South Africa and Chile.

Water Markets for Environment are increasing

FIGURE 1: ANNUAL INSTREAM FLOW ACQUISITIONS, 1990–1997



Source: Landry (1998).

Water Markets for Environment are increasing

Brewer et al (2008):
1987-2005 over 7 million acre-feet in annual flow acquired for environmental purposes in U.S.

Environmental purchases accounted for 9% of overall United States water market transactions, but for 23% of the volume of the annual flow.

Australia just allocated $3 billion out of a $12.9 billion water budget to buy water from irrigators for environmental purposes over the next 10 years.

Water Markets for Environment are increasing

Who's Selling:

80% of US water sales for water for environment from agriculture. But also urban-env & env-env.

Sellers are not necessarily those who have lowest crop values. Other factors:

- Off-farm income
- On farm heir
- Other farmers in region
- Health

Sources: Simon 1998 & Bjornlund 2004

Water Markets for Environment are increasing

Who's Buying:

Overwhelmingly government buyers. Often because of regulatory requirements.

Private Water Trusts make a small but significant contribution. Especially at the small scale for specific streams or wetlands.

Water Markets for Environment are increasing

Oregon Water Trust:

- *Over 40 purchases between 1983-2007.*
- *Over 50% of its budget from government sources*
- *Can get donations that government might not*
- *Can affect water quantity and quality even in the absence of formal markets*
- *Not clear what environmental goals Water Trusts represent, whether broad environmental ones or species specific ones (e.g. Oregon Trout)*

What's Being Bought?

- In U.S. market, predominantly leases, which offer less long term security than sales
- Sales
- Dry year options, which have the potential of providing a cushion during drought, but are not that common.

Because water for environmental purposes is most needed in dry years when lease prices are high, options could provide a method for reducing costs and uncertainty.

What's Being Bought? Water vs. Water Rights

- Real Water or Not?
- In Australia (& Chile?) many purchases are for sleeper rights, or rights that were unused anyway. If so, this may actually increase water use away from the environment.
- In U.S. often junior rights are sold, which are cheaper but less useful in drought years when water is most needed
- Water "saved" through efficiency gains
- There are questions of monitoring and enforcement to ensure that water left instream actually stays instream

The Price of Environmental Acquisitions

Brown (2006) found that prices paid for water for environmental purposes in the U.S. tended to be lower than those paid by municipalities and irrigation, raising questions regarding ability of environmental flows to compete in a marketplace.

The prices paid for environmental water in sales and leases in the U.S. markets did tend to conform with the estimates of for such services using various nonmarket economic valuation methods, thus MAYBE adding credibility to the use of such methods in policy planning.

Financing Environmental Flow Acquisition

- General funds
- User fees (e.g., CVPIA)
- Bonds and millages
- Percentage requirements from transfers between other sectors (e.g., in Oregon 25% of water transferred is supposed to go to environment)
- Private provision

Conclusions

- Markets definitely can contribute to provision of water for environmental purposes, if proper regulatory system in place.
- Market provision can only be part of a solution
- Because of public good nature of water, transaction & info costs, and lack of financial returns to environmental flows, government will need to play an important role in legislating and financing environmental flow purchases.
- Market system will need to be augmented by minimum flow requirements
- Environmental flows demand innovative financing mechanisms

Gracias