# A Swedish CBA on acidification abatement
# -THE CAFE BASELINE SCENARIO

Mohammed Belhaj,
Stefan Åström,
Catarina Sternhufvud,

(-An economic assessment of the negative impacts of ozone on the crop yield and forest production at the Östad Estate in south-west Sweden ( Karlsson P-E, et al) Ambio no1, 2005 )

IVL Swedish Environmental Research Institute

**Two cost scenarios**

The deposition and emission levels used for the CBA scenario are based on the 'Climate Protocol, current legislation' (CP_CLE) scenario as developed by IIASA for the CAFE programme. The CP_CLE shows the European emission levels that will follow from the implementation of current and coming European legislation. The costs of abating pollution when implementing the CAFÉ baseline scenario are considered in two scenarios.

**1. The Source Contributor scenario**
Only countries for which we have cost information are considered. These countries are called the Source Contributors in the text. They basically constitute the EU 25, with the slight difference that not all of the countries in the EU 25 contribute to acidifying deposition over Sweden

**2. The tax payer scenario**
This scenario uses a study boundary regarding Sweden in order to give costs and benefits that only affect the Swedish taxpayers

**Swedish emissions (kton/year)**

| Pollutant | 2000 | 2010 | 2020 |
|---|---|---|---|
| $SO_2$ | 57.6 | 54 | 50.4 |
| $NO_x$ | 251.4 | 192.4 | 150 |
| $NH_3$ | 53.5 | 51.2 | 48.5 |

Source: www.iiasa.ac.at

**Table 25: Contributors to the deposition of Sulphur over EMEP 150*150 grid cell [21 22]**

| **Source region** | Sulphur deposition g S $m^{-2}$ | Percentage |
|---|---|---|
| Belgium, | 2.41 | 0.7 |
| Czech Republic | 3.12 | 0.9 |
| Denmark | 2.98 | 0.9 |
| Estonia | 0.65 | 0.2 |
| Finland | 2.78 | 0.8 |
| France | 4.77 | 1.4 |
| Germany East | 6.26 | 1.8 |
| Germany West | 11.42 | 3.3 |
| Hungary | 1.77 | 0.5 |
| Italy | 0.49 | 0.1 |
| Latvia | 0.99 | 0.3 |
| Lithuania | 2.87 | 0.8 |
| Netherlands | 1.86 | 0.5 |
| Poland | 49.08 | 14.1 |
| Slovakia | 0.87 | 0.3 |
| Spain | 0.38 | 0.1 |
| **Sweden** | **22.21** | **6.4** |
| United Kingdom | 5.56 | 1.6 |
| **Source Contributors deposition %** | | **34.7** |

Source: adapted from www.iiasa.ac.at

**Biodiversity**

-Since there is no definitive measure of biodiversity,
-Since  most reliable information is available on fish population,
-Since in the different studies- respondents are willing to pay to maintain and enhance fish stock in lakes and watercourses.

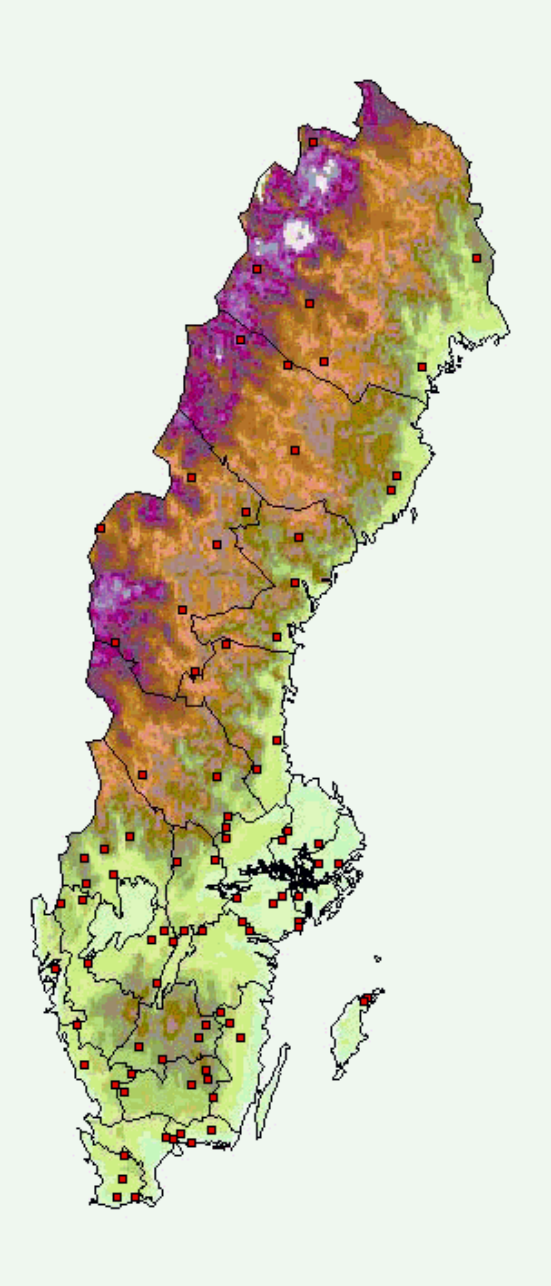
This study relates to the totality of the fish habitat in lakes represented by fish stock used as a proxy for the preservation of ecologically significant species.

# pH levels and acidity

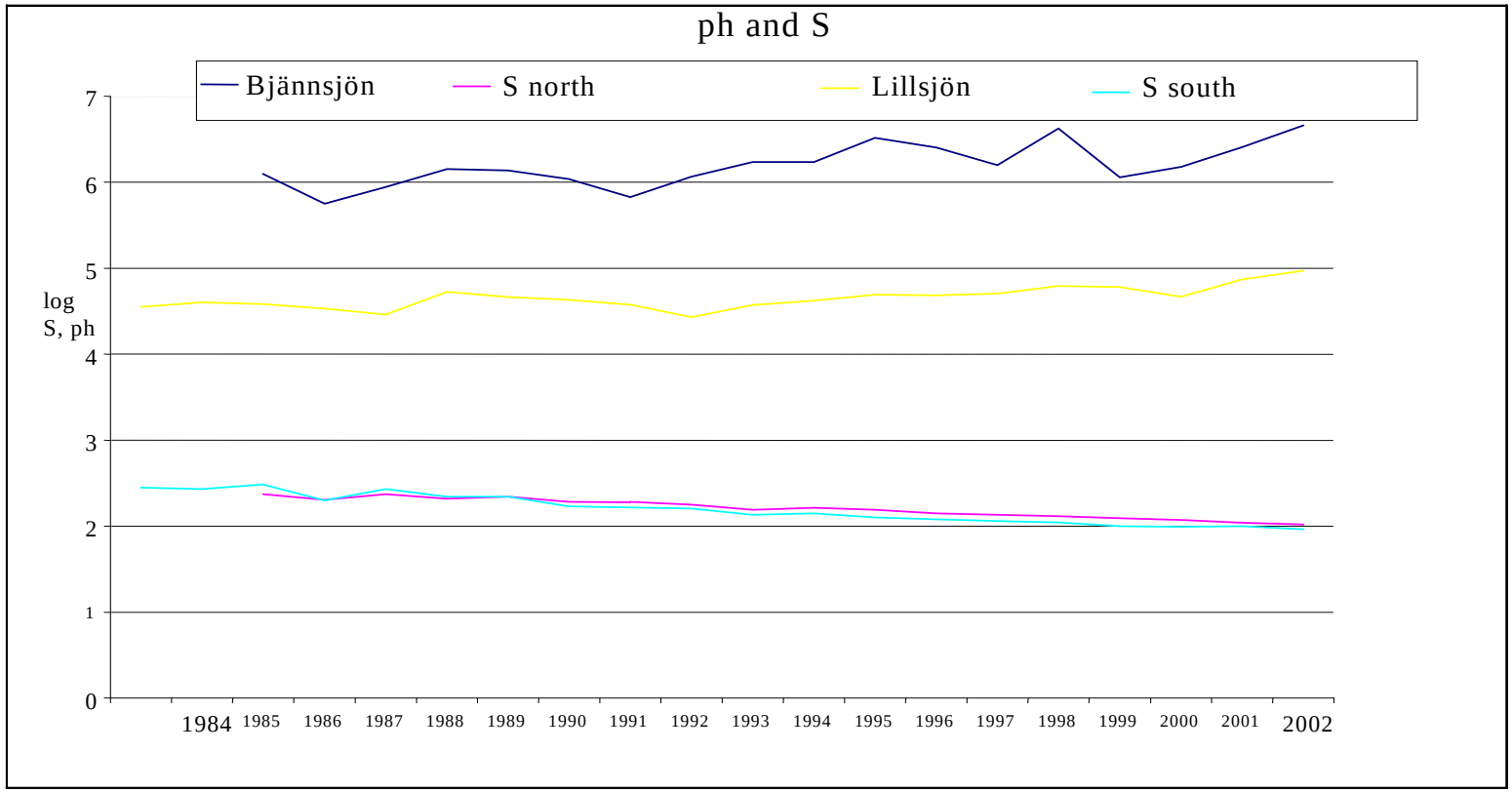
| PH | Condition |
|---|---|
| > 6.8 | Nearly non-acid |
| 6.5-6.8 | Weakly non- acid |
| 6.2-6.5 | Fairly non-acid |
| 5.6-6.2 | Acid |
| <5.6 | Highly acid |

Source: Swedish EPA (2005).

Reference lakes in Sweden



**S deposition at two sites and pH in lake Bjännsjön and lake Lillsjön**



## Characteristics of the sample

| | PH North | Sulphur North (ton) | Ph South | Sulphur South (ton) |
|---|---|---|---|---|
| Mean | 6.24 | 171.3 | 4.65 | 171.9 |
| Std Deviation | 0.25 | 43.26 | 0.13 | 71.32 |
| Minimum | 5.75 | 105 | 4.42 | 92 |
| Maximum | 6.66 | 235 | 4.97 | 305 |
| Number of observations | | 49 | | 78 |

## Regression estimates

| Variable | North | South |
|---|---|---|
| Intercept | 9.23 | 5.76 |
| | (8.79 | (27.93) |
| S deposition | -1.38 | -0.50 |
| | (2.86) | (5.38) |
| Number of observations | 49 | 78 |

## Valuation studies

| Reference | Value | Method |
|---|---|---|
| Johansson & Kriström (1988) | -4500 SEK elimination of sulphur emissions | CVM |
| Johansson (1989) | -555 SEK Preservation of endangered species | CVM |
| Toivonen et al (2000) | -408 SEK to preserve fish stock (1999 prices) | CVM |
| Laitila et al (2002) | -46.61 for an extra fish caught<br>-15.60 SEK. Extra fish caught | CVM |
| Paulrud et al (2003) | -(24-160) SEK for doubling the # of fish (average = 92)<br>-26 SEK for doubling the kilo of fish<br>-44 SEK for an extra fish to bring home | CVM |
| Paulrud et al (2003) | -17 SEK for an extra small fish | CVM |

# Relation between fish stock and pH values in Sweden

| Fish stock % | 20 | 25 | 50 | 80 | 90 | 95 |
|---|---|---|---|---|---|---|
| PH | 4.64 | 4.80 | 5.61 | 6.58 | 7.15 | 7.64 |

## Yearly benefits of biodiversity due to acidification reduction in Sweden (€)

| | PH limit 6.58 | | | | pH limit 7.93 | | | |
|---|---|---|---|---|---|---|---|---|
| WTP | 0.42 | 1.61 | 2.8 | 10.8 | 1.5 | 5.6 | 9.7 | 37.7 |
| Total benefits (mio)* | 0.4 | 1.7 | 2.9 | 11.2 | 1.5 | 5.8 | 10.1 | 38.9 |
| Total benefits(mio) ** | 1.7 | 6.5 | 11.3 | 43.9 | 5.9 | 22.7 | 39.6 | 153 |

*) if 14% fishing population (only adults and elderly and 0-17 not included, **) if 55% fishing population.

In the case of MWTP of 24 SEK (2.2 €), this value would correspond to around 0.42 € in the case of increasing the pH levels from the status quo situation to 6.58

**PV of Costs for the Swedish TP and SC scenarios**

| | Taxpayers scenario | Source contributor scenario |
|---|---|---|
| SO2 abatement MC | 10.56 | 49.9 |
| NOx- stationary abatement MC | 106 | 118.4 |
| NH3 abatement MC | 4.8 | 4.4 |
| Total | 121.4 | 172.8 |

**Biodiversity benefits (million €$_{2000}$)**

| | PV |
|---|---|
| Biodiversity – fish occurrence concerning 14 % of the Swedish population | 19.02 |
| Biodiversity – fish occurrence concerning 55 % of the Swedish population | 74.71 |

**Benefits of reduced base cation depletion (million €$_{2000}$)**

| | PV |
|---|---|
| Total acid equivalent reduction | 14.86 |
| Reduced base cation depletion if dep > CL | 12.72 |

**Benefits of reduced corrosion (million €$_{2000}$)**

| | PV |
|---|---|
| Construction material | 31.28 |

## Health benefits (million €$_{2000}$)

| | PV |
|---|---|
| Reduced days of breathing discomfort from NO2 | 0.017 |
| Reduced mortality from NO2 - elders | 10.290 |
| Congestive heart failure - elders | 0.047 |
| Restricted activity days - adults | 7.707 |
| Bronchodilator usage - asthma adults | 1.814 |
| Cough - asthma adults | 2.101 |
| Lower resp symptoms - asthma adults | 0.135 |
| Bronchodilator usage - asthma children | 0.131 |
| Cough - asthma children | 0.255 |
| Lower resp symptoms - asthma children | 0.035 |
| Respiratory hospital admission (RHA) | 0.039 |
| Cerebrovascular hospital admission | 0.364 |
| Chronic mortality - deaths | 86.690 |
| Chronic bronchitis - adults | 11.010 |
| Chronic cough – children | 0.370 |
| | |
| (Chronic mortality - non-discounted VSL | 194.0 |

## Net present value

| | Tax payer, (TP) | Source contributor, (SC) | Control scenario, TP | Control scenario, SC |
|---|---|---|---|---|
| Estimates: | 121.2 | 69.8 | 204.6 | 144.3 |

## Sensitivity analysis

| Scenario Summary<br>Variable Discount rate | | | | | | |
|---|---|---|---|---|---|---|
| Changing Cells: | | | | | | |
| Discount Rate | 0% | 2.00% | 4.00% | 6.00% | 8.00% | 10.00% |
| Mortality (million €) | 1.00 | 0.70 | 0.49 | 0.35 | 0.25 | 0.18 |
| Net benefit (million €): | | | | | | |
| TP | 316.50 | 191.86 | 121.24 | 80.08 | 55.39 | 40.12 |
| SC | 262.25 | 139.32 | 69.76 | 29.24 | 4.93 | -10.09 |