Leibniz Universität Hannover

Efficiency of Market-Based Instruments for Protecting Ecosystems: The Example of Wetlands

Anna Segerstedt and Dirk Röttgers
Institute for Environmental Economics and World Trade, Leibniz University of Hannover

Outline

- State of Wetlands
- Research Question
- Basic Model
- Efficiency of Instruments
- Conclusion & Outlook

Wetland Eco-System Services

Research Question

Given the many externalities and the complexity of a wetland:

→ Which market-based instruments are efficient and appropriate for wetland protection?

Step 1: Theoretical framework

Step 2: Simulation with empirical data

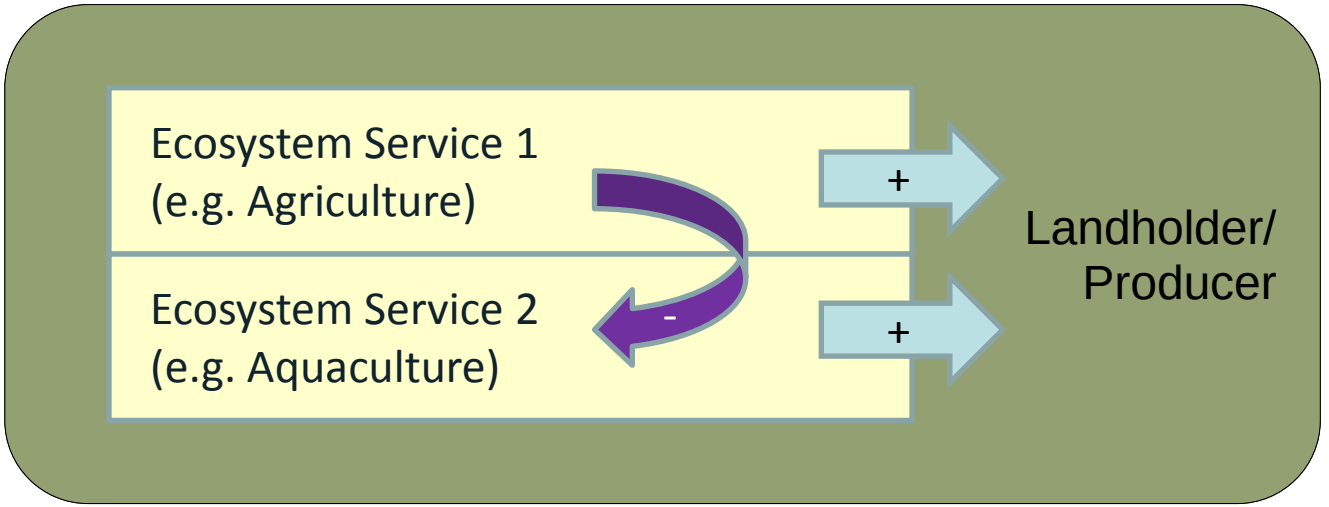
Previous Literature

- Wetland ecosystem services
  - Economic valuation (Ghermandi et al., 2008; Brander et al., 2006)
  - Institutional frameworks (Keddy et al. 2009, Brinson & Malvarez 2002)
- Non-point agriculture pollution
  - Taxes and subsidies: Pearce & Koundouri (2003), Lankoski & Ollikainen (2003)
  - Mitigation trading: Prabodanie et al. (2010)
- Holistic approaches
  - Impact of subsidies and water trading schemes on water quality (Heberling et al., 2010)

A Basic Producer Model

Single Producer

- Uses the land to produce 2 eco-system services

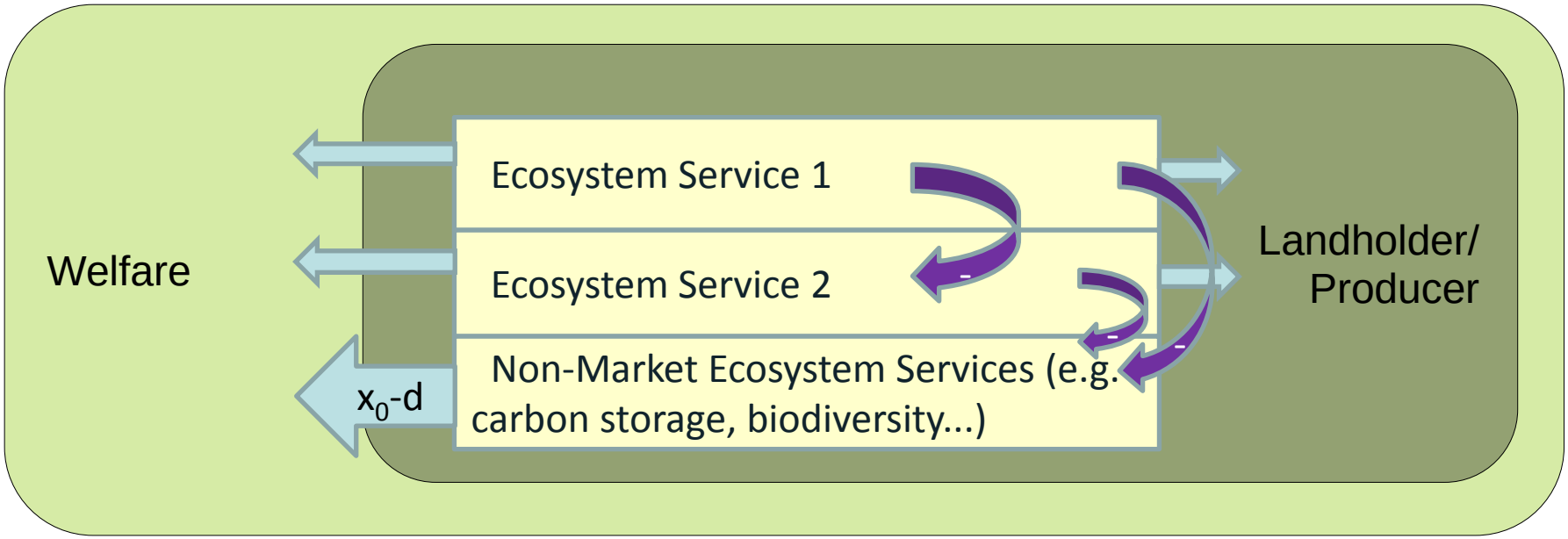


$$\max_{l_1,l_2,a_1} \pi = f_1(l_1) \cdot p_1 + f_2(l_2, \overbrace{f_1(l_1)}^{(-)}, \overbrace{a_1}^{(+)}) \cdot p_2 - c_1(l_1, a_1) - c_2(l_2)$$

Land constraint: $l_1 + l_2 = L$ Non-negativity constraints: $l_1, l_2, a_1 \geq 0$

A Basic Producer Model

Total Welfare



$$\max_{l_1,l_2,a_1} WF = \pi + x_0 - d(\overbrace{f_1(l_1)}^{(+)}, \overbrace{f_2(l_2)}^{(+)}, \overbrace{a_1}^{(-)})$$

Differences without/with Welfare

$$p_1 = \frac{-\frac{\partial f_2}{\partial f_1} \cdot \frac{\partial f_1}{\partial l_1} \cdot p_2 + \frac{\partial c_1}{\partial l_1} + \mu}{\frac{\partial f_1}{\partial l_1}}$$

- Producer incorporates value loss of the first good on the second

p_2 analogous

Differences without/with Welfare

$$p_1 = \frac{-\frac{\partial f_2}{\partial f_1} \cdot \frac{\partial f_1}{\partial l_1} \cdot p_2 + \frac{\partial c_1}{\partial l_1} + \mu + \frac{\partial d}{\partial f_1}\frac{\partial f_1}{\partial l_1}}{\frac{\partial f_1}{\partial l_1}}$$

- Producer incorporates value loss of the first good on the second
- ... but not the social loss $\frac{\partial d}{\partial l_1}$ ($p_1$too low)

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$$\frac{\partial c_1}{\partial a_1} = \frac{\partial f_2}{\partial a_1} \cdot p_2$$

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- Producer incorporates value loss of the first good on the second
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p_2 analogous

$$\frac{\partial c_1}{\partial a_1} = \frac{\partial f_2}{\partial a_1} \cdot p_2 - \overbrace{\frac{\partial d}{\partial a_1}}^{-}$$

- Accordingly also abatement will be too low

3 Market-based Instruments

Product Certification

Mitigation Trading

Wetland Certification

Product Certification

Example: Organic, fair-trade…

Certify Eco-System Service 1 to neutralize damage

- Fixed abatement level $\overline{a_1^{ce}} > a_1^{co}$ for certified product
- Additional price premium of p_p per certified product $f_1^{ce}(l_1^{ce})$

$$\rightarrow \max_{l_1, l_2, a_1} \pi = f_1^{co}(l_1^{co}) \cdot p_1 + f_1^{ce}(l_1^{ce}) \cdot (p_p + p_1) + f_2(l_2, f_1(l_1), a_1^{co}) \cdot p_2 - c_1^{co}(l_1^{co}, a_1^{co}) - c_2(l_2) - c_1^{ce}(l_1^{ce}, \overline{a_1^{ce}})$$

Product Certification

- Case 1: Certification possible only for former cropland
  - If l_2 fixed, reallocation from $f_1^{co}(l_1^{co})$ to $f_1^{ce}(l_1^{ce})$
  - p_1^{co} ↑ as opportunity costs of land increases
  - Leakage → increased productivity of eco-system service 2
    →pollution of this good may increase
  - May reduce (or magnify) impact of instrument

- Case 2: If l_2 variable (e.g. re-allocation from $f_2(l_2)$ to $f_1^{co}(l_1^{co})$ and from $f_1^{co}(l_1^{co})$ to $f_1^{ce}(l_1^{ce})$)
  - Damage of the conventional farming may not decline

- Unwanted side-effects possible
- Depends on damage of both goods and the new allocation of resources

3 Market-based Instruments

Product Certification

Mitigation Trading

Wetland Certification

Mitigation Trading

Mitigation Trading

- Example: EU Emission Trading Scheme, wetland mitigation banking
- Participants can damage $f_1(l_1) \cdot w_1(a_1) + f_2(l_2) \cdot w_2(a_2)$ up to a point $\bar{d}_i$
- They buy rights to do so, or
- by creating protected areas l_{pa}

$$\max_{l_1, l_2, l_{pa}, a_1} \pi = f_1(l_1) \cdot p_1 + f_2(l_2, f_1(l_1), a_1) \cdot p_2 + l_{pa} \cdot p_{pa}$$
$$- c_1(l_1, a_1) - f_1(l_1) \cdot w_1(a_1) \cdot p_{pa} - c_2(l_2, a_2) - f_2(l_2) \cdot w_2(a_2) \cdot p_{pa} - c_{pa}(l_{pa})$$

Cap constraint: $\bar{d}_i + f_{pa}(l_{pa}) = f_1(l_1) \cdot w_1(a_1) + f_2(l_2) \cdot w_2(a_2)$

Land constraint: $l_1 + l_2 + l_{pa} = L$

Wetland Certificate

Wetland Certificate

- Example: Green Development Initiative (GDI)
- Participants get a price p_z for keeping a defined sustainability level x_z.
- Possible to chose between abatement and protected areas

$$\max_{l_1,l_2,l_{pa},a_1,a_2} \pi = f_1(l_1)\cdot p_1 + f_2(l_2, f_1(l_1), a_1)\ \cdot p_2 + x_z\left(\overbrace{f_1(l_1)}^{(-)}, \overbrace{f_2(l_2)}^{(-)}, \overbrace{f_{pa}(l_{pa})}^{(+)}, \overbrace{a_1}^{(+)}, \overbrace{a_2}^{(+)}\right) \cdot p_z - c_1(l_1, a_1) - c_2\,(l_2, a_2) - c_{pa}(l_{pa})$$

Land constraint: $l_1 + l_2 + l_{pa} = L$

Mitigation Trading vs. Wetland Certificate

FOC: Prices increase for both products according to marginal damage and shadow costs of (captured) damage

Mitigation trading

- Depends on accepted damage level of one emission
  →Only marginal damage i is taken into account
  →Inclusion of further aspects (e.g. biodiversity) difficult
- However increase in l_{pa} → other damage ↓
- Producer burden
- High set-up costs (infrastructure)

Wetland Certificate

- Depends on desired supply of non-market eco-system services
- Requires high knowledge of producer
- User burden
- Markets?

Conclusion & Outlook

- Within the model, the instruments show desired changes in producer rationale
  - Signalling works in the right direction
  - Prices increase with every instrument
- Leakage within product certification possible
  - Would reduce/increase impact
- Magnitudes empirical question
  - Simulation exercise with empirical data from Malagarasi wetland in Tanzania

Thank you

segerstedt@iuw.uni-hannover.de

CERPA-project:
cerpa.uni-hannover.de