

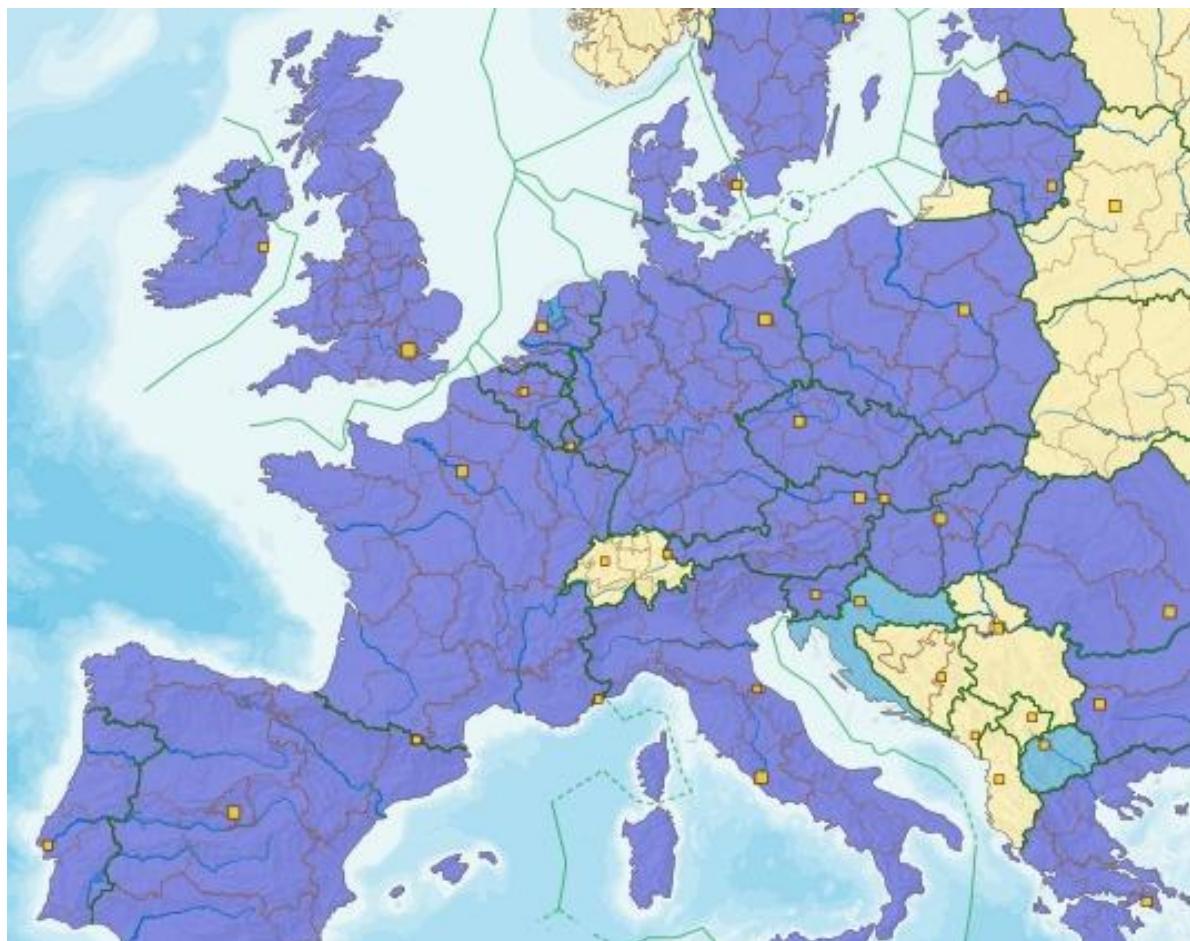
Madrid, 25-26 March 2014 | Juerg Heldstab INFRAS, Zurich

INFRAS

**Swiss Federal Office for the Environment FOEN**

**Switzerland's Nitrogen  
Budgets 1994, 2005, 2020**

# Switzerland



**Inhabitants 2010:**  
8.0 mio.

**Area**  
42'000 km<sup>2</sup>  
forests 31%  
agriculture 24%  
alpine pasture 16%  
settlement 7%

**Agricul. products**  
milk 4 mio. t  
meat 0.4 mio t  
crop, fod. 28 mio. t

# **Switzerland's N Budgets 1994, 2005, 2020**

## **Editor(s)**

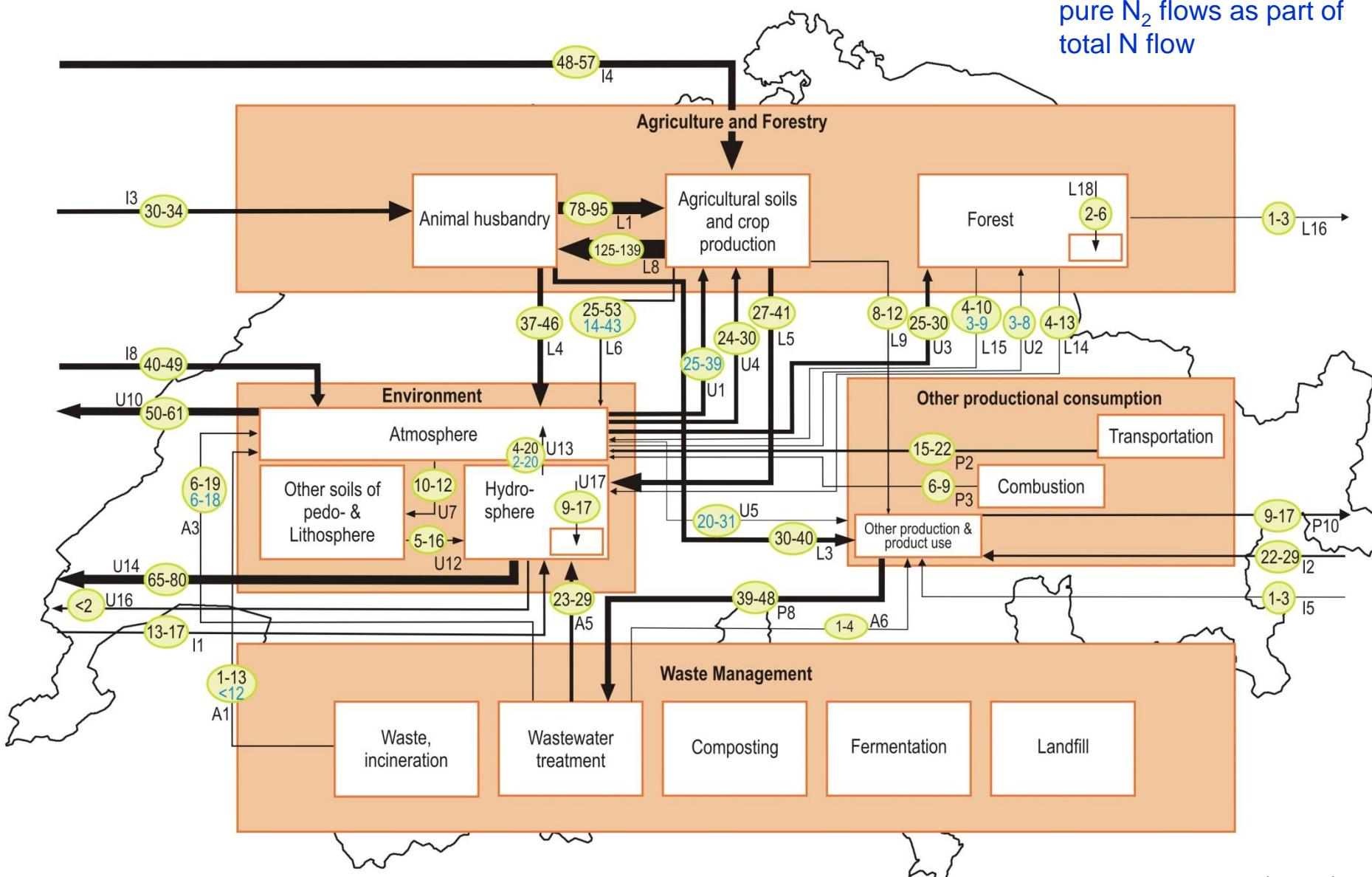
Swiss Fed. Office for the Environment (Swiss Fed. Off. of Agriculture, 1994)

## **Purpose / rationale for N budgets**

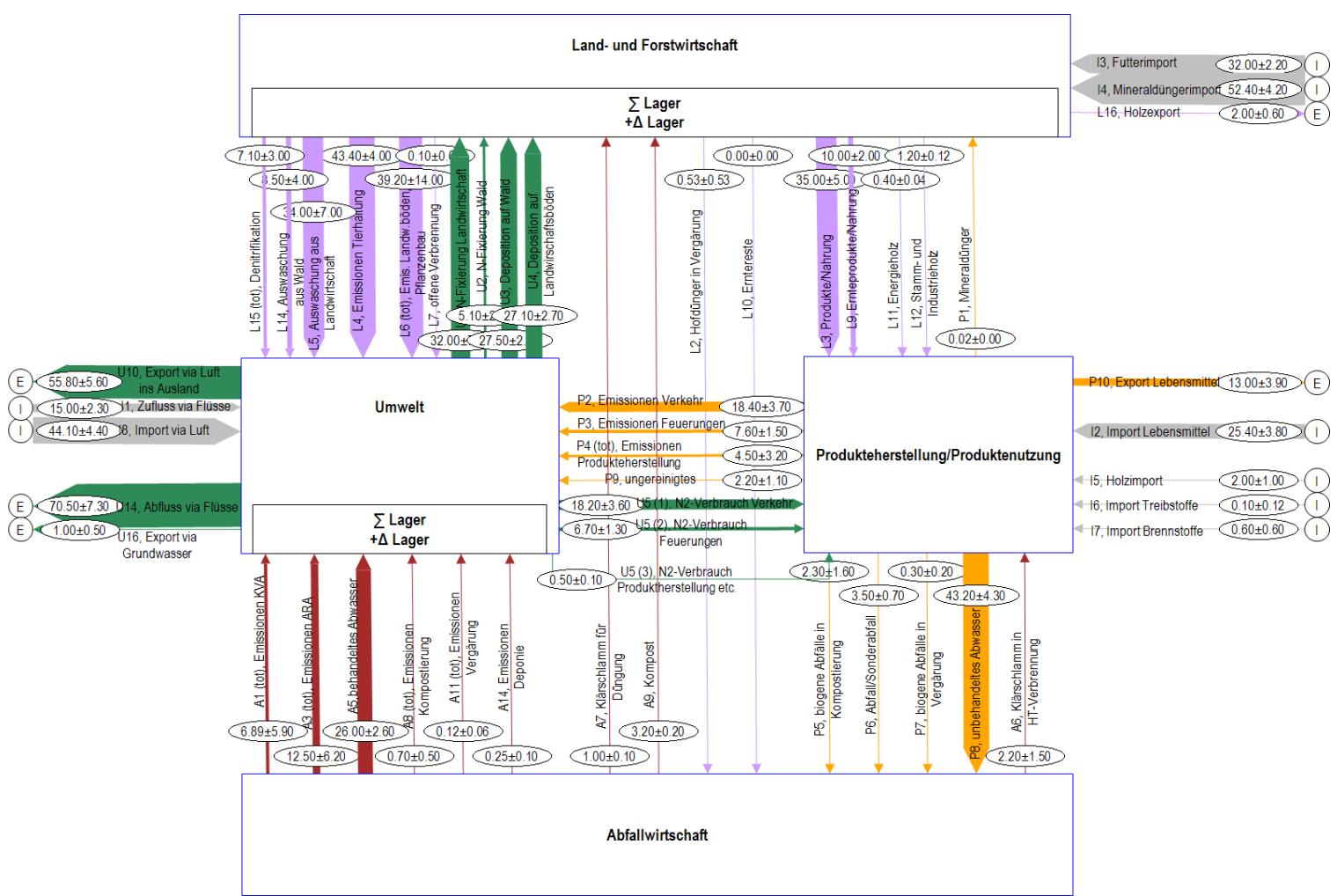
- First budget 1994:
  - Important milestone for Switzerland's environmental protection policy, N regulations and ecological targets
  - First national strategy to reduce nitrogen emissions/losses
- Update 2005:
  - what happened between 1994 and 2005?
  - Improved methodology for flow analysis, synthetic overview of Switzerland's N flows
- Projection 2020: are we on track with N targets?

# N Budget Switzerland 2005

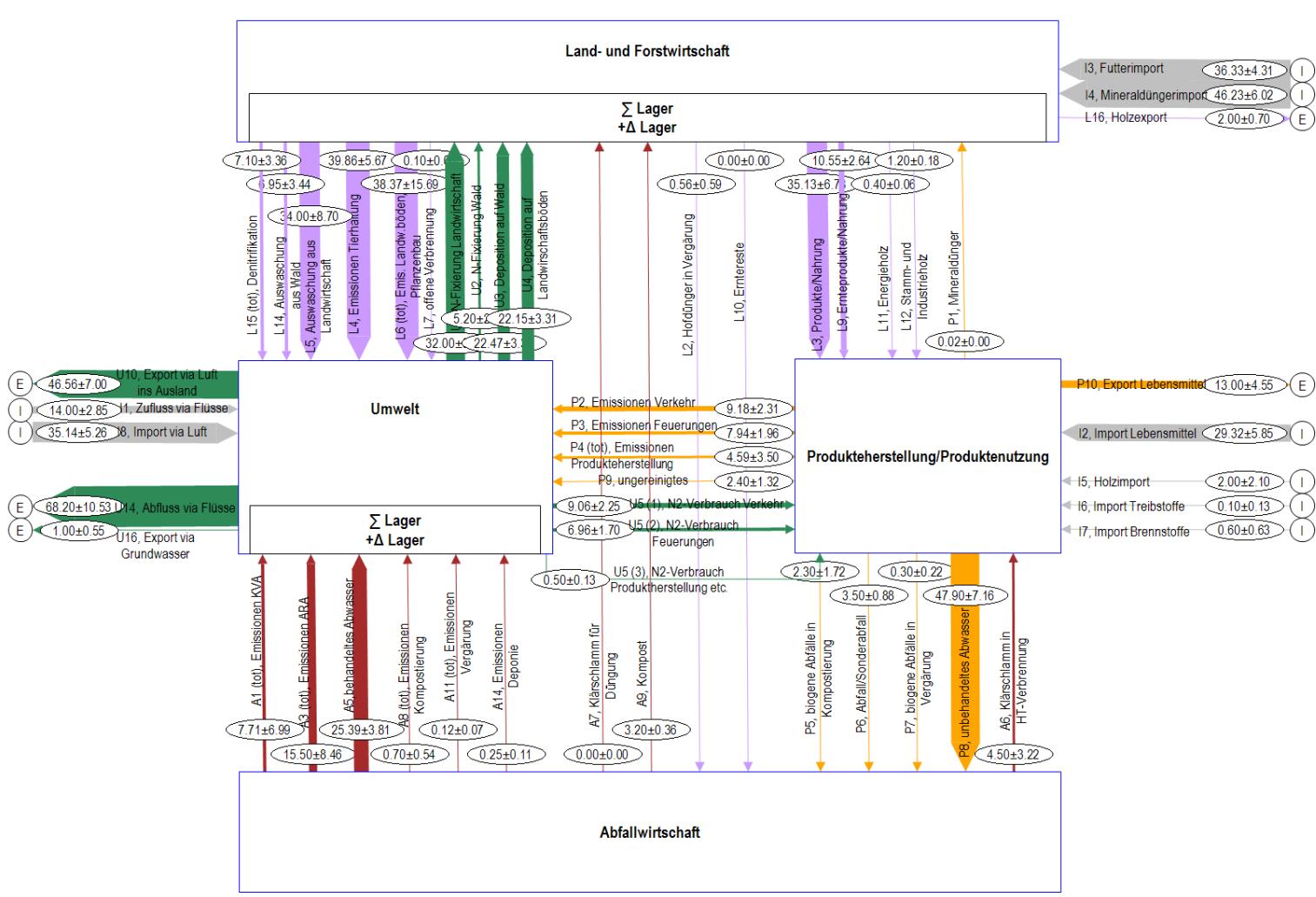
total flow in 1000 t N / a  
pure  $\text{N}_2$  flows as part of  
total N flow



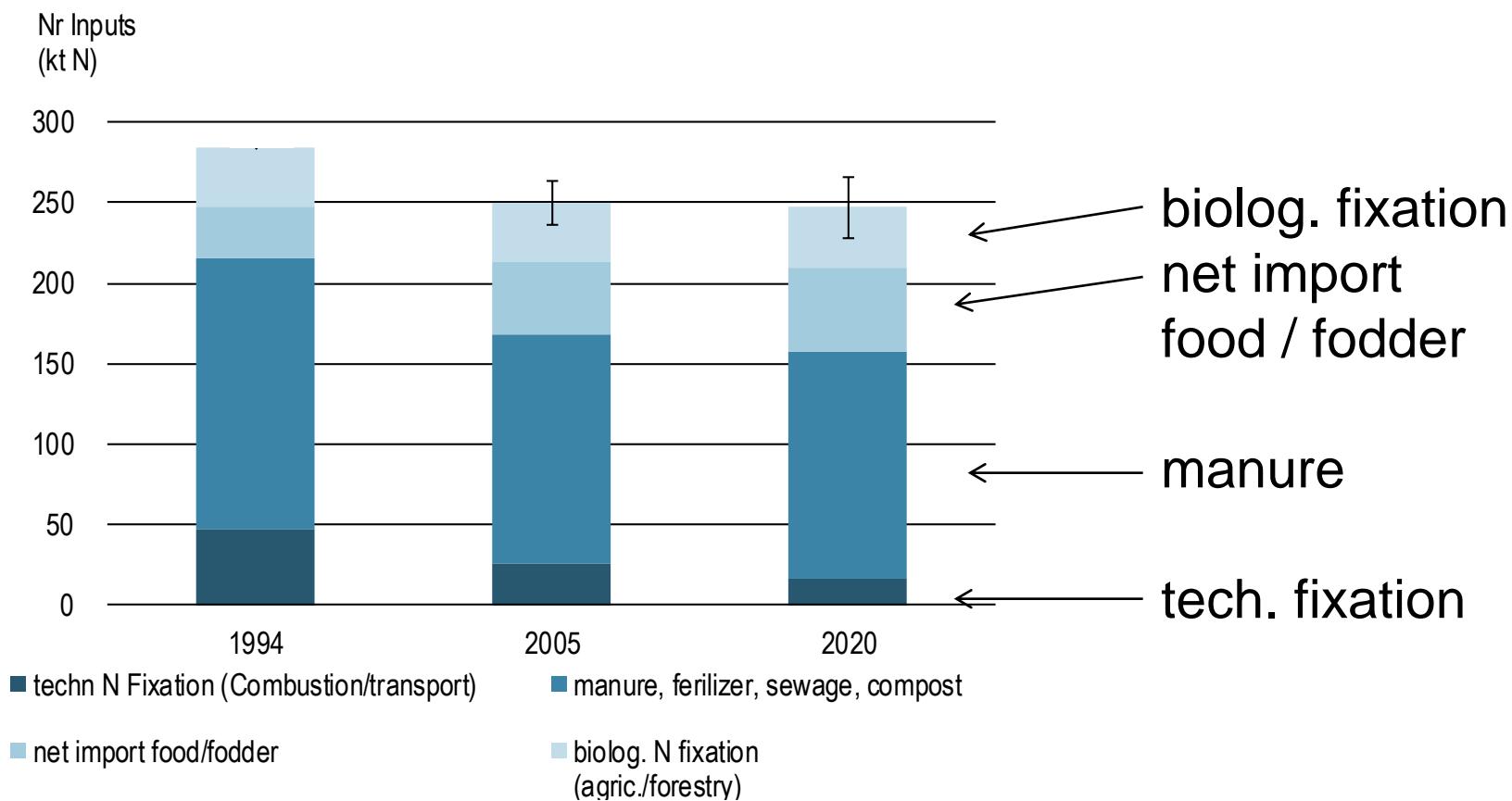
# N flows 2005 (aggregated to 4 sub-systems)



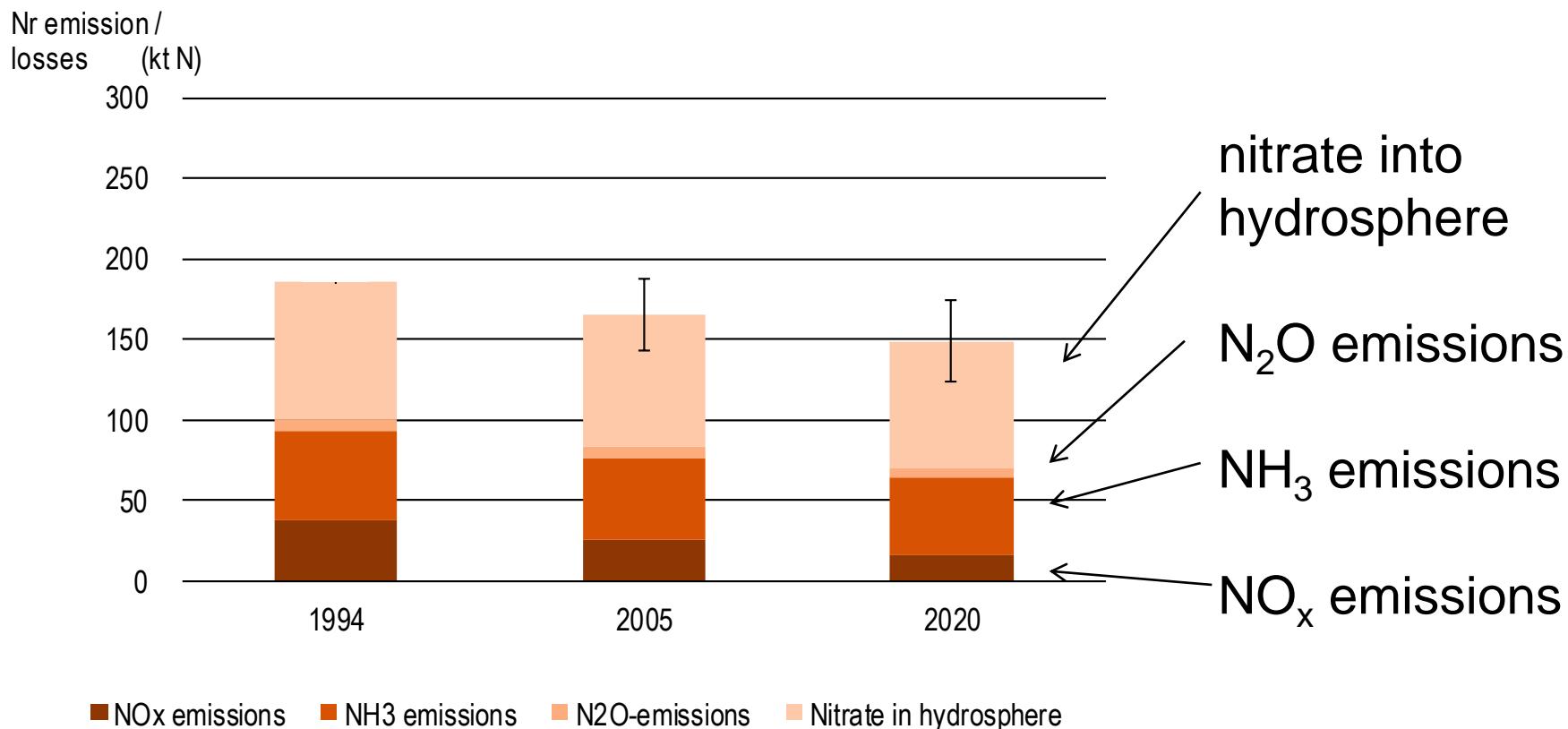
# N flows 2020 (aggregated to 4 sub-systems)



# Nr Inputs (ENA representation)



# Nr Losses / Emissions (ENA representation)



# N Balance OSPAR

| N balance OSPAR           | 1994       | 2005       | 2020       |
|---------------------------|------------|------------|------------|
|                           | k t N      |            |            |
| <b>Input</b>              |            |            |            |
| import fodder             | 26         | 32         | 36         |
| mineral fert.             | 59         | 52         | 46         |
| compost                   | 7          | 5          | 5          |
| deposition on agric. land | 31         | 27         | 22         |
| N fixation agric.         | 32         | 32         | 32         |
| Sum IN                    | <b>155</b> | <b>148</b> | <b>141</b> |

| Output  |           |           |           |
|---------|-----------|-----------|-----------|
| crops   | 10        | 10        | 11        |
| meat    | 28        | 35        | 35        |
| Sum OUT | <b>38</b> | <b>45</b> | <b>46</b> |

|                              |              |              |              |
|------------------------------|--------------|--------------|--------------|
| <b>losses (IN-OUT)</b>       | 117          | 103          | 95           |
| <b>N efficiency (OUT/IN)</b> | <b>24.5%</b> | <b>30.6%</b> | <b>32.6%</b> |

# Imports and Exports of Nr

| subsystem N flow             | imports<br>kt N | exports<br>kt N | net<br>kt N |
|------------------------------|-----------------|-----------------|-------------|
| Agriculture/Forestry         |                 |                 |             |
| wood                         |                 | 2               | -2          |
| fodder                       | 32              |                 | 32          |
| mineral fertilizer           | 52              |                 | 52          |
| other Production/Consumption |                 |                 |             |
| food                         | 25              | 13              | 12          |
| fuels                        | 1               |                 | 1           |
| wood                         | 2               |                 | 2           |
| Environment                  |                 |                 |             |
| atmosphere                   | 44              | 56              | -12         |
| rivers                       | 15              | 73              | -58         |
| groundwater                  |                 | 1               | -1          |
| total                        | 171             | 145             | 26          |
| increase of stocks           |                 | 17              | -17         |
| unbalanced                   |                 | 9               | -9          |
| sum (control)                | 171             | 171             | 0           |

Switzerland is a net importer: 2005: 26 kt N => 3.5 kg N per inhabitant

# Projections 2020 and Targets

| Parameter           | Target systems          |                 |                          |              |
|---------------------|-------------------------|-----------------|--------------------------|--------------|
|                     | Air Poll./Crit.<br>Load | Crit. Load      | Env. target<br>agric.    | OSPAR        |
|                     | emissions               |                 |                          | losses hydro |
|                     | NO <sub>x</sub>         | NH <sub>3</sub> | NH <sub>3</sub> (agric.) | N            |
|                     | in 1000 ton N (kt N)    |                 |                          |              |
| Target              | 13                      | 31              | 25                       | 42           |
| Level 2005          | 25                      | 51              | 49                       | 72           |
| Level 2020/baseline | 16                      | 48              | 45                       | 69           |
| Gap to target 2020  | 3                       | 17              | 20                       | 28           |

No one of the N targets is supposed to be met in 2020!

# If...Then Analyses for further reductions until 2020

## 1. New national energy strategy + climate policy

Back out of nuclear energy and CO<sub>2</sub>: -20% (2020)

=> emissions -1% N (compared to baseline 2020)

## 2. Federal air pollution strategy (2009)

Implementation / realisation of all measures (transport, combustion)

=> emissions -2% N (compared to baseline 2020)

## 3. Agriculture

measures for animal housing, manure storage+application

=> emissions /losses -1%...-2% N (2020), -20%...-30% (2040)

Reduction potential 2020 in all sectors energy, industry, agriculture are very low, in agriculture also low but rather high – in the long run!

# **Factors for successful realisation of N budget**

## **Basis**

Willingness of administration to establish N budgets

## **Data availability**

UNFCCC inventory

CLRTAP inventory

broad agricultural surveys exist and research results available  
custom statistics

## **Interannual comparison 2005/2020**

homogeneous and consistent time series of important flows

# **Challenges to build up N budgets**

## **Coordination**

between environment, agriculture, transport, waste,...

## **Data**

missing data (leaching) incomplete data (export by rivers) or different values for same flows

missing knowledge of uncertainties (unbalanced eq.)  
verification is complex, laborious and expensive

## **Methods**

different definitions of pools complicate budgeting (1994!)  
sharp annual values versus means (outflow rivers)

## **Interannual comparison 1994 < = > 2005/2020**

incompatibilities caused by switching methods  
inconsistent time series (e.g. dislocation of measurement sites)

# **Publications**

**Reports in German only – but with summaries in English, French, Italian**

**Report 1994**

<http://www.bafu.admin.ch/publikationen/publikation/01546/index.html?lang=de>

**Report 2005**

<http://www.bafu.admin.ch/publikationen/publikation/01586/index.html?lang=de>

**Report 2020**

[http://www.bafu.admin.ch/publikationen/publikation/01713/index.html?lang=de&show\\_kat=/publikationen](http://www.bafu.admin.ch/publikationen/publikation/01713/index.html?lang=de&show_kat=/publikationen)

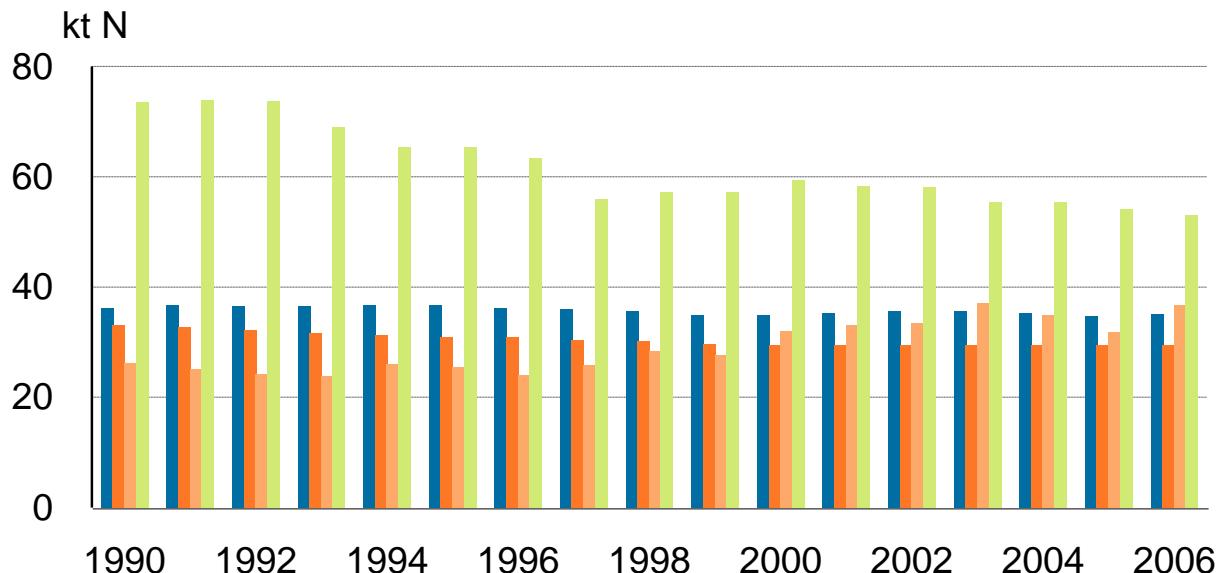
[juerg.heldstab@infras.ch](mailto:juerg.heldstab@infras.ch) - [www.infras.ch](http://www.infras.ch)

**The end...**

# Trends 1994-2005

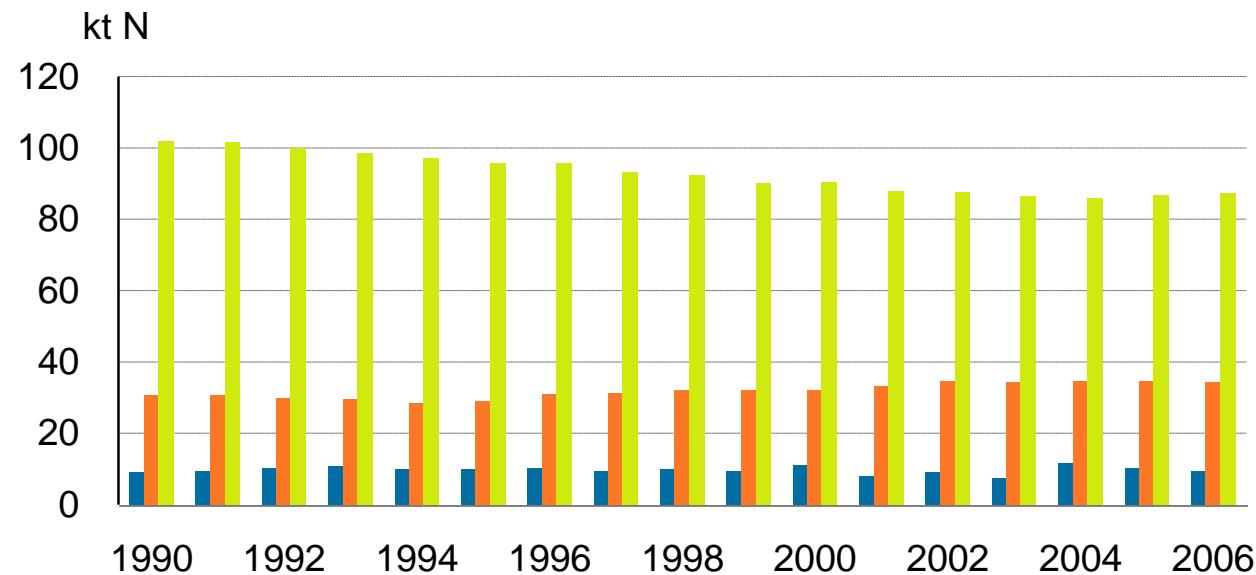
## Inputs agriculture

- N-fixation
- deposition
- imported fodder
- mineral fertilizer



## Outputs agriculture

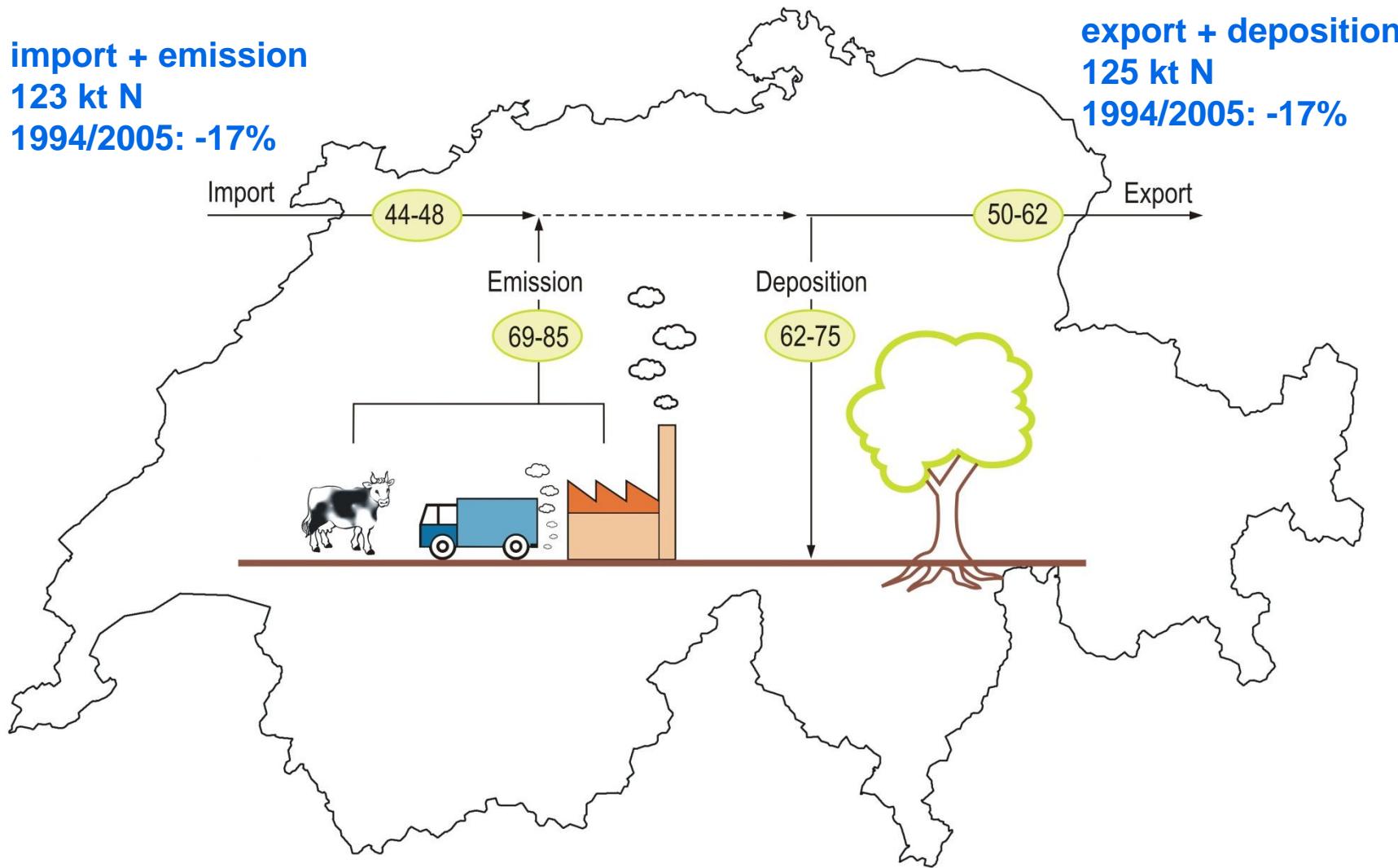
- vegetable products
- animal products
- manure (liquid and solid)



# Atmospheric N budget 2005

import + emission  
123 kt N  
1994/2005: -17%

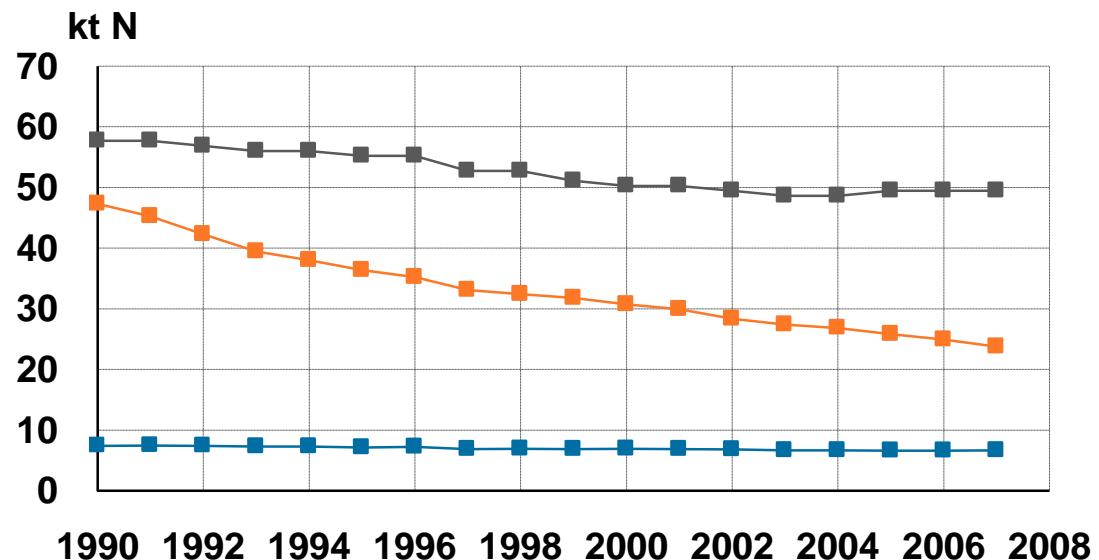
export + deposition  
125 kt N  
1994/2005: -17%



# Emission trends 1994-2005

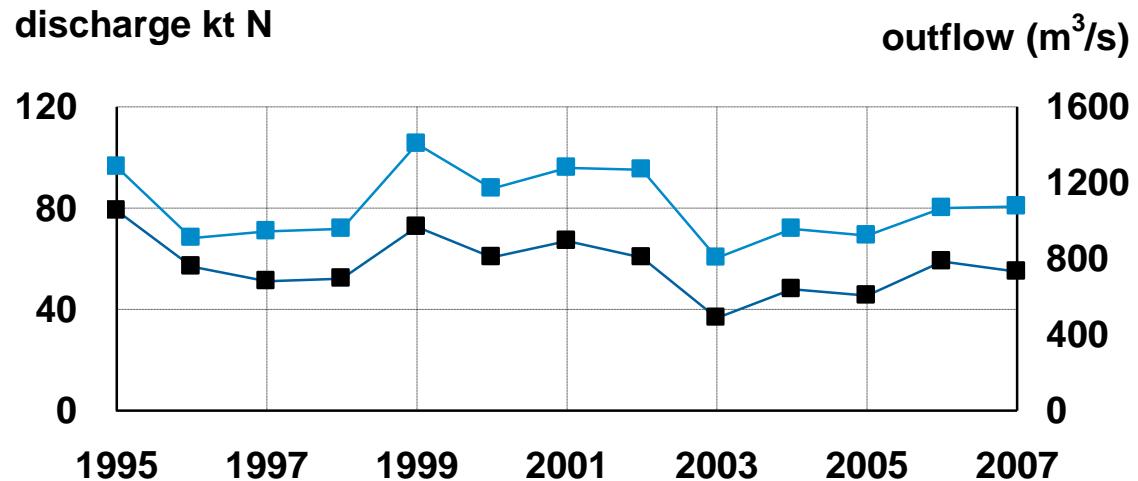
## Emissions in atmosphere

- □ NOx
- ■ NH<sub>3</sub>
- □ N<sub>2</sub>O



## Export via waterflow

- ■ outflow (m<sup>3</sup>/s)
- □ mean discharge (kt N)

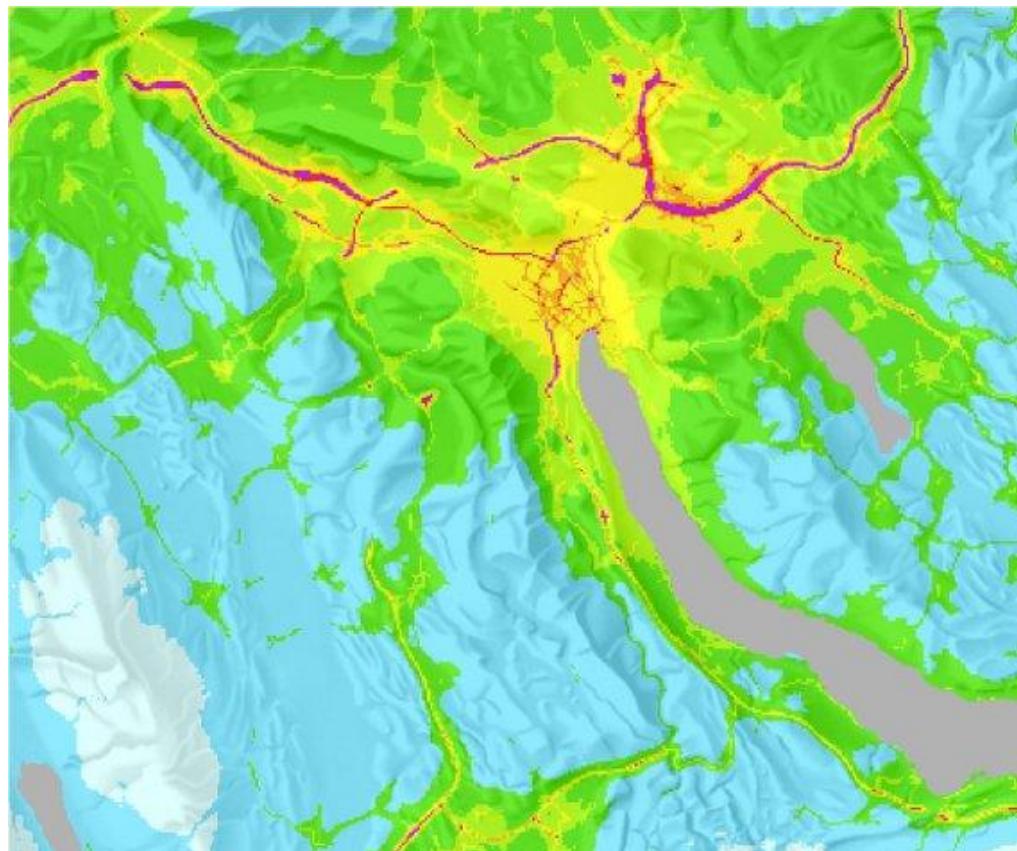


# Exceedance of environmental targets (1)

## Ambient NO<sub>2</sub> concentration

limit value (30 µg/m<sup>3</sup>) exceeded in cities / along highways (2010)

Zurich metropolitan area:



NO<sub>2</sub> in µg/m<sup>3</sup>

|         |
|---------|
| > 36    |
| 33 - 36 |
| 30 - 33 |
| 25 - 30 |
| 20 - 25 |
| 15 - 20 |
| 10 - 15 |
| ≤ 10    |

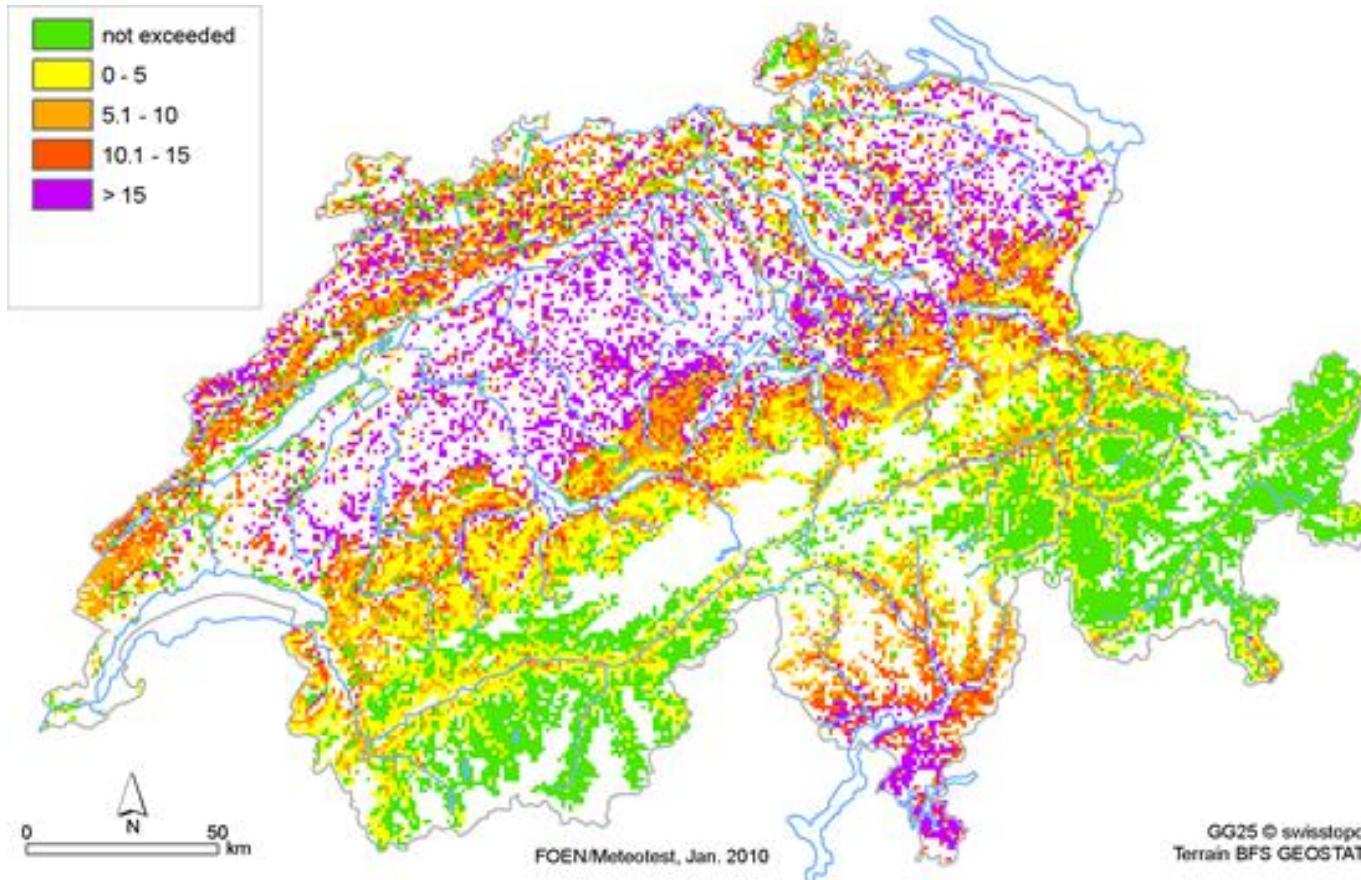
above  
limit

FOEN (2011)

# Exceedance of environmental targets (2)

## Critical loads

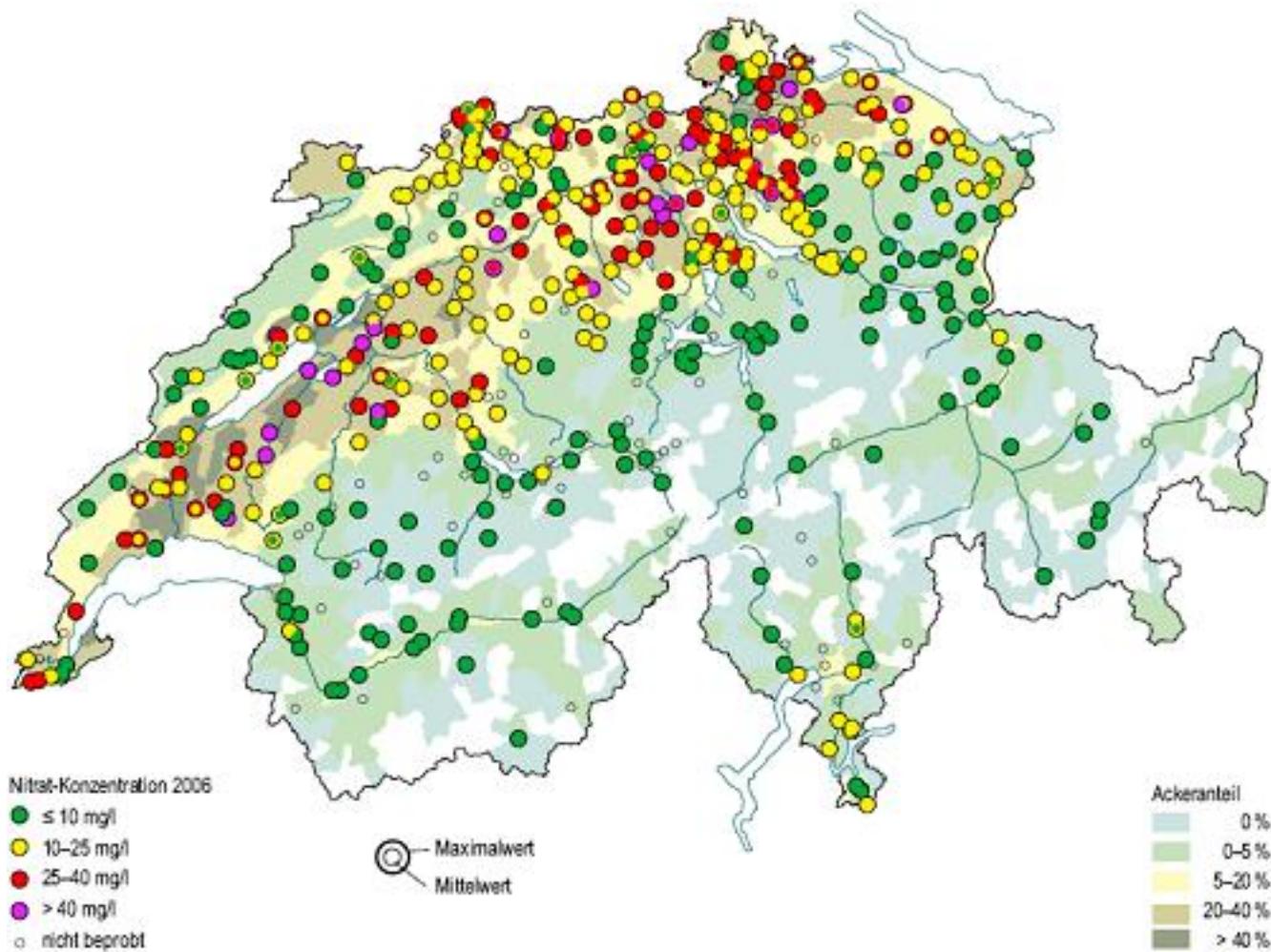
exceedances of critical N load in 2007 (kg N per hectare per year)



CLnutN = Critical Loads for Nitrogen for forest ecosystems (mass balance method, UNECE Mapping Manual)  
CLempN = Empirical Critical Loads for Nitrogen for (semi)natural ecosystems (UNECE Mapping Manual).

# Exceedance of environmental targets (3)

Limit for nitrate concentration in groundwater: < 25 mg/l



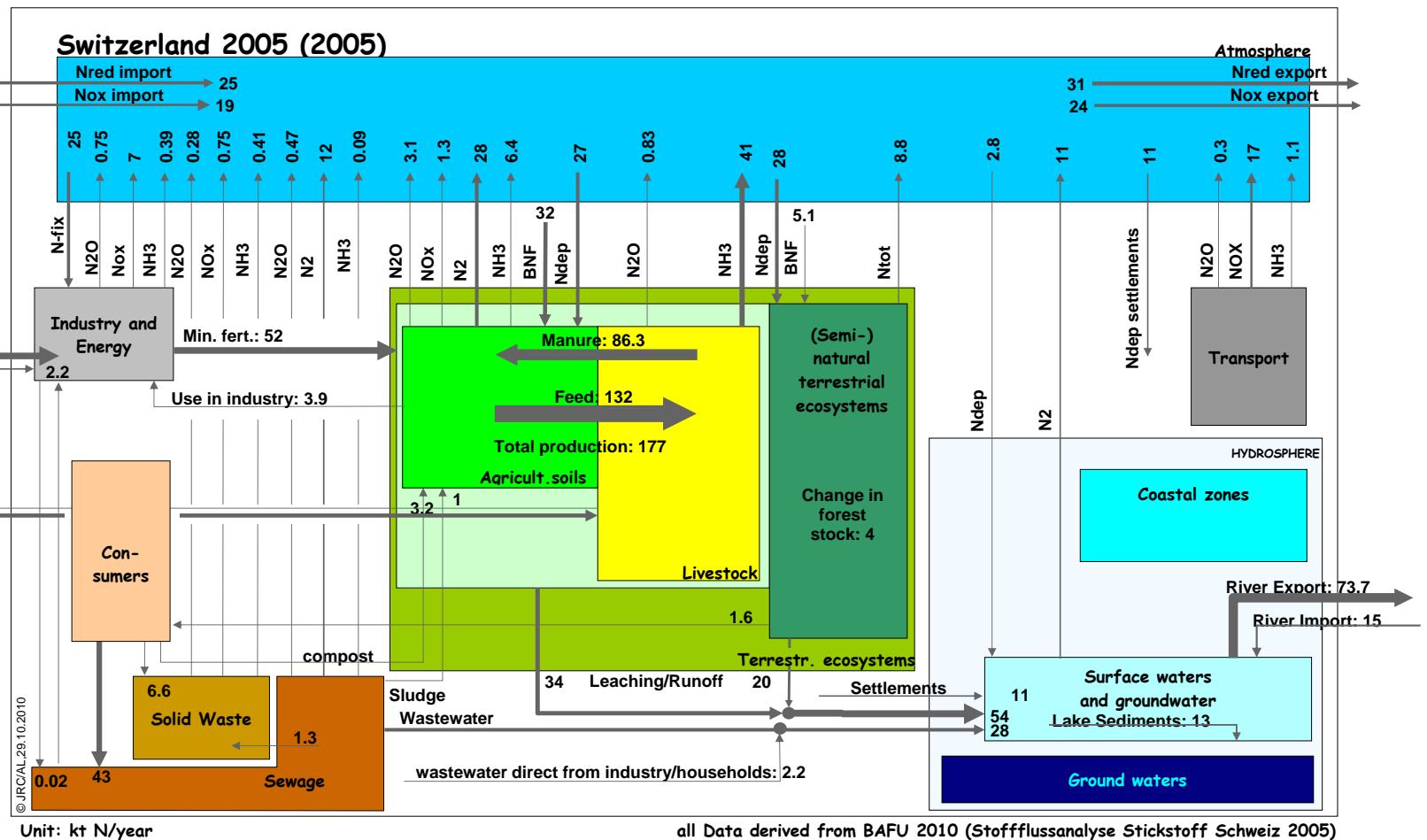
# Exceedance of environmental targets (4)

**N input to surface waters for the Rhine catchment area,  
PARCOM recommendation 88/2 of 17 June 1988:  
50% reduction within 1985-1995**

N reduction achieved between 1985 and 2001 for the Rhine catchment:  
(Prasuhn/Sieber, 2005)

| target 1985-1995 | reduction achieved until 2001 |
|------------------|-------------------------------|
| -50%             | -23%                          |

# Transcription to Adrian Leip's tool JRC/EPNB



see also Adrian Leip's poster here in Edinburgh in S13!