Gains from trans-boundary water quality management in linked catchment and coastal ecosystems

By:

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ARH CENTRO
Administração da Região Hidrográfica do Centro I.P.

Overview

- Introduction
- Objectives
- Methodology
- Results
- Conclusions & discussion

Introduction

❑ **Agricultural land use in coastal catchments**

… leads to …

diffuse source water pollution (sediments, nutrients and chemicals)

❑ **Impact on natural coastal & marine ecosystems**

… as well as …

economics sectors that depend on these for income generation

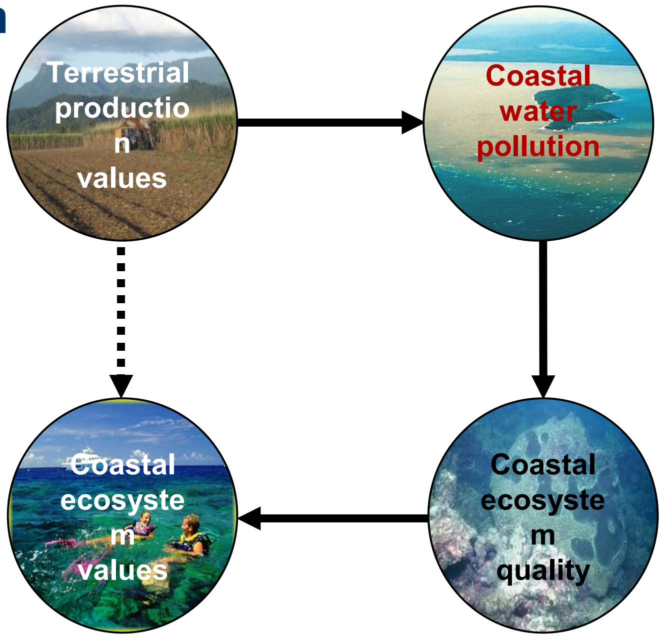
❑ **Sustainable water quality management in coastal catchments requires balancing**

► marginal benefits terrestrial water pollution

&

► marginal costs coastal water pollution

Social welfare maximizing outcomes



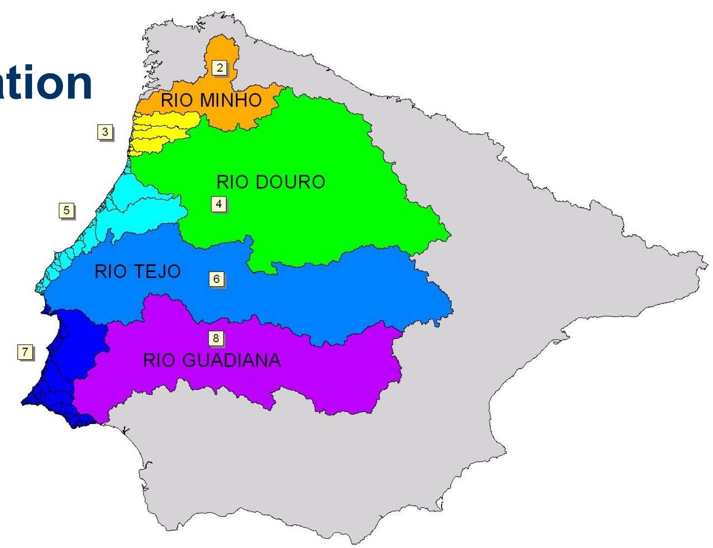
Introduction

- **Sustainable water quality management in trans-boundary catchments complex … because …**
  winners and losers from water pollution not one and the same

- **Example – the Iberian peninsula:**
  - Benefits terrestrial water pollution accrue to ES and PT
  - Costs coastal water pollution accrue to PT only

- **Private vs. social welfare maximizing outcomes**

- **What are potential gains from cooperation in trans-boundary water quality management?**

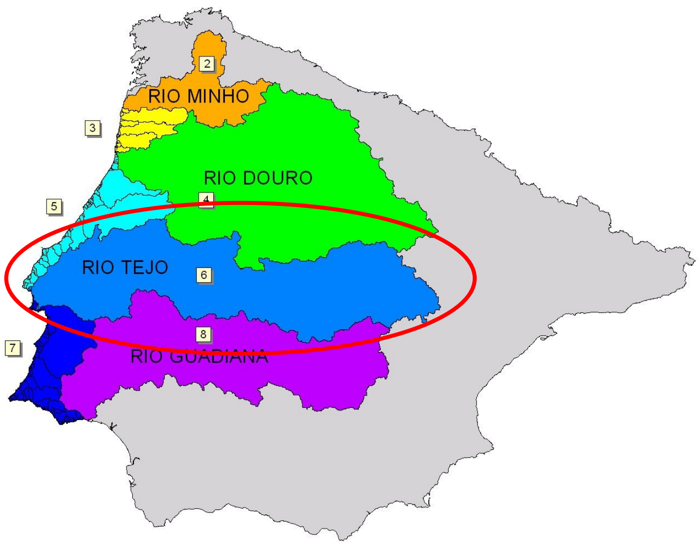


Objective

- Development environmental-economic optimal control approach that allows for exploration of private and social welfare maximizing rates of water pollution abatement in trans-boundary catchments

- **We will compare:**
  - Base scenario (current situation)
  - Private welfare maximizing scenario
  - Social welfare maximizing scenario
  - Non-cooperation scenario

- **Case study: - Tejo catchment**
  - Sediment pollution



Methodology

- **Environmental-econ. optimal control approach: *intra-boundary***

$$\underset{R_t}{Max}\, W = \int_0^{\infty} \left[B_{ter}(R_t) + B_{coa}(P_t) \right] e^{-rt} dt$$

subject to: $\dot{P}_t = b + R_t - aP_t$

where: $B_{ter}(R_t)$ **Terrestrial benefits …**

increasing in rate of terrestrial water pollution R_t

$B_{coa}(P_t)$ **Coastal benefits …**

decreasing in level of coastal water pollution P_t

r **Time discount rate**

b **Exogenous 'water pollution'**

a **Re-suspension factor**

Methodology

- ❑ **Environmental-econ. optimal control approach: *trans-boundary***

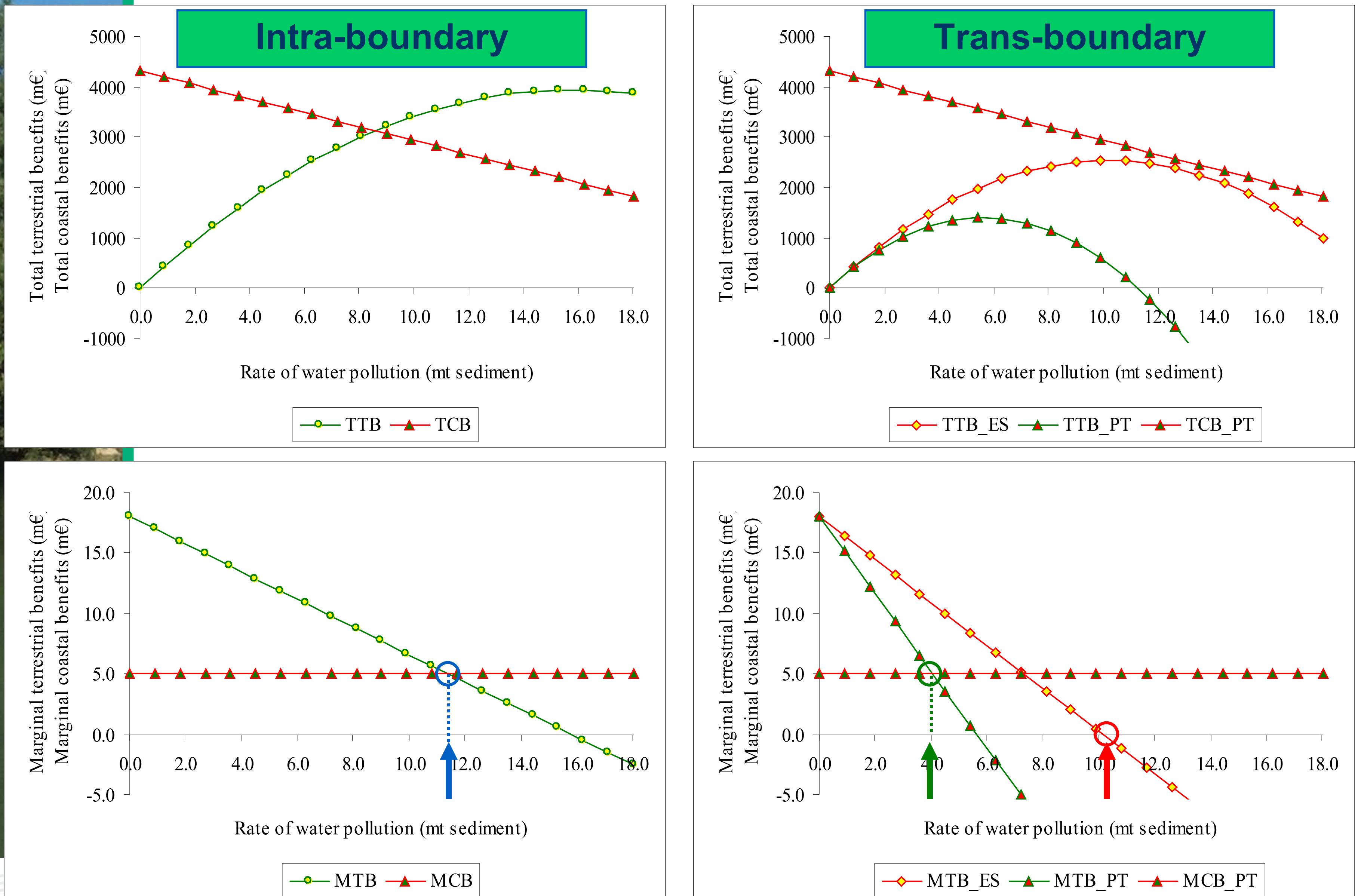
$$W = \underset{R_{t,ES}}{Max} \int_0^{\infty} \left[B_{ter}(R_{t,ES}) \right] e^{-rt} dt$$

$$+ \underset{R_{t,PT}}{Max} \int_0^{\infty} \left[B_{ter}(R_{t,PT}) + B_{coa}(P_{t,PT}) \right] e^{-rt} dt$$

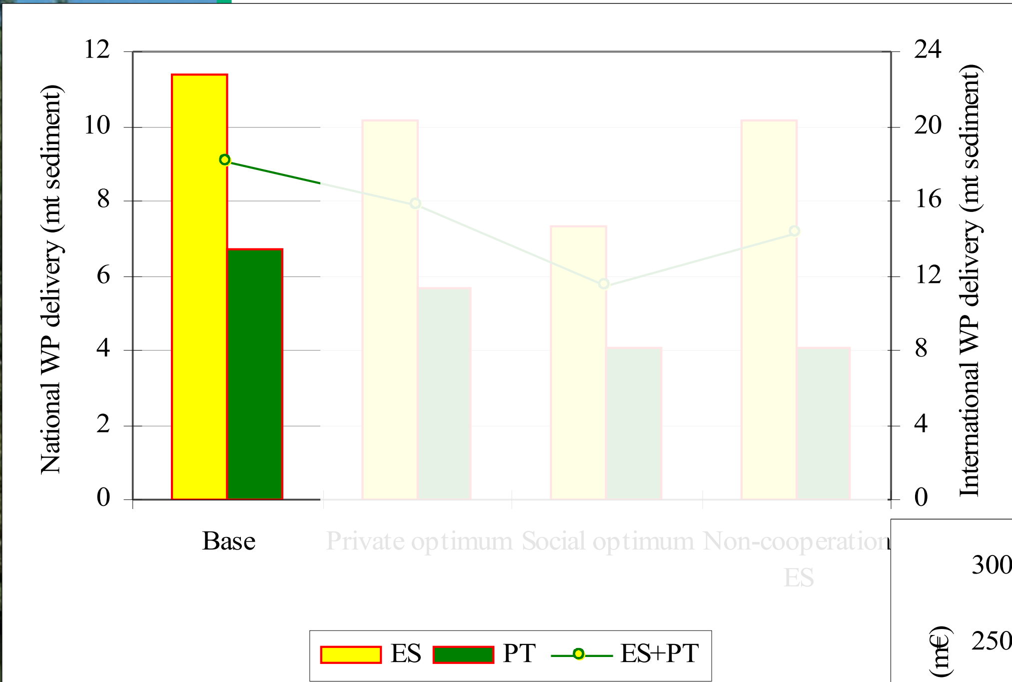
$$\text{s.t. } \dot{P}_{t,PT} = b + R_{t,ES} + R_{t,PT} - aP_{t,PT}$$

where:	$B_{ter}(R_{t,ES})$	**Terrestrial benefits Spain (ES)**
	$B_{ter}(R_{t,PT})$	**Terrestrial benefits Portugal (PT)**
	$B_{coa}(P_{t,PT})$	**Coastal benefits Portugal (PT)**
	r	**Time discount rate**
	b	**Exogenous water pollution**
	a	**Re-suspension factor**

Methodology

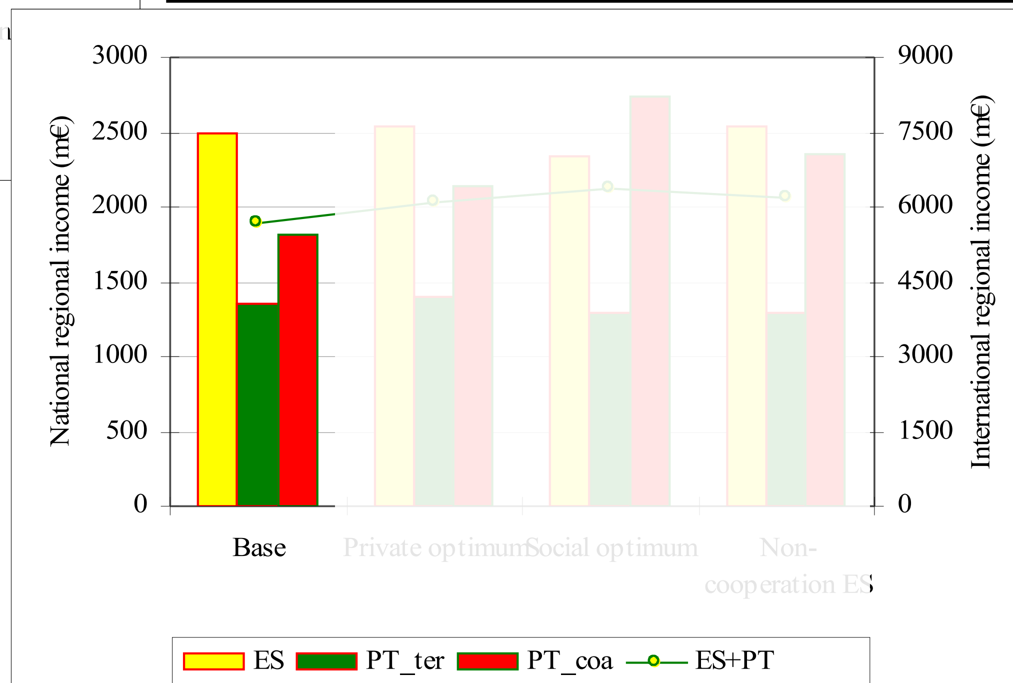


Results: Tejo case study



Regional income (m$)	ES	PT_ ter	PT_ coa	ES+ PT
Base	2,496	1,358	1,820	5,674
Private optimum	2,532	1,406	2,132	6,070
Social optimum	2,336	1,298	2,740	6,374
Non-cooperation ES	2,532	1,298	2,349	6,179

Sediment delivery (mt)	ES	PT	ES+PT
Base	11.4	6.7	18.0
Private optimum	10.1	5.6	15.8
Social optimum	7.3	4.1	11.4
Non-cooperation ES	10.1	4.1	14.2



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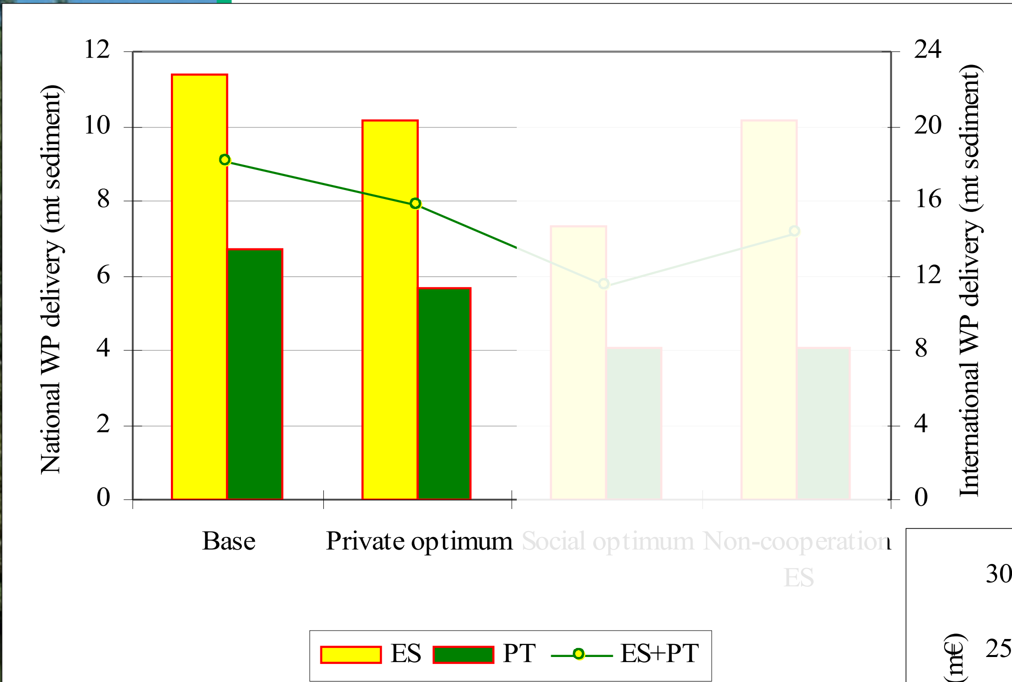

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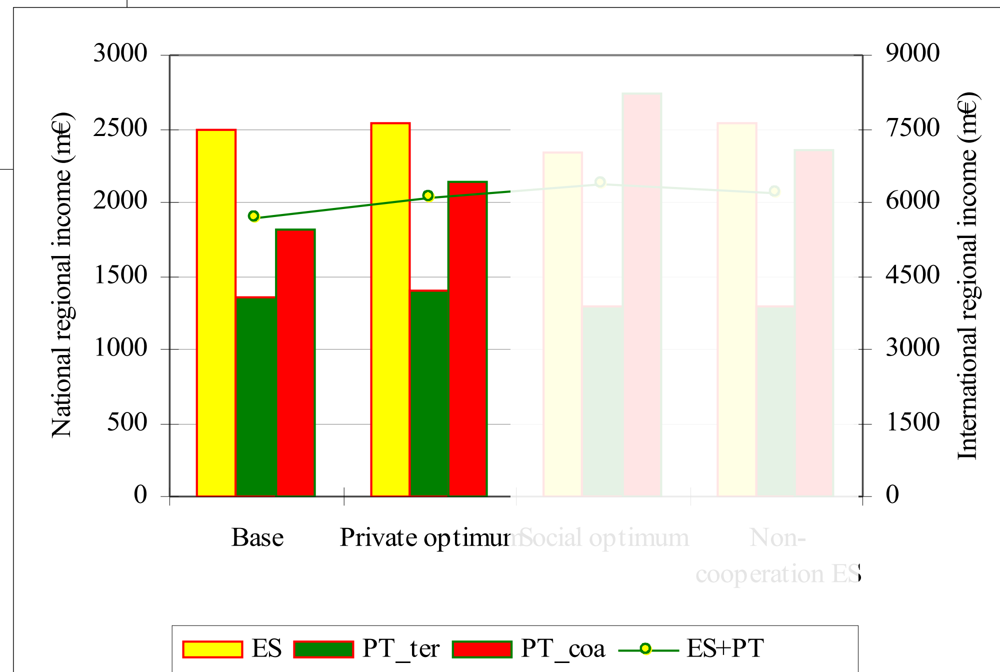

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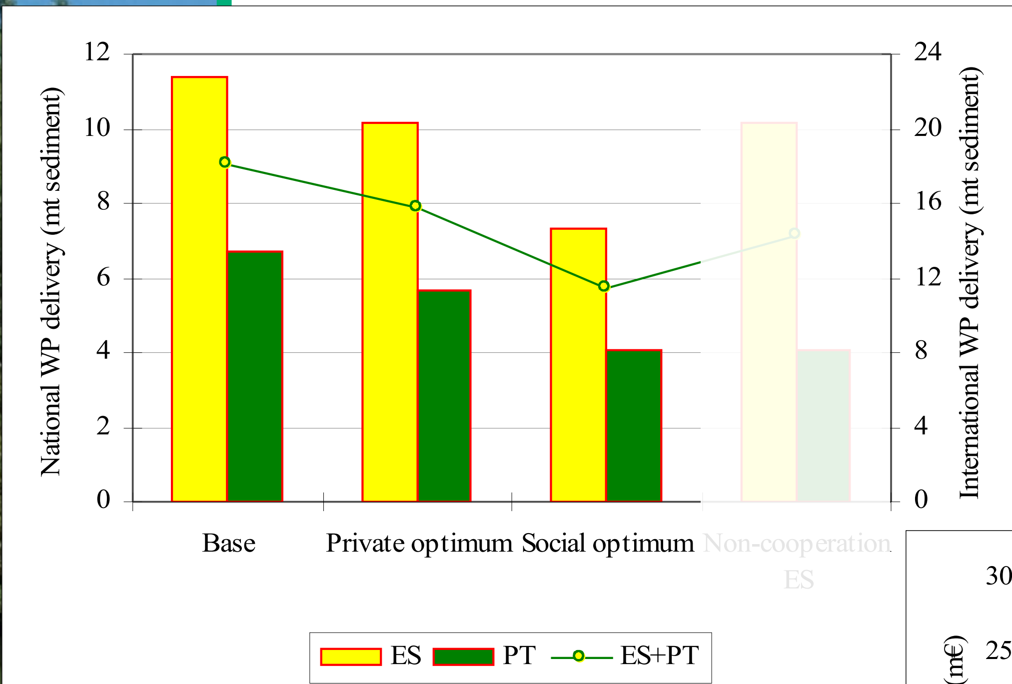

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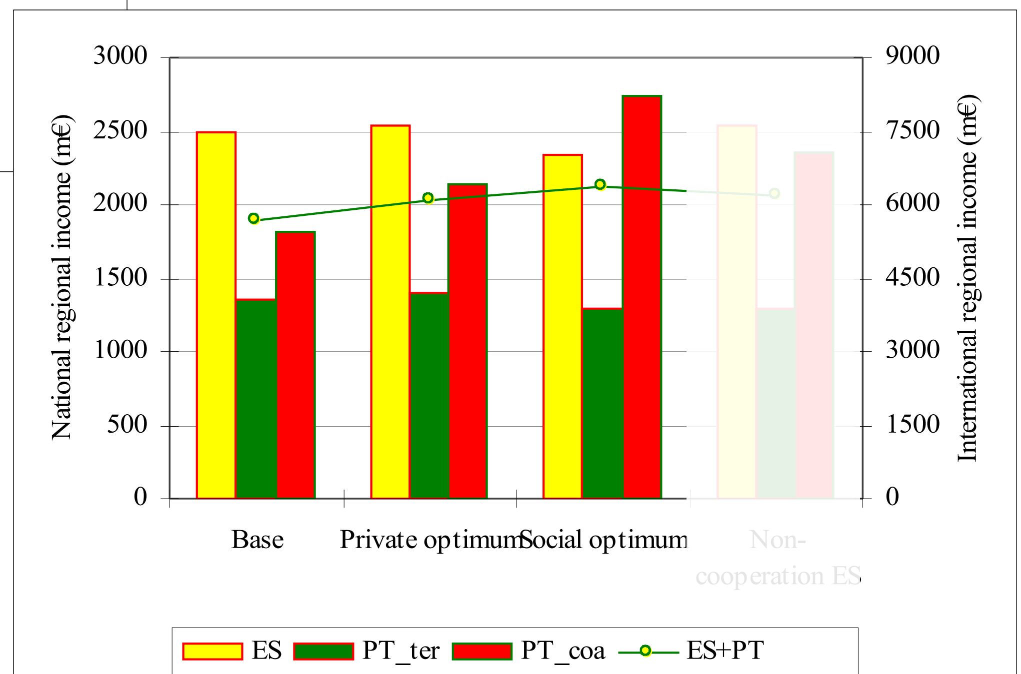

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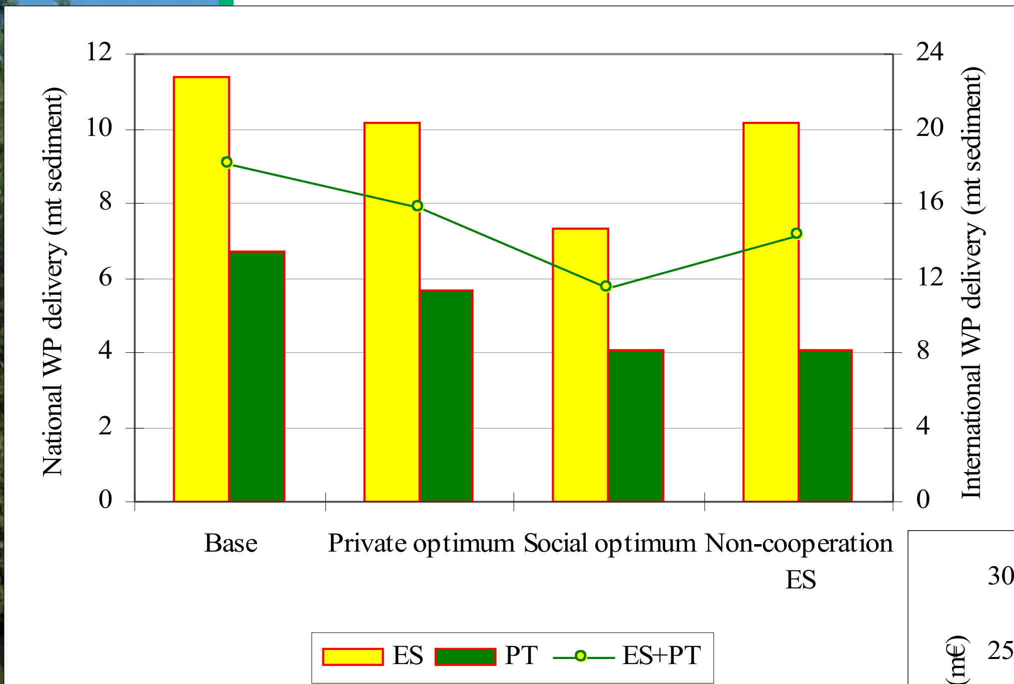

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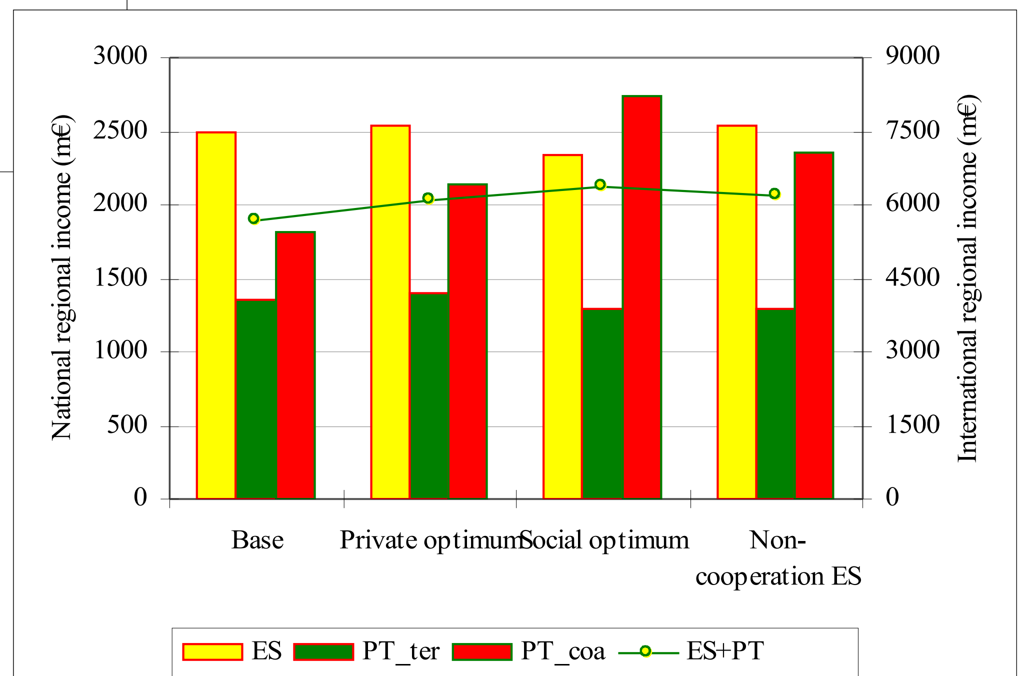

Conclusions & discussion

- **Environmental-economic optimal control approach that:**
  - Relates costs and benefits from water quality management in linked catchment and coastal ecosystems
  - Allows for exploration of private and social welfare maximizing rates of water pollution abatement in trans-boundary catchments
- **For the Tejo case-study it is shown that:**
  - Significant water quality (12%) and social welfare (7%) gains can be obtained through adoption of win-win land use practices
  - Largest water quality (35%) and social welfare (12%) gains can be obtained through adoption of win-lose land use practices
  - Constrained water quality (20%) and social welfare (9% ~ 200 m€/yr) gains can be obtained due to non-cooperation Spain
- **Future research:**
  - Institutional arrangements that allow for international transfer of social welfare gains from trans-boundary water quality management
  - Economic incentives to internalize beneficial spill-overs from trans-boundary water quality improvement

Thank you!

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