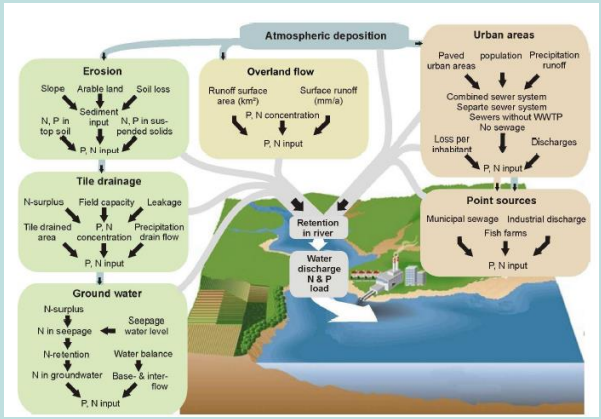

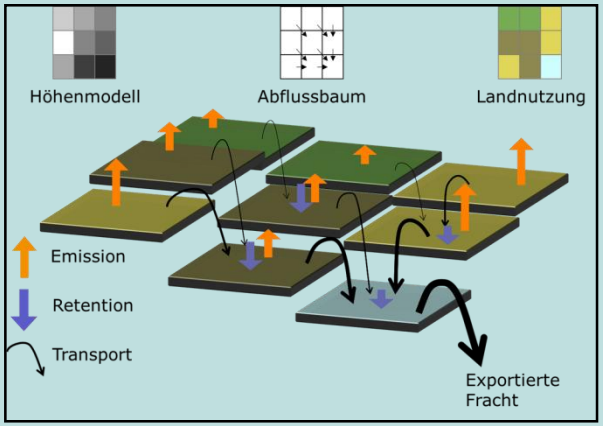

Assessment of cost-effectiveness of measures to reduce N and P emissions to surface waters in Upper Austria – a catchment scale approach

Oliver Gabriel, Gerold Hepp, Max Kuderna, Christine Weinberger, Matthias Zessner

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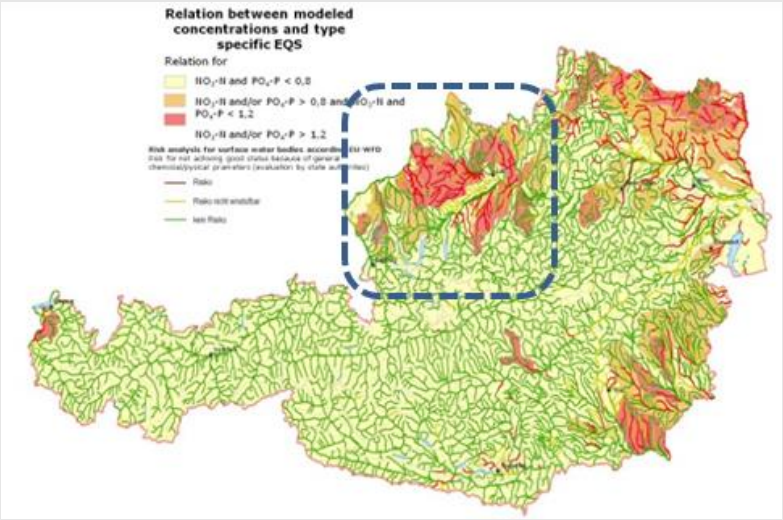
Status in surface waters of Upper Austria

- 30% of surface waters fail the good ecological status due to chemical pollution (organic substances and nutrients)
- In most cases o-PO_4-P exceeds the standard value
- Main pressures stem from diffuse emissions from agriculture:
  - groundwater and drainages (N), caused by increased N surpluses in regions of intensive agriculture
  - Erosion (P), especially caused by root crops (maize) cultivation at steep hills and tillage near the receiving water



Background - Emission model approach

- **Emission modelling** on catchment level provides a sound overview of catchment specific pressures and is a precondition for action planning
- **Quantification of pathways and sources** of N and P emissions in 81 sub catchments provides a detailed characterization of the actual state
- Recalculation of resulting surface water concentrations from N and P emissions enables **modelling of standard value attainment**
- Implementation of practicable **measures concerning Point Sources and** Implementation of **measures concerning diffuse sources** from the voluntary "Austrian Program for environmental sound agriculture" (ÖPUL) enables the **calculation of potential mitigation measures effects** to reduce nutrients
- To improve the potential reduction we **combined measures in packages**

Selection of effective measures (N)

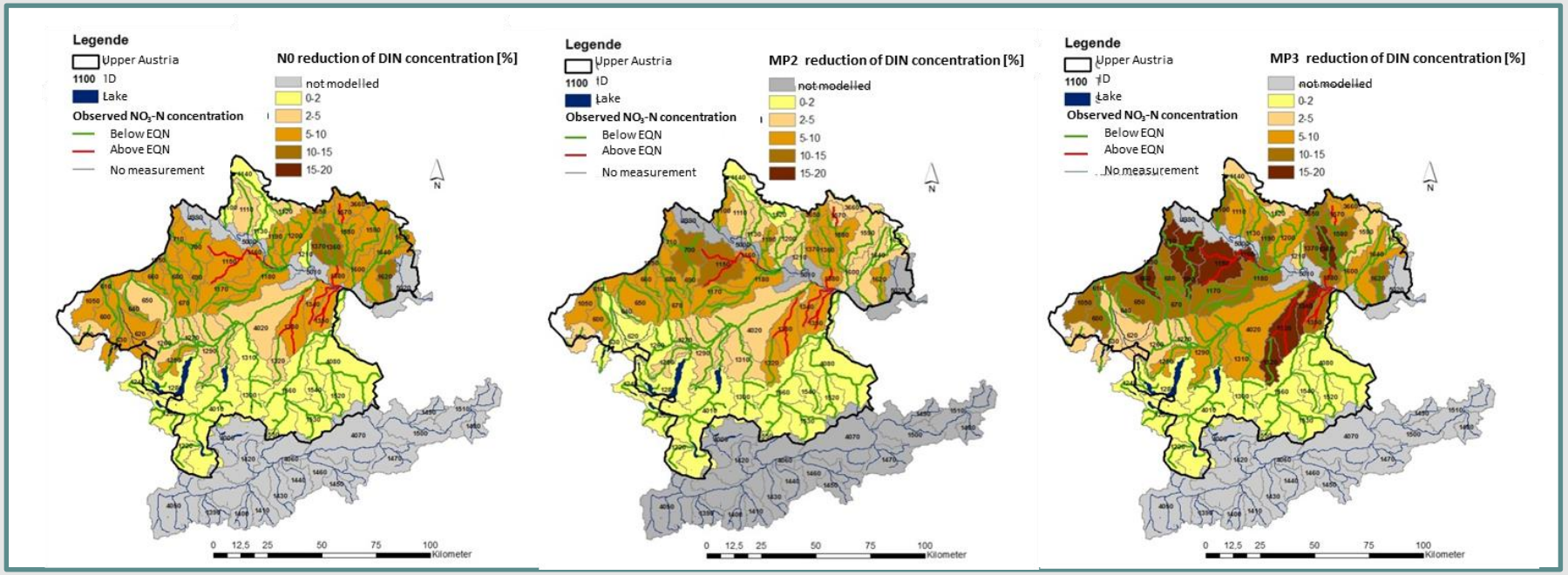
- Twelve measures for reducing N emissions to surface waters were evaluated and their combination tested
- Mix of measures was developed and participation scenarios established (actual incentives – improved incentives – potential):
  - **Greening or green fallow** → (1%; 3,5%; 7% of arable land)
  - **Winter greening** → (21%; 35%; 45% of arable land)
  - **Fertilization according on soil demand** → (23%; 35%; 70% of arable land)
  - **Exhaust air purification of stables** → (10%; 50% 100% of pig and poultry stables with venting systems)
- All calculations started on base of a "Zero Scenario", in which effects of all measures from the past years are calculated

Effect of combined measures (N reduction)

Zero Scenario

Improved incentives

Potential reduction



- In catchment at risk it is expected that NO_3-N concentrations decrease by further 5-10% due to measures already implemented
- Improved incentives can lead to a further reduction of 5-15%, while the potential of reductions from this measure mix is limited to further 15-20%

Effect of measures to meet target values

River	ID	Type specific EQN NO_3-N [mg/l]	2001-2006 NO3-N [mg/l]	Reference – zero scenario [mg/l]	Realistic subsidies - reduction NO_3-N [mg/l]	Ambitious subsidies - reduction NO_3-N [mg/l]	Potenzial reduction NO_3-N [mg/l]
Krems	1330	5,5	5,3	5,0	4,8		
Ipfbach	1340	5,5	8,4	7,6	7,3	6,9	6,3
Kristeinerbach	1350	5,5	7,0	6,4	6,2	5,9	5,5
Kleine Gusen	1360	5,5	5,2	4,5			
Große Gusen	1370	5,5	5,1	4,5			
Gusen	1380	5,5	5,1	4,6			
Feldaist	1570	4,0	4,5	4,2	4,1	4,0	3,8
Feldaist	1580	5,5	5,2	4,9			

- risk
- potential risk (+/- 20%)
- no risk

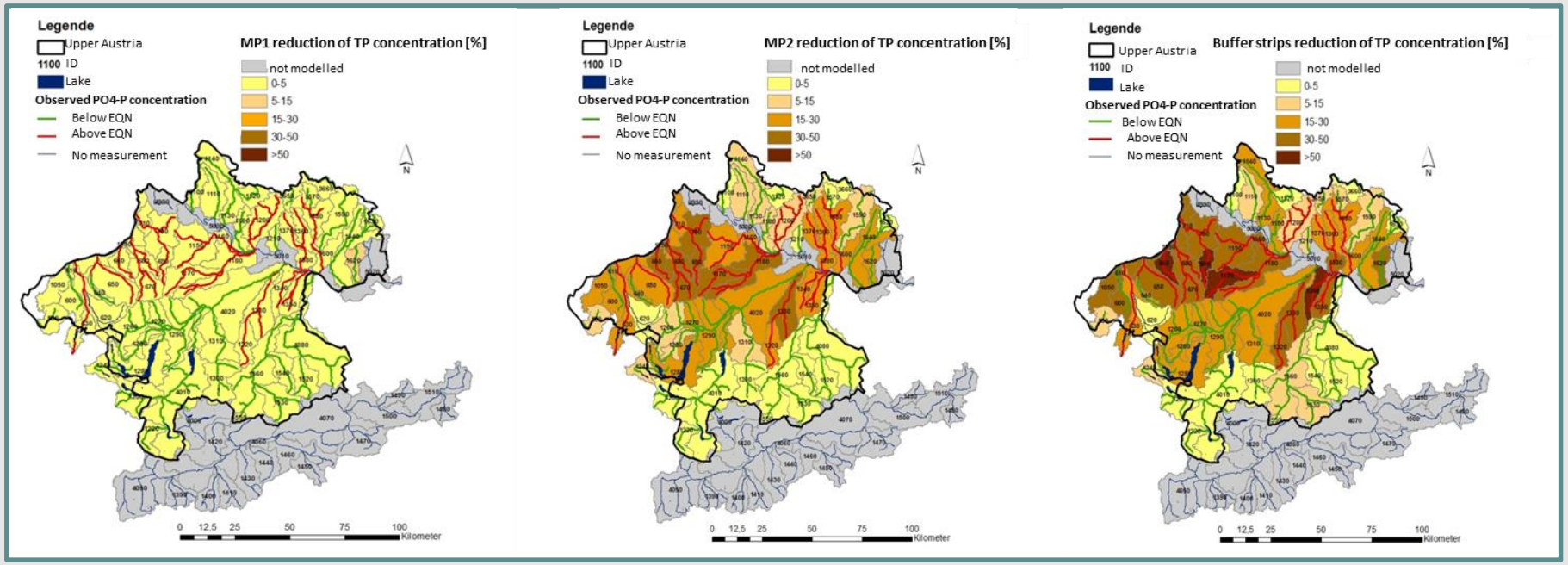
- Measures applied will led to standard value attainment in most catchments
- Only three rivers beyond type-specific standard value
- Attainment of standard values only under extreme efforts or impossible

Selection of effective measures (P)

- Nine measures for reducing P emissions to surface waters were evaluated
- Mix of measures was developed and participation scenarios established (actual incentives – improved incentives – potential):
  - **Greening or green fallow on connected areas** → (1%; 3,5%; 7% of arable land)
  - **Riparian buffer strips** → (1%; 10%; 100% of riverine arable land)
  - **Winter greening** → (21%; 31%; 31% + mulch seedbeds on 10% of arable land)
  - **Constraints for crop rotation** at steep slopes → grass-clover instead of silage maize; wheat instead of grain maize (31% on areas > 8% slope; 50% on areas > 8% slope; 100% of areas >8%)
  - **Increased P removal on WWTP** - effluent < 0,5 mgP/l → (on WWTPs >2000 p.e.; on WWTPs >1000 p.e.; on all WWTPs)

Effect of combined measures (TP reduction)

Actual incentives	Improved incentives	Buffer Strips + WWTP



- Actual incentives/participation will reduce surface water concentrations in catchments at risk by < 5%
- Improved incentives could led to a 15-50% reduction of the TP surface water concentration, while an consequent implementation of buffer strips and effluent reduction in these catchments could reduce TP concentration by 15 to > 50%

Effect of measures to meet target values

River	Type specific EQN PO_4-P [mg/l]	2001-2006 PO_4-P [mg/l]	Realistic subsidies - PO_4-P [mg/l	Ambitious subsidies - PO_4-P [mg/l]	Buffer Strips and Effluent reduction PO_4-P [mg/l]
Mattig	0,05	0,05	0,05	0,04	
Mülheimer A.	0,05	0,07	0,07	0,05	0,04
Gurtenbach	0,05	0,12	0,12	0,08	0,04
Antiesen	0,05	0,20	0,19	0,12	0,09
Antiesen	0,05	0,20	0,19	0,13	0,09
Pram	0,05	0,32	0,30	0,19	0,12
Pram	0,05	0,14	0,13	0,09	0,06
Pram	0,05	0,15	0,14	0,10	0,07
Kleine Mühl	0,10	0,09	0,08		
D. Aschach	0,05	0,13	0,12	0,09	0,06
Aschach	0,05	0,14	0,13	0,10	0,07
Trattnach	0,05	0,12	0,11	0,07	0,05
Innbach	0,05	0,21	0,20	0,13	0,08
Persenbach	0,05	0,05	0,05	0,04	
Große Rodl	0,05	0,06	0,06	0,05	0,05
Krems	0,05	0,09	0,08	0,06	0,04
Krems	0,05	0,07	0,07	0,05	0,03
Ipfbach	0,05	0,05	0,05	0,04	
Kristeinerbach	0,05	0,08	0,08	0,06	0,03
Kleine Gusen	0,10	0,18	0,18	0,15	0,14
Große Gusen	0,10	0,21	0,21	0,17	0,16
Gusen	0,05	0,20	0,19	0,15	0,13
Feldaist	0,08	0,07	0,06		
Feldaist	0,10	0,15	0,15	0,12	0,11
Aist	0,05	0,07	0,07	0,06	0,05

risk potential risk (+/- 20%) no risk

- 2/3 of catchments in a good ecological state
- In several rivers concentration exceed the type specific standard value by far – with necessary reduction of concentration >75%
- Ambitious packages of measures would lead to significant reductions of concentrations (upto 50%)
- In catchments with >2 or 3fold overshooting the attainment of standard values seems unrealistic

Estimation of Costs

- Cost – Effectiveness calculation does only consider the reduction of nutrient inputs into surface waters
- Aspects like conservation of resources; climate- and groundwater protection are not included in the approach
- Base of cost calculations are the funding amounts from the ÖPUL programme
- Costs of measures not included in ÖPUL are calculated by
  - Differences of contribution margins (culture after and before measure)
  - Acquisition- and construction costs

Example: greening of arable land

- Mean contribution margins of most important cultures: 816€/ha
- Meen contribution margins of grassland (silage/hey): 502€/ha

Costs: arable land into grassland: 314€/ha
Costs: arable land into green fallow: 816€/ha

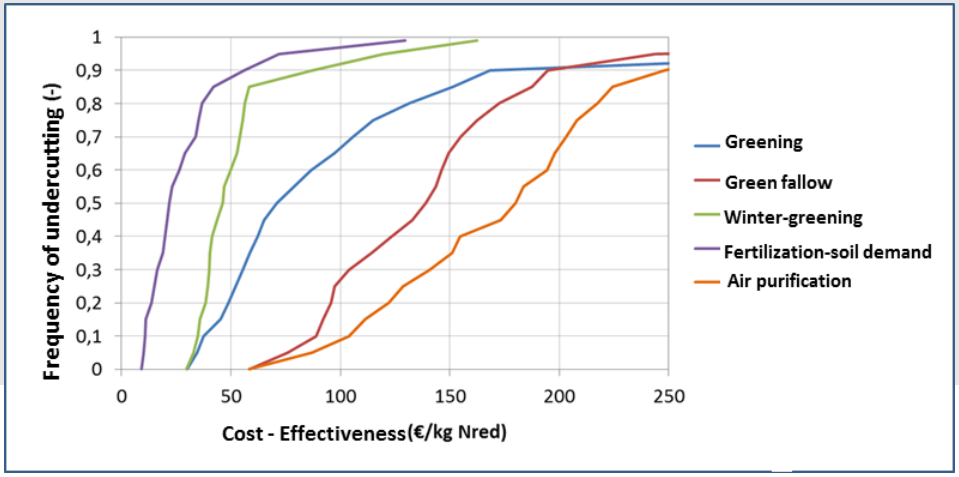
Ranking of Cost – Effectiveness (N)

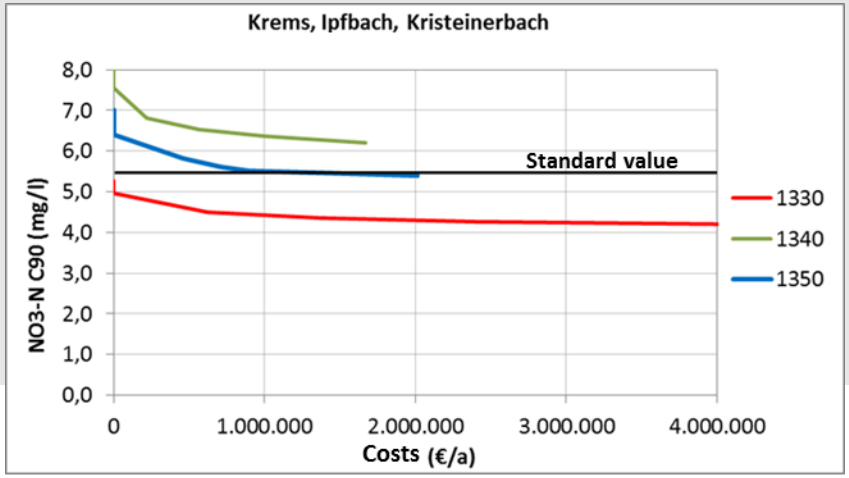
- Cost - effectiveness of measures in catchments varies due to regional differences (e.g. retention; fertilization practice; distribution of crops)

In 85% of all catchments:

- **Fertilization according on soil demand:** 10 - 40€/kg N reduced
- **Winter greening:** 35 - 55€/kgN reduced
- **Green fallow:** 60 - 190€/kgN reduced
- **Exhaust air purification of stables** (pigs and poultry): 60 - 225€/kgN reduced

- Costs to meet the standard value in a catchment with exceedance will range at 1 Mio. €/a



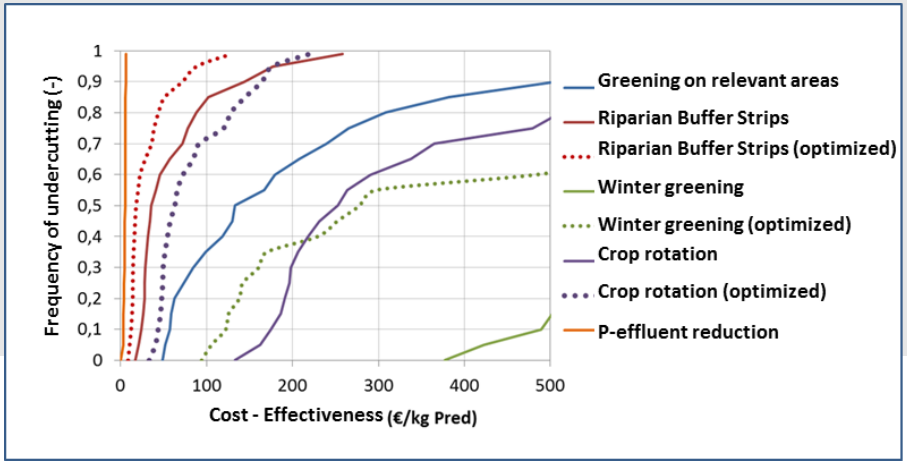


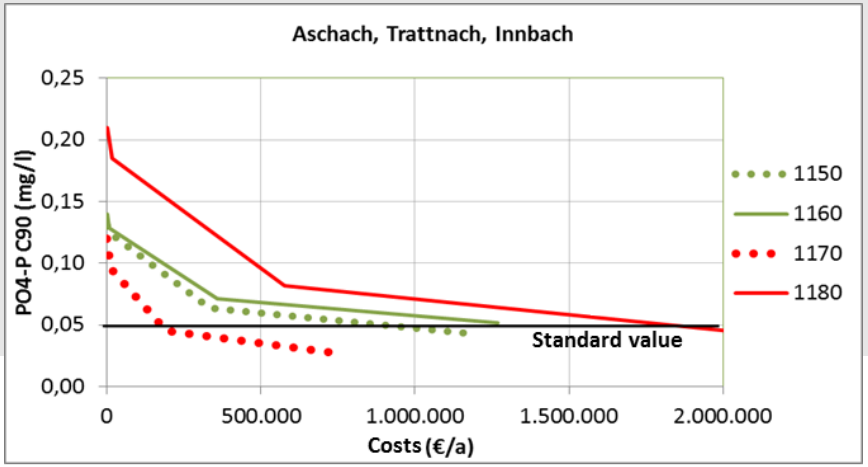
Ranking of Cost – Effectiveness (P)

- Cost - effectiveness of measures in catchments varies due to regional differences (e.g. slope, distribution of crops; size of WWTP)

In 80% of all catchments:

- **Reduction of effluent values** on WWTPs: 3 - 6€/kgP (-2 - 6t TP/a)
- **Riparian buffer stripes**: 30-100€/kgP (10 - 37t TP/a)
- **Crop rotation at slopes >8%:** 50 – 300€/kgP
- **Wintergreening + mulch seeding** when possible: >400€/kgP
- Localization of erosion reduction measures significantly increases cost - effectiveness
- Costs for standard value attainment varies from additional 50.000€/a - 2.000000€/a





Conclusions

Nitrate

- In most catchments at risk applied measures or realistic improvements of efforts seem to be sufficient to meet the standard values in future
- In three catchments even at increased efforts standard value attainment is unsecure (necessary reduction of NO_3-N concentrations of >20%)
- Most cost effective mitigation measures are fertilization according on soil demand and winter greening

Orthophosphate

- Efforts in Upper Austria should focus on phosphorus reduction
- Mitigation measures can lead to a serious reduction of o-PO_4-P concentrations (>50%) when incentives are improved
- At >2-3fold overshootings of standard values an attainment in most cases becomes unrealstic
- Most cost effective mitigation measures are reduction of effluent values on WWTPs (however restricted potential) and riparian buffer strips
- Cost – effectiveness of erosion measures significantly increases when hot-spots can be localized
- Costs for standard value attainment on catchment scale widely ranges from few 10.000€/a upto 2.000000€/a with respect to overshooting and specific conditions

Thank you for your attention!

Acknowledgement

LAND OBERÖSTERREICH

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