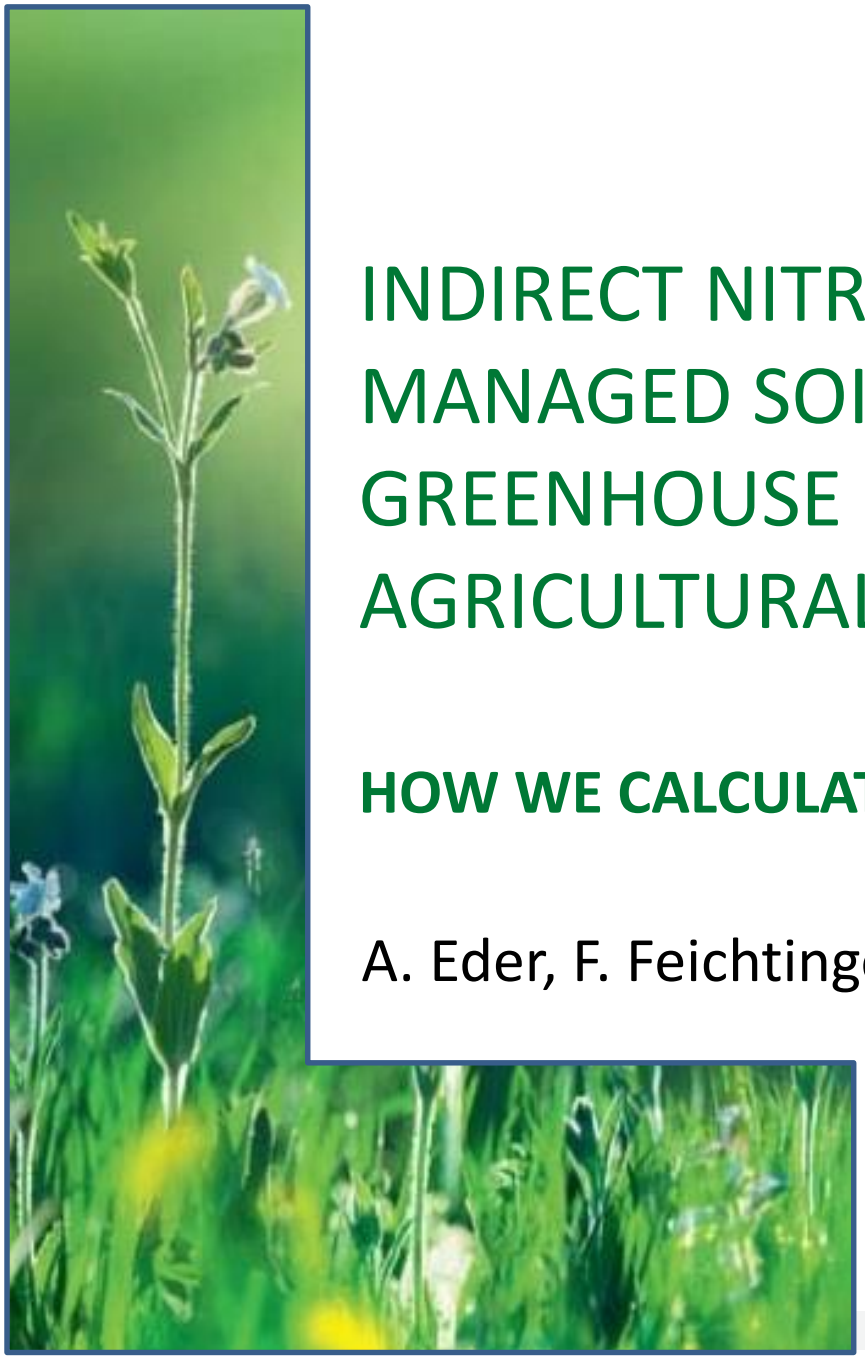


MINISTERIUM FÜR EIN LEBENSWERTES ÖSTERREICH

BUNDESAMT FÜR WASSERWIRTSCHAFT

INDIRECT NITROGEN LOSSES OF MANAGED SOILS CONTRIBUTING TO GREENHOUSE GASES EMISSIONS OF AGRICULTURAL AREAS IN AUSTRIA OR

HOW WE CALCULATED THE FACTOR $FRAC_{LEACH}$

A. Eder, F. Feichtinger, G. Blöschl, P. Strauss,

With support from

M. Herndl, G. Klammler, J. Hösch, E. Erhart

BACKGROUND

- The Kyoto protocol asks for legally binding reductions in national greenhouse gas emissions

- Special emphasis on N_2O (global warming potential 296 times of CO_2)

- Main sources of N_2O emissions are agriculture, forestry and other land uses (59% of total N_2O emissions) but only 9.1% of total greenhouse gases are emissions from agriculture, forestry and other land uses

- Annual national inventory reports must be compiled using methodology according to IPCC guidelines (IPCC, 2006)
    - CO_2
    - Other gases than CO_2 (N_2O)
        - Direct emissions from managed land
        - Indirect emissions from managed land
            - ✓ Volatilisation
            - ✓ **Leaching**

The IPCC 'Tier 1' method

$$N_2O_{(L)} - N = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) \cdot Frac_{LEACH} \cdot EF_5$$

$N_2O_{(L)}$-N = annual amount of N_2O nitrogen by leaching and runoff of nitrogen additions to managed soils ($kg \cdot yr^{-1}$)

F_{SN} = annual amount of synthetic fertilizer nitrogen applied to soils ($kg \cdot yr^{-1}$)

F_{ON} = annual amount of managed animal manure, compost, sewage sludge and other organic nitrogen additions applied to soils ($kg \cdot yr^{-1}$)

F_{PRP} = annual amount of urine and dung nitrogen deposited by grazing animals ($kg \cdot yr^{-1}$)

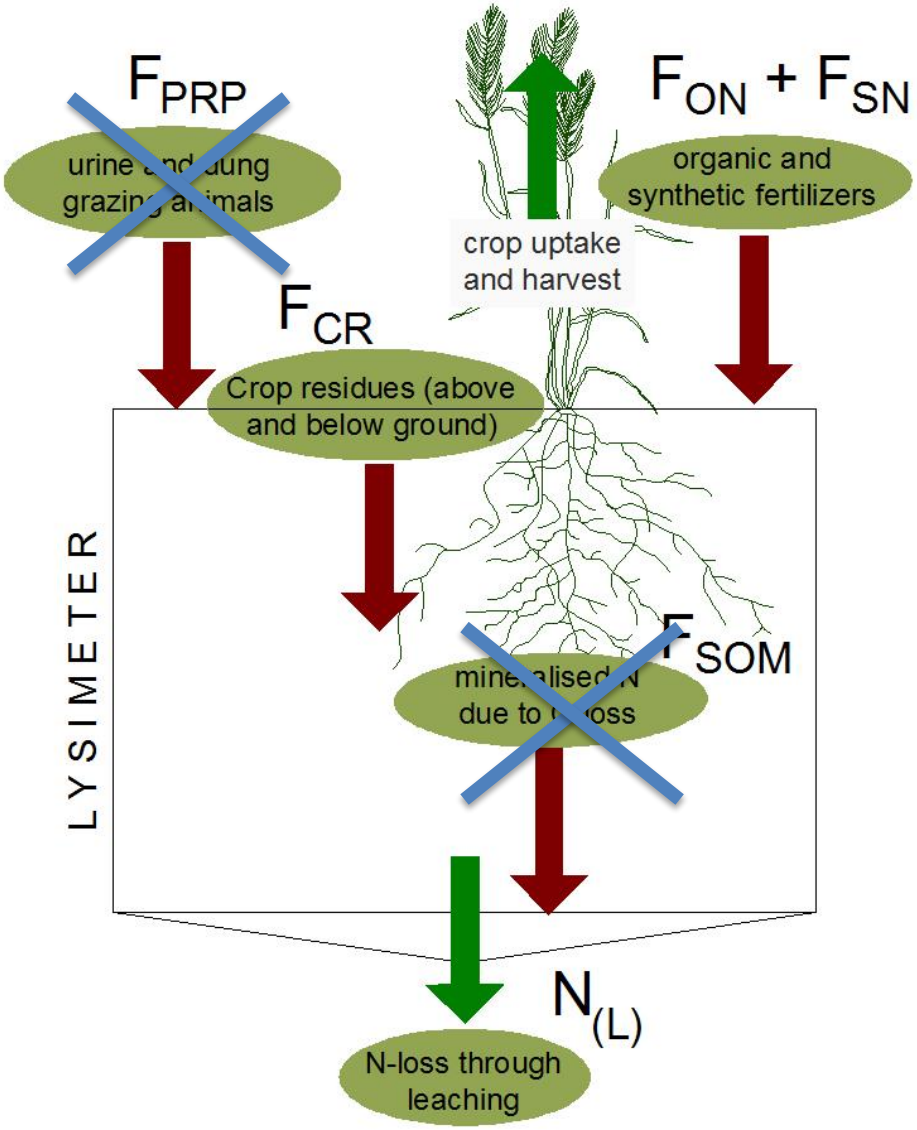
F_{CR} = amount of nitrogen in crop residues (above and below ground, including nitrogen fixing crops, and from forage/pasture renewal, returned to soils annually ($kg \cdot yr^{-1}$)

F_{SOM} = annual amount of nitrogen mineralised in soils associated with loss of soil carbon from soil organic matter as a result of changes in land use or land management ($kg \cdot yr^{-1}$)

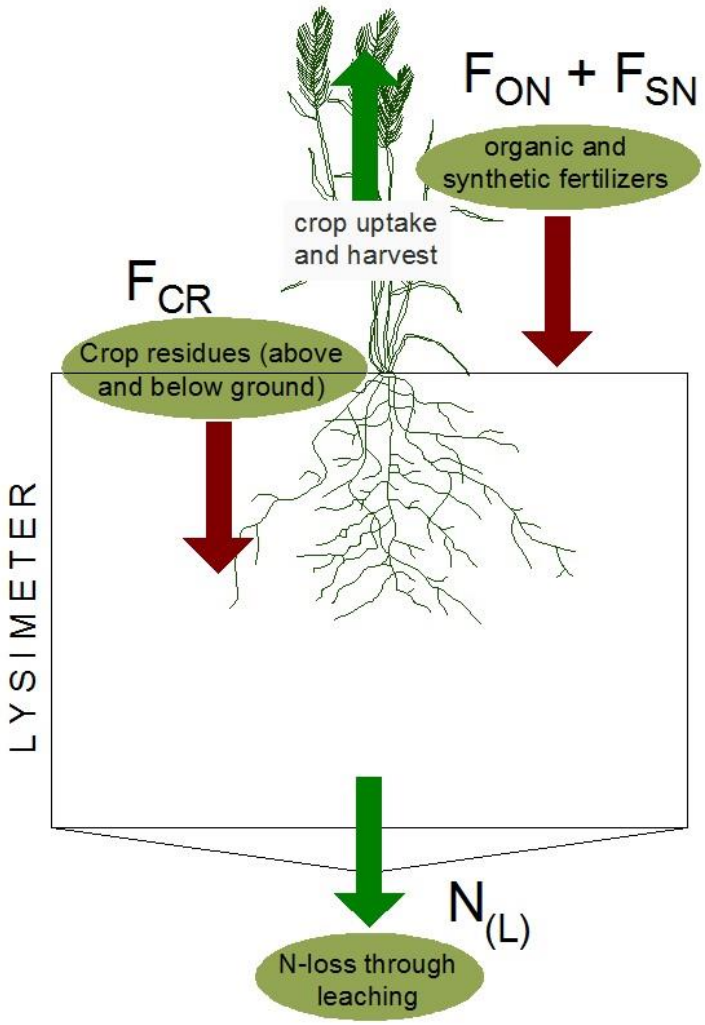
$Frac_{LEACH}$ = fraction of all nitrogen added to or mineralised in managed soils that is lost through leaching and runoff ($kg \cdot kg^{-1}$)

EF_5 = emission factor for N_2O emissions from nitrogen leaching and runoff ($kg \cdot kg^{-1}$)

The IPCC 'Tier 1' method as graph (I)



The IPCC ‘Tier 1’ method as graph (II)



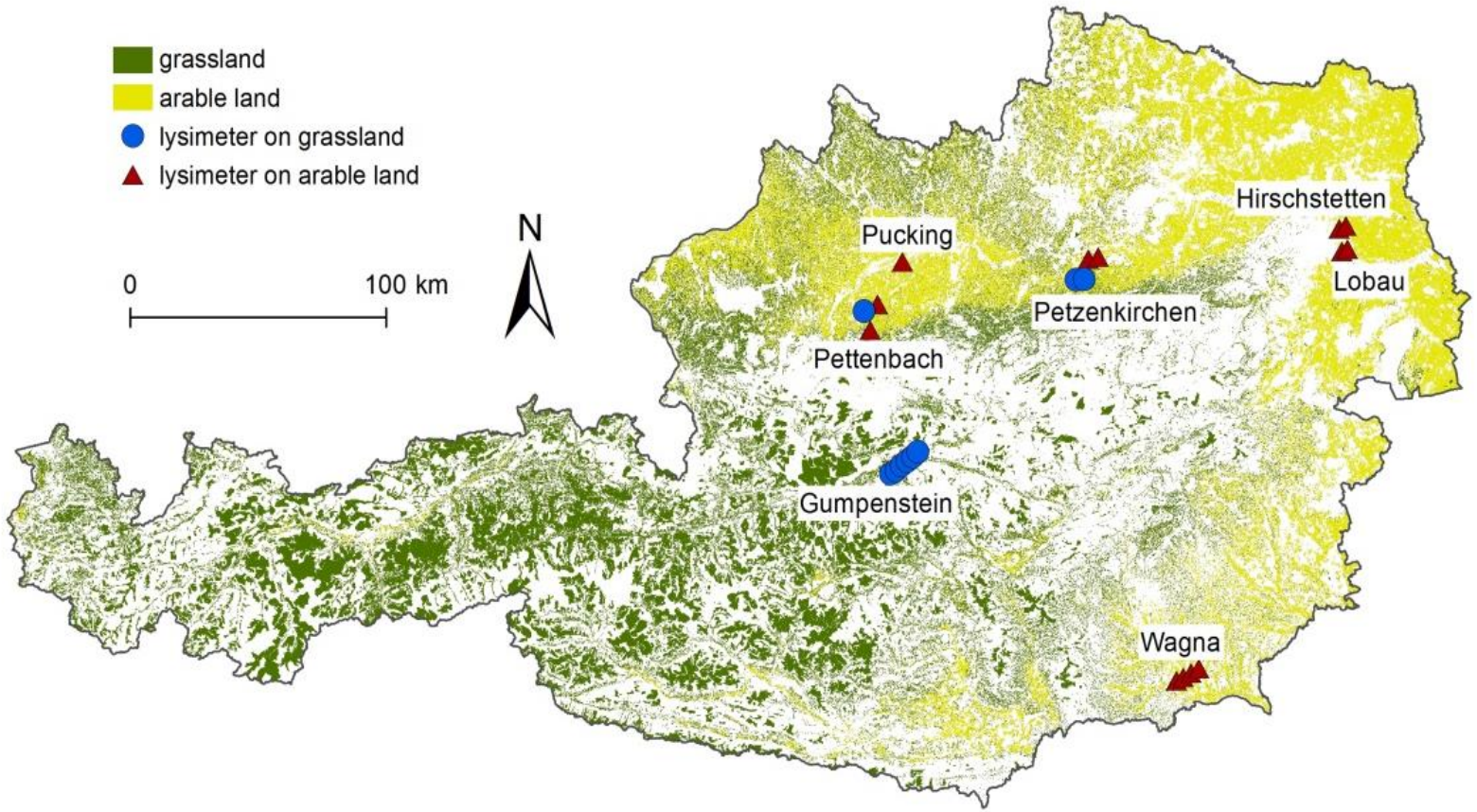
$$Frac_{LEACH} = N_{(L)} / (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM})$$

Some values presently used for $Frac_{LEACH}$

Default value for **$Frac_{LEACH}$** (IPCC) = 0.3

Country	**$Frac_{LEACH}$**
Belgium	0.12
Canada	0.18
Finland	0.15
Ireland	0.10
Kazakhstan	0.06
Liechtenstein	0.20
Netherlands	0.12
New Zealand	0.07
Norway	0.18
Slovakia	0.14
Switzerland	0.20
Ukraine	0.21

Lysimeter sites and distribution of agricultural land use in Austria



Necessary steps for a joint analysis

- Correcting for type, size and depth of lysimeter

  Example: gravity lysimeters yield different amount of seepage water compared to lysimeters with suction rack

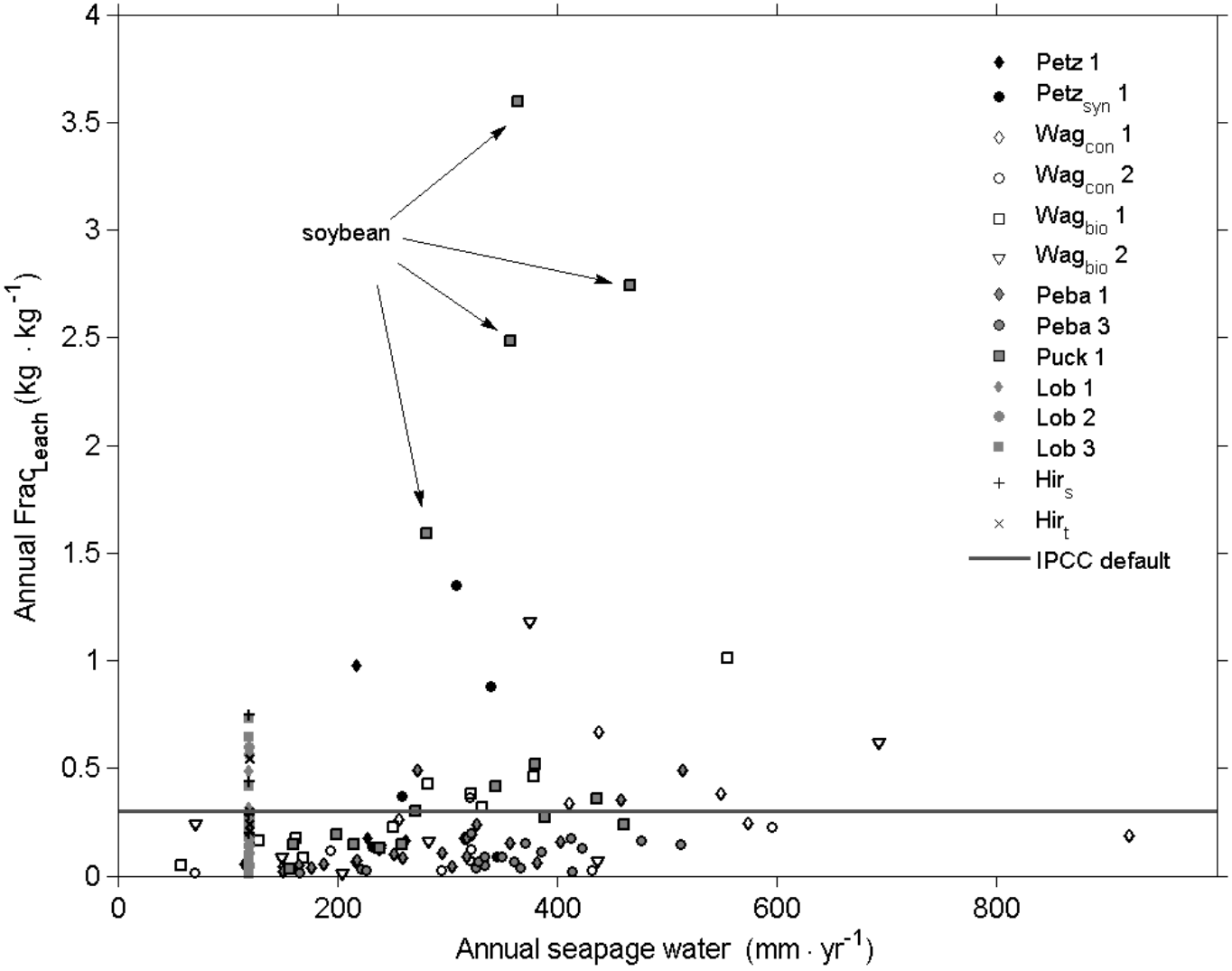
- Dealing with missing data

  Example: No data available, therefore calculation of below ground plant residues according to IPCC as a fraction of yield

Nitrogen losses through leaching, nitrogen sources and values for $Frac_{LEACH}$ on arable sites

site	$N_{(L)\_tot}$ kg N · ha^{-1}	F_{SN_tot} kg N · ha^{-1}	F_{ON_tot} kg N · ha^{-1}	F_{CR_tot} kg N · ha^{-1}	$Frac_{LEACH\_tot}$ -	$Frac_{LEACH\_mean}$ -	std. dev. -	n
Petz 1	225	908	366	357	**0.138**	0.288	0.390	5
$Petz_{syn}$ 1	278	0	506	398	**0.307**	0.565	0.541	5
Wag_{con} 1	638	1608	0	910	**0.253**	0.261	0.172	10
Wag_{con} 2	164	548	476	1151	**0.075**	0.121	0.120	8
Wag_{bio} 1	818	1370	293	1077	**0.299**	0.330	0.278	10
Wag_{bio} 2	270	0	0	1625	**0.166**	0.309	0.398	8
Peba 1	479	1571	769	1552	**0.123**	0.153	0.147	18
Peba 3	301	116	1888	1568	**0.084**	0.088	0.059	18
Puck 1	815	725	793	885	**0.921**	0.832	1.126	16
Lob 1	183	0	0	1041	**0.176**	0.207	0.151	13
Lob 2	248	0	285	929	**0.204**	0.230	0.173	13
Lob 3	241	302	0	1087	**0.173**	0.240	0.230	13
Hir_s	168	0	311	156	**0.359**	0.416	0.241	4
Hir_t	163	0	373	203	**0.282**	0.320	0.152	4

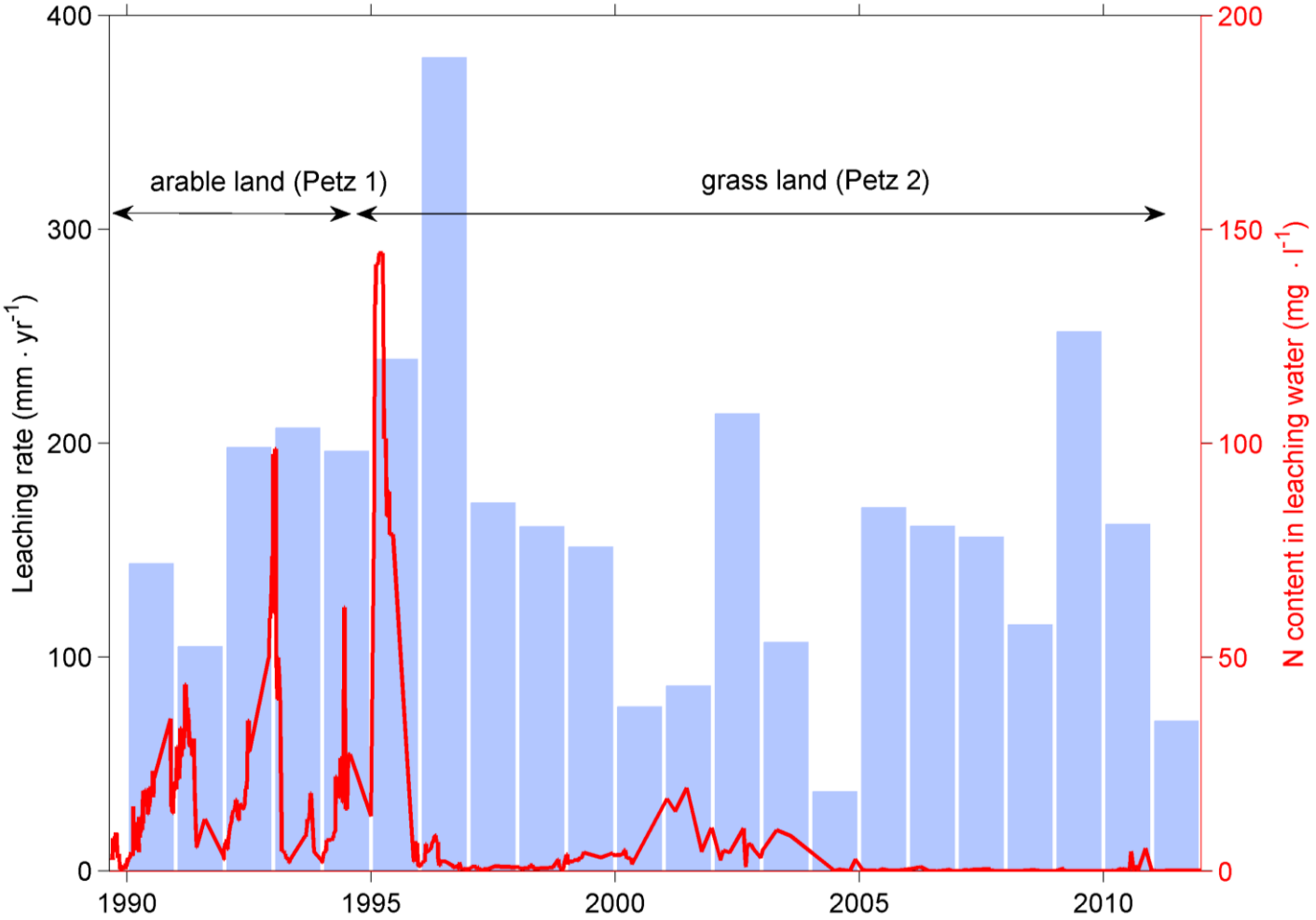
Annual values of $Frac_{LEACH}$ as a function of annual seepage water



Nitrogen losses through leaching, nitrogen sources and values for $Frac_{LEACH}$ on grassland sites

site	$N_{(L)\_tot}$ kg N · ha^{-1}	F_{SN_tot} kg N · ha^{-1}	F_{ON_tot} kg N · ha^{-1}	F_{CR_tot} kg N · ha^{-1}	$Frac_{LEACH\_tot}$ -	$Frac_{LEACH\_mean}$ -	std. dev. -	n
Petz 2	36	0	0	2279	**0.016**	0.018	0.015	6
$Petz_{syn}$ 2	18	0	0	1753	**0.011**	0.010	0.011	4
Peba 2	121	955	597	708	**0.054**	0.057	0.033	6
Gump 1	3	120	0	201	**0.011**	0.010	0.012	3
Gump 2	5	238	0	327	**0.008**	0.007	0.009	3
Gump 3	23	214	0	319	**0.043**	0.038	0.053	3
Gump 4	4	311	0	377	**0.006**	0.006	0.002	3
Gump 5	13	409	0	331	**0.017**	0.018	0.004	3

The grassland effect for leaching



Adding runoff

No measurements available – Data from simulation study on national balances of nitrogen input into rivers (BMLFUW, 2011) = 30 % addition for nitrogen in runoff, includes

- emissions from non agricultural land
- denitrification losses

Upper boundary

CONCLUSIONS

Mean values for $Frac_{LEACH}$ (only leaching) and modified $Frac_{Leach}$* (leaching and runoff) of all arable and grassland sites estimated from lysimeter data

	$Frac_{LEACH}$	$Frac_{LEACH}$*
arable land	0.254	0.277
grassland	0.021	0.027
Austria overall	0.135	0.150

Nutr Cycl Agroecosyst (2015) 101:351–364
DOI 10.1007/s10705-015-9682-9

ORIGINAL ARTICLE

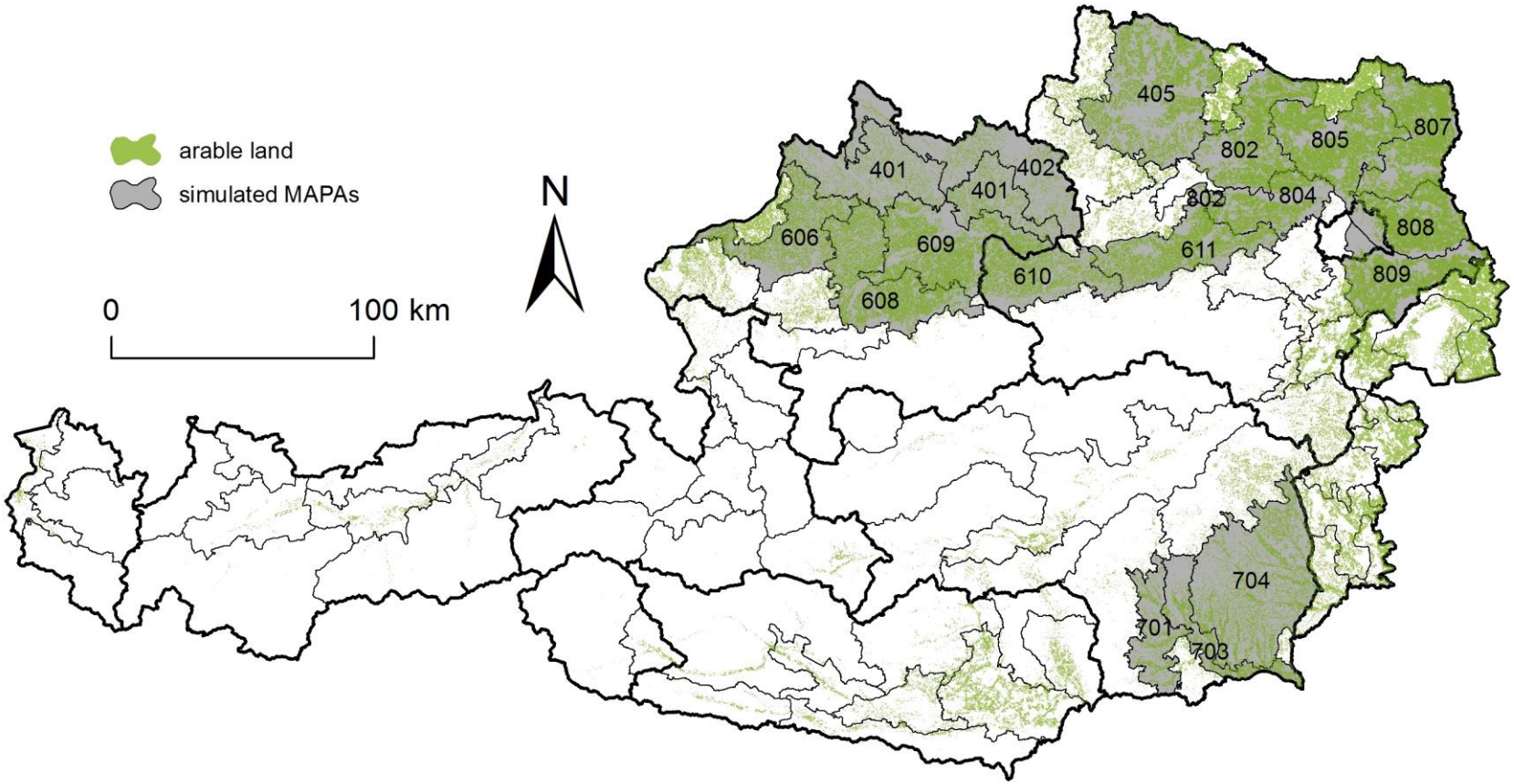
Indirect nitrogen losses of managed soils contributing to greenhouse emissions of agricultural areas in Austria: results from lysimeter studies

Alexander Eder · Günter Blöschl · Franz Feichtinger · Markus Herndl · Gernot Klammler · Johannes Hösch · Eva Erhart · Peter Strauss

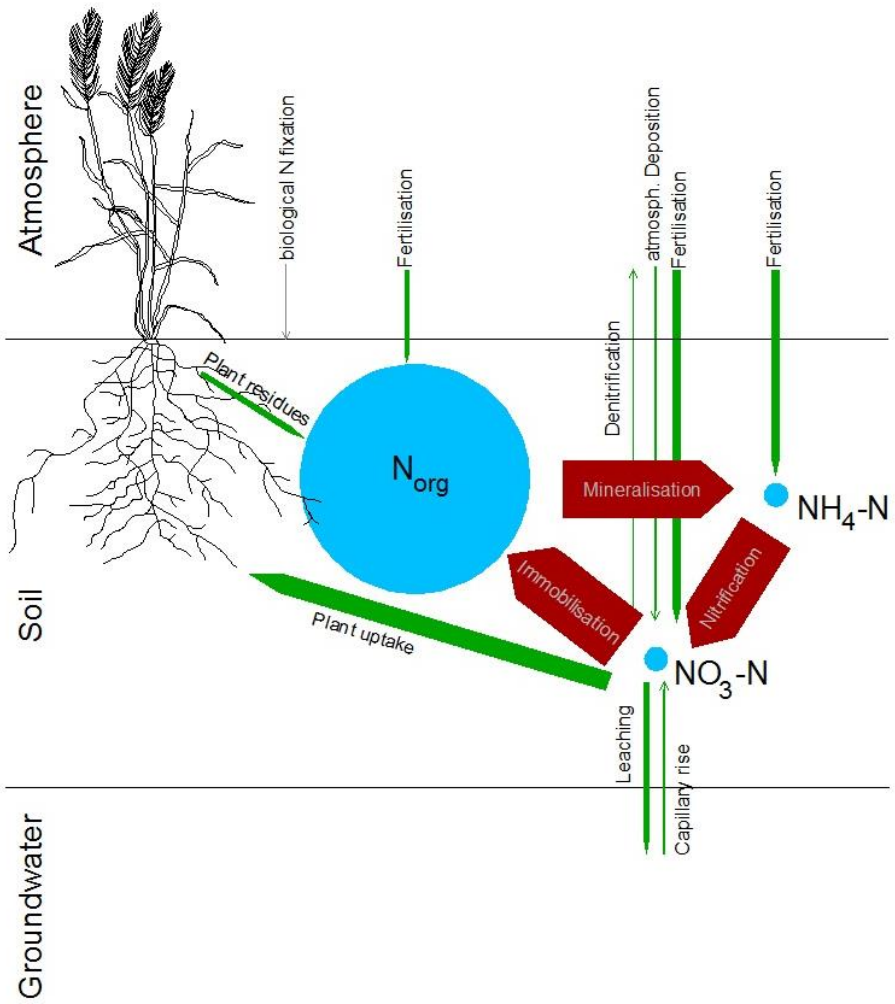
Received: 18 August 2014 / Accepted: 11 February 2015 / Published online: 19 February 2015

ONGOING

Application of model simulations for the main arable areas in Austria



Processes and intensities of the nitrogen cycle considered in STOTRASIM



transport = green

transformation = red

arrow width = mean annual nitrogen transport or transformation rate

cycles area = dimension of the nitrogen source

Mean values for $Frac_{LEACH}$ (only leaching) and modified $Frac_{Leach}$* (leaching and runoff) of all arable and grassland sites estimated from lysimeter data

	FracLEACH	FracLEACH*
Arable land	0.156	0.203
Grassland	0.021	0.027
Austria overall	0.087	0.113

Thank you for your attention

Peter Strauss, Alexander Eder, Franz Feichtinger
Institute for Land and Water Management Research
Federal Agency for Water Management
Petzenkirchen

Günter Blöschl
Institute of Hydraulic Engineering and Water Resources Management
Technical University
Vienna