



**DAAD-Alumni Expert Seminar**  
**Rural Sanitation and Watershed Management in Latin America**

**“WATER-USE AND WATER-POLLUTION CHARGE IN  
BRAZIL”  
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**MSC. ENG. JOAO MARCELLO GOMES PINHEIRO**  
**BRAZIL**

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

More than 40 years ago

“...the air and waters surrounding us cannot readily be fenced, and so the tragedy of the commons as a cesspool must be prevented by different means, by coercive laws or taxing devices that make it cheaper for the polluter to treat his pollutants than to discharge them untreated”.

Hardin, Garrett. “The Tragedy of the Commons”. *Science*, Vol. 162, 13 December 1968.

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Today

- The growth of population in the next 25 years will require an water availability increase of:
  - 17% for irrigation
  - 70% for urban supplying
  - 40% in the total demand
  
- In the year 2050 there will be a lack of fresh water for more than 70% of the world population, due to exaggerated collection and pollution

*Source: World Commission on Water, supported by ONU and the World Bank*

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Conduct change in the use of fresh water

United Nations Conference on Environment and  
Development (Rio de Janeiro, 1992):

- ✓ The development must be sustainable. The uses of the water resources must make compatible the socio-economic development with the protection of natural ecosystems;
- ✓ The development must be supported, in all the levels, by the participation of the users, decisions makers and planners;
- ✓ The water has economic value for everyone and for all its uses.

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## International Policies

- Developed European countries: those who use the water in an inefficient way have to pay more or transfer the water to higher value uses, among them, the environmental uses.
- Consequences:
  - ❖ obsolete conducts have been abandoned, leading up to reduction of the wastefulness and environmental recovery
  - ❖ France: reduction of 12 % in the annual water consumption of the industrial sector between 1981 and 1990
  - ❖ Germany: River Rhine, which 30 years ago was strong polluted, presents nowadays a fauna comparable to the one observed 100 years ago

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## France (1960s) – basis for the Brazilian system

- “User pays” and “Polluter pays” principles
- Compensation system – subsidy for wastewater treatment
- Water charges at the level of river basins (6 in France)

Pollution charges	Use charges
<ul style="list-style-type: none"> <li>• Levied each year based on the average daily quantity of pollution generated during the month of maximum discharge</li> <li>• Pollutants as suspended solids, oxidizable substances and nitrogen are taken in account</li> </ul>	<ul style="list-style-type: none"> <li>• Purpose of quantitative management</li> <li>• Public and private bodies or individuals are liable to pay for extracting water or altering the aquatic environment</li> </ul>

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Brazilian Policy

- Water Federal Law 9.433/1997 – water is a scarce resource with economic value
- The Brazilian National Water Agency (ANA) was created in July 2000
- Federal Law 9.984/2000: possibility of charging for water in federal river basins
- Water charge system as management and economical instrument, applied for collection, consumption and pollution
- Charges introduced in the river basins forces individuals and polluting companies to internalize the costs associated with water use and pollution
- Charges are not just a source of revenue, but incentives for the socio-environmental sustainability of water resources !!!

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Pilot Project – The Paraíba do Sul basin

- First basin in Brazil where the charge was implemented (approved in 29 May 2002)



figure: [www.hidro.ufrj.br/ppg/principal.html](http://www.hidro.ufrj.br/ppg/principal.html)

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Description of the area



- Localization: Southeast region, between the States of Minas Gerais, Rio de Janeiro and Sao Paulo
- Drainage area: 55.500 Km<sup>2</sup>
- Characteristics: there are 180 municipalities in the basin, which concentrate 5 million residents and approximately 10% of the country's industries
- Vegetation: the natural forest, part of the Brazilian Atlantic Forest biome, is reduced to 7% of its original extension
- Biodiversity: Despite the accentuated devastation, the area is still considered one of the “hotspots” of the world, having 250 species of mammals, 340 of amphibians, 197 of reptiles, 1,023 of birds and approximately 350 species of fish



# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Pilot Project – Characteristics

- ❑ All users of federal rivers in the basin are potential payers, excluding users whose collection does not exceed 1 l/s and Small Hydropower Plants with installed capacity lower than 1 Mw
- ❑ Incomes are applied in recovery and preservation projects within the basin, approved by a committee formed by representatives of the users, civil society and public power
- ❑ Calculations privilege with lower cost those who collect and pollute less water
- ❑ Important assumption of the charge methodology is the conceptual and operational simplicity:
  - Possible short-term application
  - Minimize insecurity of paying users front to newness of the charge

“WATER-USE AND WATER-POLLUTION CHARGE IN  
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Pilot Project – Methodology

$$C = Q_{col} \times K_0 \times UPP + Q_{col} \times K_1 \times UPP + Q_{col} \times (1 - K_1) \times (1 - K_2 \times K_3) \times UPP$$

collection

consumption

pollution/effluents dilution(BOD)

$Q_{col}$  – collection flow (m<sup>3</sup>/s); given by the user

$K_2$  – relation between the discharge treated and the total; given by the user

$K_0$  – unitary price reduction for collection (<1); defined by the Committee

$K_3$  – level of efficiency of BOD reduction in the wastewater treatment; given by the user

$K_1$  – relation between the consumed volume and the collected volume; given by the user

**UPP** – unitary public price, defined by the Committee



# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Parcels contribution

Collection	Consumption	Pollution
<ul style="list-style-type: none"> <li>• Making a “water reserve” is already enough to be chargeable; another user cannot use this water</li> <li>• <math>K_0 &lt; 1</math> indicates that collection has lower impact than the consumption of water</li> </ul>	<ul style="list-style-type: none"> <li>• Flow effectively consumed</li> <li>• Besides Brazil, France is the only country that clearly charges for consumption</li> </ul>	<ul style="list-style-type: none"> <li>• Consider efforts of those who already try to reduce the levels of pollution of its discharges</li> <li>• Qualitative aspects simplified by the choice of only one parameter, the BOD:                             <ul style="list-style-type: none"> <li>✓ Can easily be measured or estimated</li> <li>✓ Representative of domestic sewers and present in different types of industrial discharges</li> </ul> </li> </ul>

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Preliminary Results

According to study of the Sao Paulo University (USP):

- ✓ All the analyzed index of pollution are below the tolerant limits
- ✓ Level of fecal coliforms is 43 for each 100 ml of water (tolerated limit is 1000 coliforms for 100 ml of water)
- ✓ No more heavy metals in the water and despite the proximity with the Nuclear Industries of Brazil, no presence of radiation

But the situation in the basin is still far of be considered good, due to some factors in the current methodology:

- The charge does not take in account the present load in the final discharge, penalizing those who release great volumes even with low load
- The unitary uniform price for the entire basin does not reflect the scarcity or abundance of water in different stretches of it.

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Use of Charge Resources

- River Basin Committee use the charge resources in the Programa Produtor de Água



- Pilot programme with 3 years duration in the PCJ committee: Piracicaba, Capivari and Jundiaí Rivers
- Properties within the microbasins: Ribeirões Cancã in Joanópolis e do Moinho em Nazaré – possibility of expansion for the whole state of SP soon

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Use of Charge Resources

- 220 rural farmers are remunerated for environmental services provision
- R\$3,9 million from the water charge in the PCJ Basin
- R\$115 thousand for soil conservation practices – R\$75/ha.year
- R\$ 78 thousand for restoration of APP (Permanent Protection Areas) - R\$125/ha.year
- R\$202 thousand for forests maintenance - R\$125/ha.year



# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Use of Charge Resources

- Sítio Duas Cachoeiras in PCJ Basin



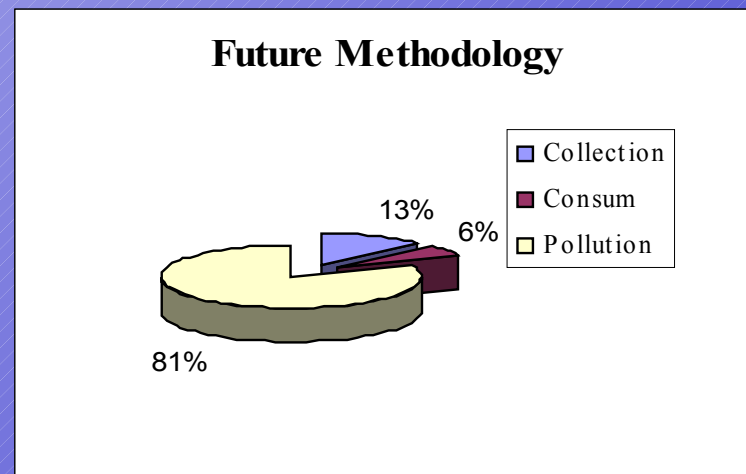
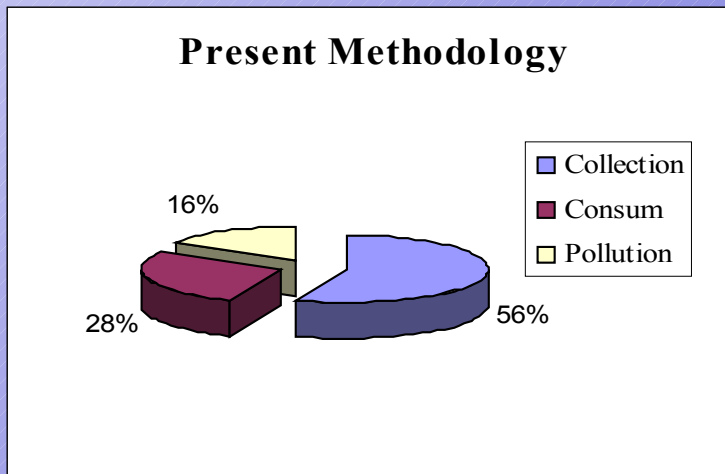
- Production of 74,2 million l/year  
=> reforestation resulted in 2  
new fountainheads (production  
and conservation)

- Annual income of R\$742,00

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Future Methodology

- Variation of the UPP in function of: seasonality; spatial localization of the user; and value of a scarcity index
- The capacity of dilution of the receiving body will be considered
- Financial compensation for the user who return to the river, water in a superior quality than the water collected
- Attack more incisively the pollution, giving a higher weight for the cost of the pollution parcel



# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Existing Theories and Projects

J. H. Dales in 1968:

- 1<sup>st</sup> level: **social and sustainable value** of the resource determined by the society (represented by the government), through **pollution emissions maximum limits**  
objective - reducing social differences in present generation & differences between

this and next generations.

- 2<sup>nd</sup> level: total limit distributed among “users”  
negotiated, traded and reallocated in a free market - economic value  
government play a minimum role (supervisor)  
➤ efficient market equilibrium: pollution target is reached at lowest cost for the industries or the resource is used in a way that produces the most value to the society.

Fox River Project (Wisconsin, USA, 1981):

- after 14 years of existence not a single trade
- regulatory authorities were not yet quite ready for this
- governmental water control, environmental regulations and restrictions on the right to use water
- polemic concerning "hot spots", locals of high concentrations of the pollution

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## “ The Water Pollution Market ”

- ❖ “Cap and trade” system: based on Dales’s theory + mechanisms of carbon trading
- ❖ 1<sup>st</sup> level – river basin committee - total pollution, based on water body's assimilation capacity and pollution standards
- ❖ sum of pollution rights distributed among “users” meet total pollution load
- ❖ 2<sup>nd</sup> level – allowances “freely” traded
- ❖ pollution rights holders - meet their allowances
- ❖ options: control discharge or purchase more allowances
- ❖ creation of pollution rights market
- ❖ polluter decides which alternative would bring more economic advantages
- ❖ depending on costs comparative analysis between pollution certificates in the market and pollution control (depending on the kind of production processes and technology)

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## First Level – The Permits

River Basin Committee – tasks as regulatory agency:

- ✓ monitor polluters by verifying if their discharges meet the totality of pollution certificates they have
- ✓ modify total pollution load acceptable in the water body – 2 mechanisms:
  - ❑ emitting more allowances and negotiating them in the market in order to increase the cap
  - ❑ purchase allowances, taking them away of the market, in order to reduce the total acceptable pollution in the water body
- 1<sup>st</sup> mechanism: also used in case of unfair competition or market monopolization (if any participant buy allowances with the only objective of damaging the competitor)
- 2<sup>nd</sup> mechanism: also adopted by non-governmental institutions (ONG's) that have the objective of better environmental quality



# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Second Level – The Trade

A) Growth of economic activity	B) Maintenance of economic activity	C) Reduction of economic activity
1. Increasing the discharges, by obtaining more certificates in the market.	1. Reducing the discharges by adopting the techniques of control mentioned before, which generates certificates that could be sold in the market	Generating certificates that could be sold in the market (if a higher pollution control was adopted at the same time, more certificates could be sold).
2. Controlling the incremental pollution by advanced treatment, recycling or improving the production technology.	2. Maintaining the current discharges.	

Source: Lanna, 2002

**Scenario 1:** incremental income > costs of certificates > costs of pollution control => **A2**



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Source: Lanna, 2002

❑ **Scenario 2:** incremental income > costs of certificates < costs of pollution control => **A1**  
Certificates bought from industry that chose either B1 or C.



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## Second Level – The Trade

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1. Increasing the discharges, by obtaining more certificates in the market.	1. Reducing the discharges by adopting the techniques of control mentioned before, which generates certificates that could be sold in the market	Generating certificates that could be sold in the market (if a higher pollution control was adopted at the same time, more certificates could be sold).
2. Controlling the incremental pollution by advanced treatment, recycling or improving the production technology.	2. Maintaining the current discharges.	

Source: Lanna, 2002

□ **Scenario 3:** incremental income < costs of certificates & costs of pollution control => **B2**

▪ **Scenario 3a:** income from the certificates sells > income of economic activity => **C**



# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Second Level – The Trade

A) Growth of economic activity	B) Maintenance of economic activity	C) Reduction of economic activity
1. Increasing the discharges, by obtaining more certificates in the market.	1. Reducing the discharges by adopting the techniques of control mentioned before, which generates certificates that could be sold in the market	Generating certificates that could be sold in the market (if a higher pollution control was adopted at the same time, more certificates could be sold).
2. Controlling the incremental pollution by advanced treatment, recycling or improving the production technology.	2. Maintaining the current discharges.	

Source: Lanna, 2002

□ **Scenario 3:** incremental income < costs of certificates & costs of pollution control => **B2**

▪ **Scenario 3b:** income from the certificates sells > costs of pollution control => **B1**

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Pre-requirements & Challenges

First step - establishment of the total maximum pollution load that can be present in the water body and still maintain all the water quality standards (cap).

### ❑ USA => Total Maximum Daily Load (TMDL)

- ✓ defined for each water body and a **specific pollutant** or pollutant combination
- ✓ take into account critical conditions and periods
- ✓ quantification: point sources, non-point sources, margin of safety and future pollution growth.

### ❑ Germany => tools focused on control of accumulation matter (nitrogen and phosphorus) and pharmaceuticals

### ❑ Developing Countries as Brazil => problem still oxygen consuming matter (BOD) in rivers located in very dense and high populated basins!

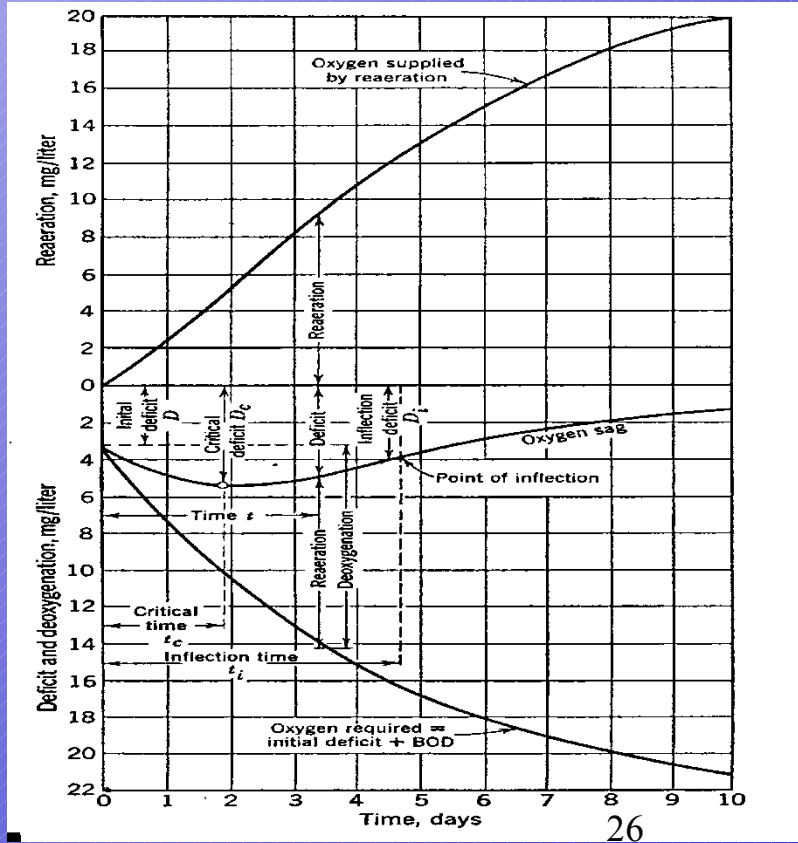


# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

□ Developing Countries: development of a water quality information system (WQIS) to support the water quality trading scheme within the river basin

## Modeling of BOD discharge:

- calculate  $O_2$  profile along the river after including all possible point discharges (taking in account processes of degradation, reaeration and dissipation)
- establish the minimum oxygen content tolerated
- maximum load could be accurately set (depending also on the localization of the discharges)
- minimum water quality condition would be respected along all the river
- input of physical parameters (flow velocity, water depth, layering, temperature ...) & chemical parameters (salinity, alkalinity ...)
- simulation of credits trades in “hot spots”
- better distribution of industrial plants in the basin !



Source: Hahn, 1986

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Conclusions

- The charge should be viewed by the society as signalization for the rational use of the water resources, as proposed by Hardin
- But, in none of the analyzed countries, and nor in Brazil, the values of charges are based on the valuation of the enviromental damages caused by the use of water
- Despite of this, all the experiences lead to a more rational and sustainable use of the water resources
- Taxes or trade fees for the Committees to support farmers preservation programes

# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Conclusions

- River basin committee as regulatory agency for the sector
- Development of water quality information system
- Water pollution as economic parameter to industries => better distribution of plants in the basin => other positive consequences, not only for the environment, but also for the society, economy, spatial planning,.....



# “WATER-USE AND WATER-POLLUTION CHARGE IN BRAZIL”

## Thank You

DAAD

Universität Siegen

Universidade Federal da Paraíba