Leaving fields - reaching streams
phosphorus emitted from
exclusively agricultural headwaters

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COMLAND & COST 869
Magdeburg
7-9th September, 2009
Czech context I.

1. **Stock change compared with 1989**: (ČSÚ, 2008)

<table>
<thead>
<tr>
<th>comp. 89</th>
<th>cows</th>
<th>pigs</th>
<th>poultry</th>
</tr>
</thead>
<tbody>
<tr>
<td>10⁶ cap.</td>
<td>- 2,079</td>
<td>- 2,253</td>
<td>- 5,166</td>
</tr>
<tr>
<td>%</td>
<td>- 60</td>
<td>- 48</td>
<td>- 16</td>
</tr>
</tbody>
</table>

2. **Land-use change compared with 1989**: (ČSÚ, 2007)

<table>
<thead>
<tr>
<th>comp. 89</th>
<th>arable</th>
<th>grass</th>
<th>forest</th>
<th>water</th>
</tr>
</thead>
<tbody>
<tr>
<td>km²</td>
<td>- 2,000</td>
<td>+ 1,500</td>
<td>+ 224</td>
<td>+ 40</td>
</tr>
<tr>
<td>%</td>
<td>- 6,2</td>
<td>+ 18</td>
<td>+ 0,9</td>
<td>+ 2,5</td>
</tr>
</tbody>
</table>

3. **Sawing area change compared with 1989**: (ČSÚ, 2008)

<table>
<thead>
<tr>
<th>comp. 89</th>
<th>s.beet</th>
<th>potatoes</th>
<th>corn</th>
<th>rape</th>
<th>grain</th>
<th>grass (ar.l.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10³ km²</td>
<td>- 767</td>
<td>- 857</td>
<td>+ 602</td>
<td>+ 2,545</td>
<td>- 2,264</td>
<td>- 6733</td>
</tr>
<tr>
<td>%</td>
<td>- 58</td>
<td>- 73</td>
<td>+ 140</td>
<td>+ 240</td>
<td>- 14</td>
<td>- 63</td>
</tr>
</tbody>
</table>
Czech context II.

**Fertilizers consumption in CZ**

<table>
<thead>
<tr>
<th>Type</th>
<th>Percentage</th>
<th>Consumption (kg P/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral</td>
<td>-79%</td>
<td>602</td>
</tr>
<tr>
<td>Organic</td>
<td>-50%</td>
<td>563</td>
</tr>
</tbody>
</table>

(data Mze 2009, VÚRV 2006)
Sawing area 2008 [km²]
Data from 80 % a.l. CZ
(ČSÚ, 2008)

Uptake P in yield [kg P/yr]
avg. 2003-7
(MŽP 2008, Vyhl. 274/1998 Sb.)
Czech context IV.

Available P in CZ arable land
decreased for 10 % per 10 years

Available P in CZ arable land decreased for 10% per 10 years.

(data ÚKZÚS, 2008)
Czech context V.

Excretion P CZ 2008
$(38,9 \times 10^3 \text{ t P/yr})$

Animals:humans $1 : 4,5$

Land-use 2008
$(78,8 \times 10^3 \text{ km}^2)$

Humans 16%

Ovce 16%

Koně 16%

Drůbež 16%

Prasata 19%

Animals

farm animals

1 : 4,5

Skot 48%

Lidé 16%

Koně 19%

Ovce 38%

(TTP 12% (data ČÚZK, 2009)

Grass land 12%

Vineyards 9%

Water 9%

Arable land 38% (data ČÚZK, 2009)
Czech context summary

1. Atmospheric deposition: $5 - 50$ kg TP/km$^2$.yr (EEA, 2007)
   - $26$ kg SRP/km$^2$.yr (Škoda, 1994)

2. Fertilizers: $1.100$ kg P/km$^2$.yr ag.l. (Mze 2009, VÚRV 2006)

3. Uptake P in yield:
   - $335$ kg P/km$^2$.yr (area and yield weighted avg.)
     - 88 grain, 140 corn, but 2,661 potatoes and 7,249 řepa (kg P/km$^2$.r)
     - (avg. 2003-08, count from ¾ arable land CZ)

   - (arable land CZ 2005-7)

5. Outflow: $17 - 1$ kg TP/km$^2$.yr

6. Erosion: $10^0 - 10^3$ kg P/km$^2$.yr (potential)

7. Drainage: ¼ agricultural land (VÚMOP, 2007)
Why to measure non-point sources of P?

**point sources:**
registered (mostly)
improved by detergent ban (Reg. 78/2006) (less effective)
and „solved“ from 2010 UWWT (91/271/EC)
> 10,000 PE (popul. equiv.) ask tertiary treatment
> 2,000 PE ask secondary treatment

**non-point s.:**
generally decreasing in load (mineral fertilizers, abandonment of arable land, animal stock density), but not in importance.

**source apportionment:** appropriate management tool for reaching 1st WFD environmental objective but „persistent blooms during summer months“ = MODERATE status.

REDUCE EUTROPHICATION
Aims of project:

1. To measure real immisions (CZ 2000´)
2. To improve source apportionment (compare to used export coef., enhance model´s inputs)
3. Compare erosional and extraerosional portion
4. Evaluate impact of P-form on eutrofication
   • SRP, TP, BAP, DIP, DOP, PP, CP

(Reservoir Orlík, VII. 2008)
Methods & results I.a

2006: screening on 234 profiles,
162 one-shoot samples from 11 main soil types,
which represent 80% arable land of CZ
May – August, base-flow condition
Methods & results I.b

median TP = 0.046 mg/L
mean TP = 0.069 mg/L

SRP/TP = 55%

10% … CSA hotspots?
Methods & results I.b

SRP/TP = 55%

median SRP = 0.024 mg/L
mean SRP = 0.038 mg/L

10% … CSA hotspots?
Methods & results II.a

2007-9: Seasonal dynamic in 14 watersheds
≈ cca 30 profiles represent 9 major soil types
Q: instantaneous, directly at Cippoletti weir

median SRP/TP = 50 %
Methods & results II.b

1st aproximation of spec. yield: 17 – 1 kg TP/km²
Methods & results III.

storm-flow vs. base-flow

16:59
h = 16.1 cm
Q = 44.9 L/s

17:16
h = 31.5 cm
Q = 141 L/s

17:49
h = ? cm
Q = ? L/s

9:36
h = 4.1 cm
Q = 2.22 L/s

Methods & results III.
Methods & results III.

Storm 21\textsuperscript{th} Jun 2007

TP, SRP [mg/L], Q [L/s], SS [mg/L]

- TP
- PO4-P
- Q
- SS

RUSLE+SDR = 219 kg P/yr

Pop-field
Methods & results III.

Storm 21\textsuperscript{th} Jun 2007

Peak 2:46
21\textsuperscript{st} Jun, 2007 of 2007 bsfl

$Q_{\text{max}} = 141 \text{ L/s}$
sum = 449 m$^3$
0,8 %

$SS_{\text{max}} = 40 \text{ g/L}$
sum = 11 t
1563%

$TP_{\text{max}} = 81 \text{ mg/L}$
sum=20,4 kg
330 %

$SRP_{\text{max}} = 1,3 \text{ mg/L}$
sum=0,53 kg
35 %

RUSLE+SDR= 219 kg P/yr

Pop-field
Methods & results III.

**KAT009 21.6. 2007**

**TP**

![Graph of TP](image)

**SRP**

![Graph of SRP](image)

\[ \text{Q} \text{ [L/s]} \]

\[ \text{cTP [mg/L]} \]

\[ \text{cSRP [mg/L]} \]

\[ \text{PO4-P} \]
Methods & results IV.

interannual variability

<table>
<thead>
<tr>
<th>comp.</th>
<th>Q</th>
<th>SS</th>
<th>TP</th>
<th>SRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/08</td>
<td>91%</td>
<td>54%</td>
<td>55%</td>
<td>48%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comp.</th>
<th>Q</th>
<th>SS</th>
<th>TP</th>
<th>SRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PICP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Methods & results IV.

Pasive sampler
Methods & results IV.

Profile

Total Population Rsq = 0.9109
Methods & results IV.
Discusion

3. Compare erosional and extraerosional portion

4. Evaluate impact of P-form on eutrofication

Erosion or snowmelt: SRP/TP = up 10% but kg TP/hod.
... how yearly budgeting talks to algae?
… differently than disturbances!
Other sources of uncertainty ...

Thank you for attention ...

25.1.2009, 10 cm snow, 50 m from creek.
Watershed of Švihov reservoir, drinking water source for capital = 1.200.000 inhabitant ...