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National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Seasonal variation in leaching water quality

The Sand region of the
Netherlands

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1 Clarification of topic

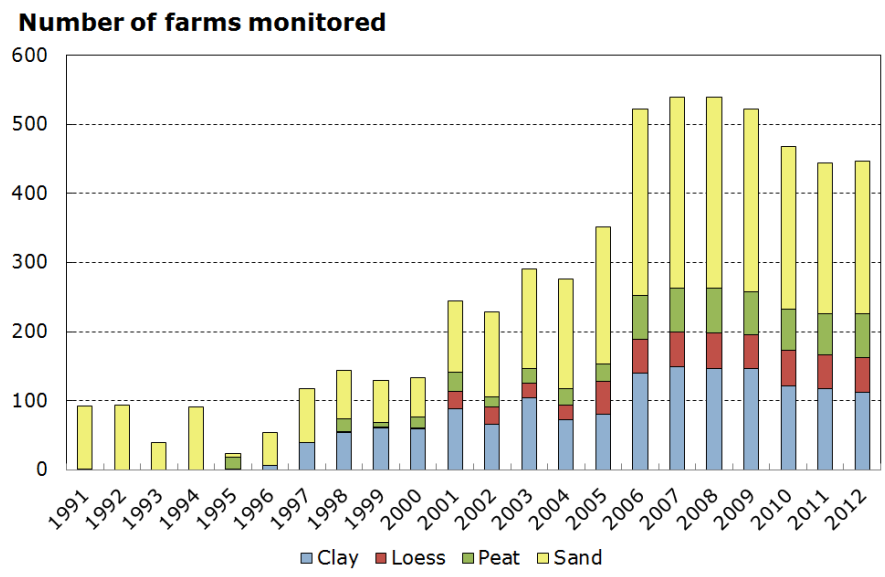
- An initial study in 1994 demonstrated that no systematic change within a year occurred in groundwater quality¹
- However, during evaluation of long term groundwater quality data, we came across seasonal variations in water quality



¹ Fraters, B., Vissenberg, H.A., Boumans, L.J.M., de Haan, T., De Hoop, D.W. (1997). Meetprogramma Kwaliteit Bovenste Grondwater Landbouwbedrijven in het zandgebied (MKBGL-zand) 1992-1995. Rijksinstituut voor Volksgezondheid en Milieu, Bilthoven, RIVM Rapport 714801014.



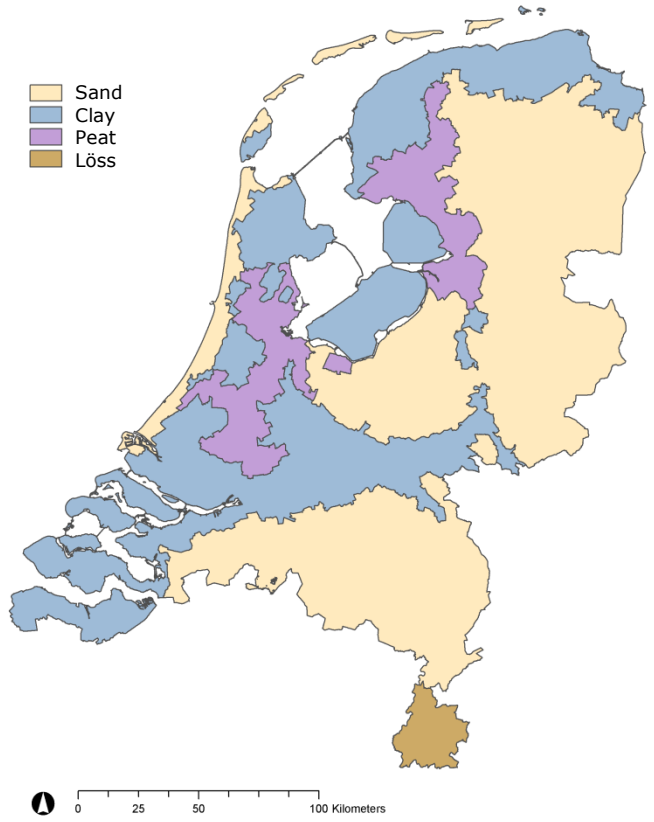
2 Minerals Policy Monitoring Programme (LMM)



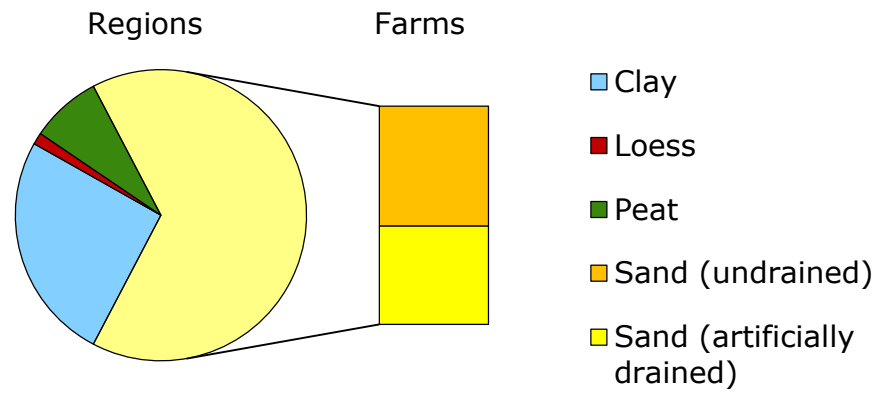
- Established in 1992
- Objective: Assessing the effects of National and European mineral policies
- Programme for monitoring agricultural practice and water quality on farms
- Combined effort of RIVM and LEI Wageningen University



2 Minerals Policy Monitoring Programme (LMM)



- Sand region largest covering >50% of total area
- Together with loess area most vulnerable to nitrate leaching
- Majority of industrial livestock farms and open field vegetables farms





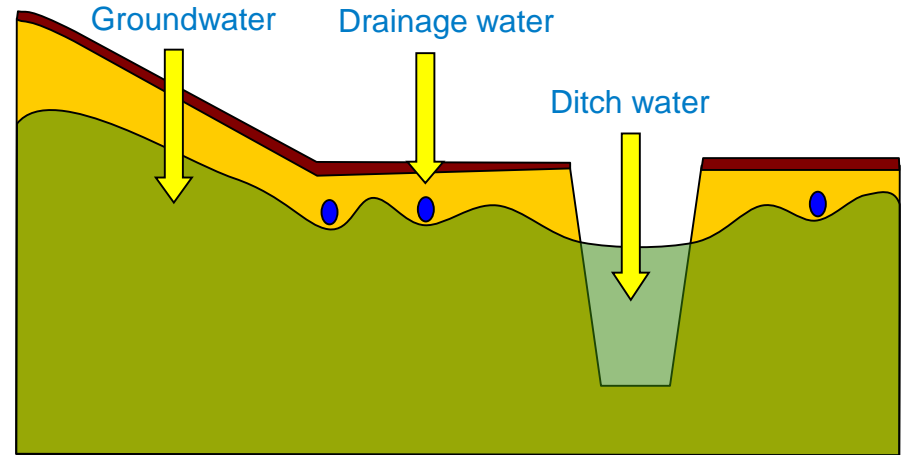
2 Monitoring in the sand region

- **Standard programme:**

- Since 1992
- Farms throughout sand region
- Sampling top 1 m of groundwater
- In summer
- ± 225 farms

- **Programme of the drained areas:**

- Since 2004
- Farms in sand region drained with drainage tubes and/or ditches
- In winter
- ± 60 farms
- Farms also included in standard programme





3 Used data sets

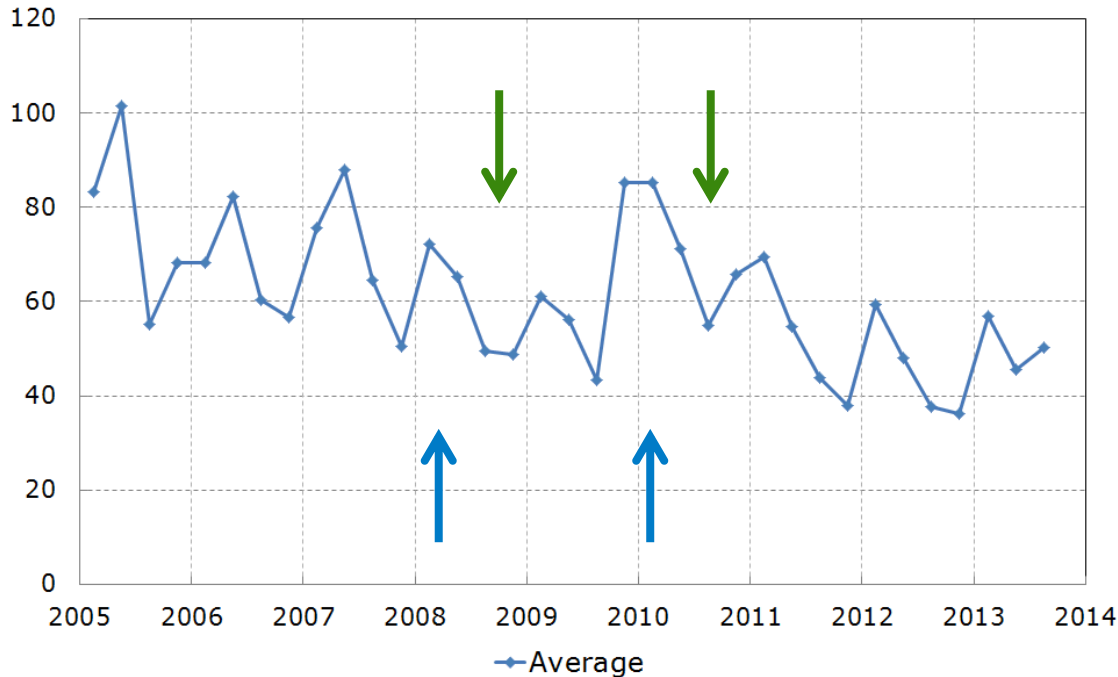
Compared different groundwater quality datasets:

- Summer data of regular programme – 225 farms / year
- Winter data of programme of drained areas – 60 farms / year
- Summer data of programme of drained areas – 60 farms / year



4 Results

[NO₃] (mg/l) groundwater per 3 months period

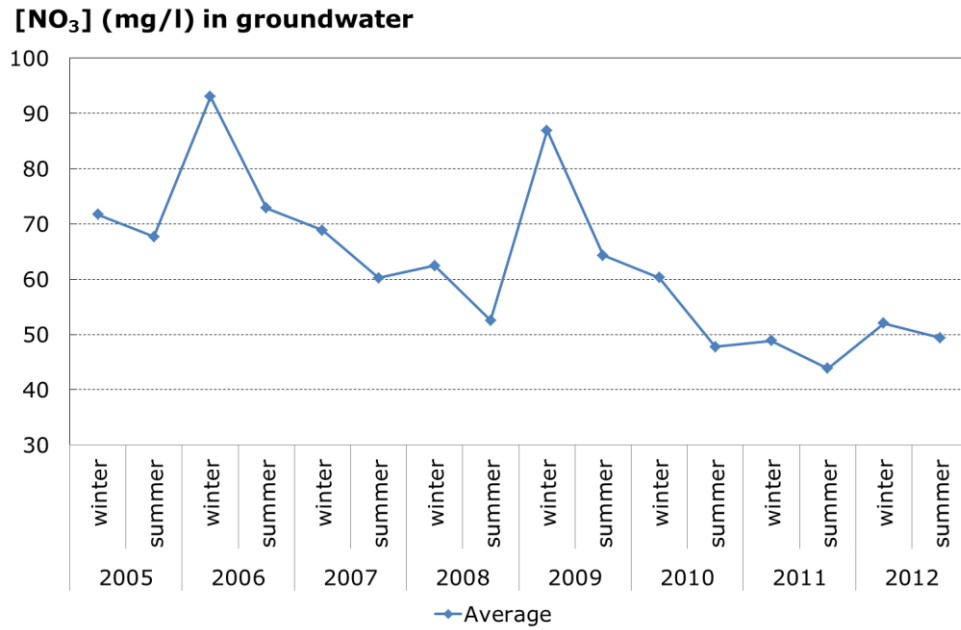


- Clear temporal fluctuations
- Summer low NO₃
- Winter high NO₃
- NO₃ in groundwater can be influenced by:
 - NO₃ leached below the root zone
 - Denitrification
- Also effect of sampling population

Dissimilar datasets: summer data of all farms combined with winter data drained farms



4 Results

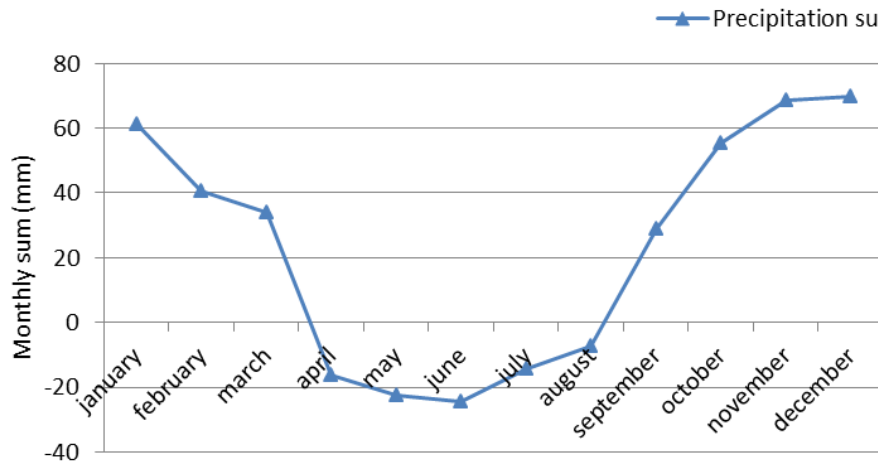


Above graph uses identical data sets per year

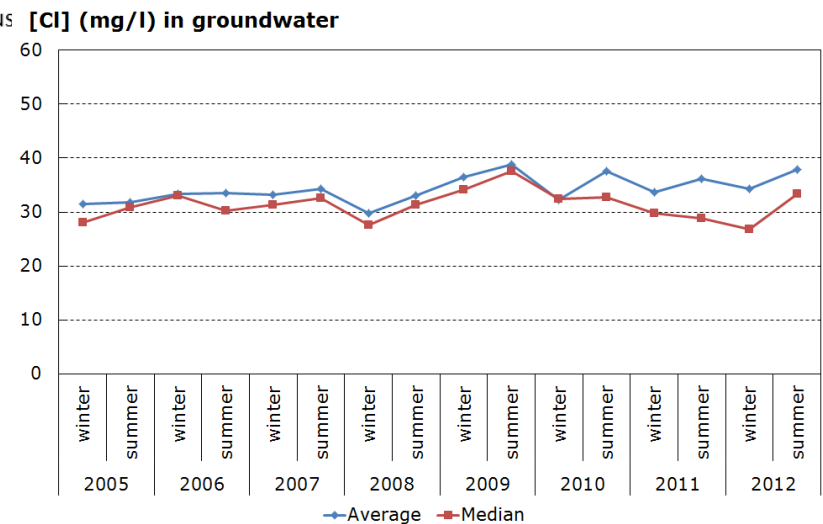
- Effect temporal fluctuations less clear
- NO₃ in winter significant higher than in summer
- Approximately 20% higher in winter than in summer
- Clear correlation between winter and following summer $R^2 = 0.73$



4 Results: nitrate leaching



Source: Dutch meteorological institute. Average 1981 - 2010

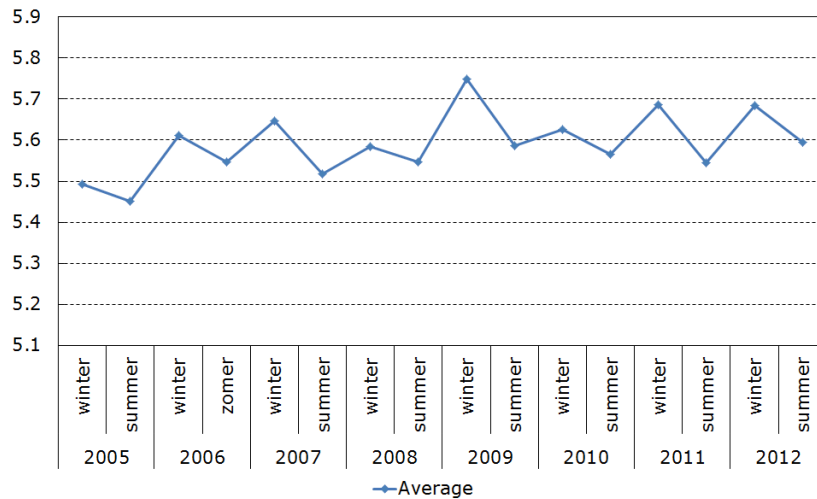


- Precipitation surplus lowest in summer, increases quickly in autumn: import aspect in higher NO_3 -concentrations in winter
- Chloride shows no real systematic seasonal fluctuations: no effect of evaporation

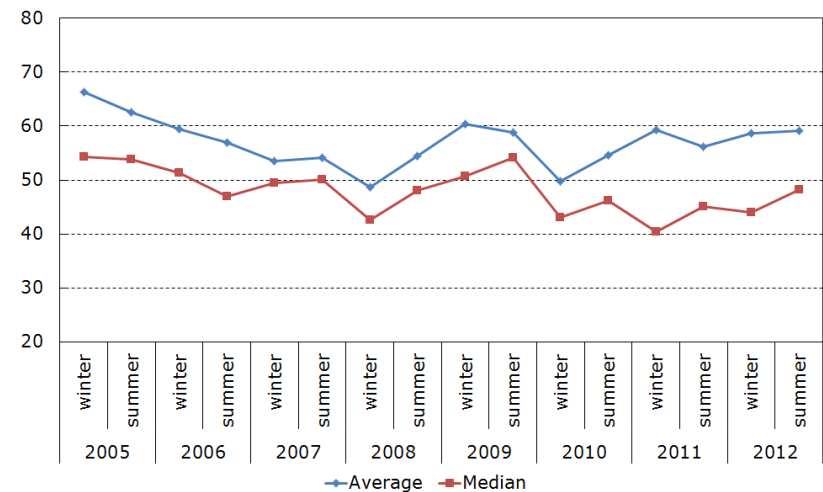


4 Results: denitrification

pH in groundwater



[SO₄] (mg/l) in groundwater



pH winter > pH summer

SO₄ summer > SO₄ winter

In winter heterotrophic denitrification with organic matter -> uptake of H⁺

In summer deeper groundwater levels, possibly more autotrophic denitrification with pyrite -> release of H⁺ and SO₄

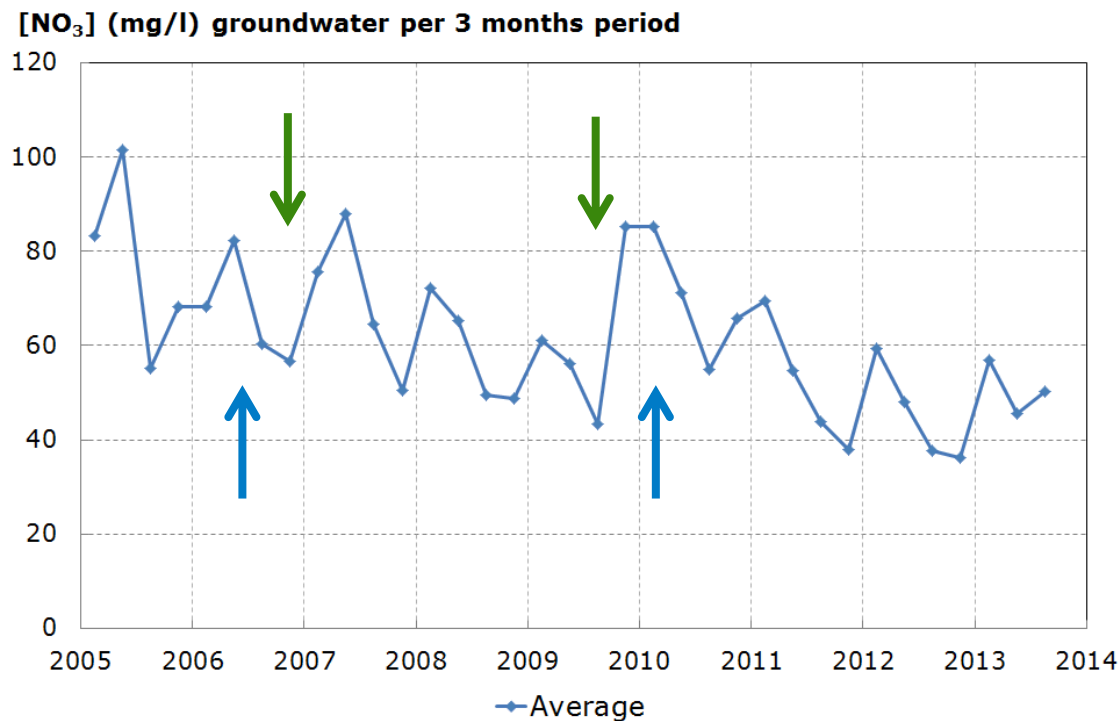


5 Discussion

- If you want to assess effect of policy measures on water quality, you want to assess yearly trends...
- And you want to see effects of policy measures, not of other factors
- Clearly we see effects of temporal fluctuations
- So: just sample all farms at the highest concentration?
 - Practically impossible
 - When is the peak moment?



5 Discussion

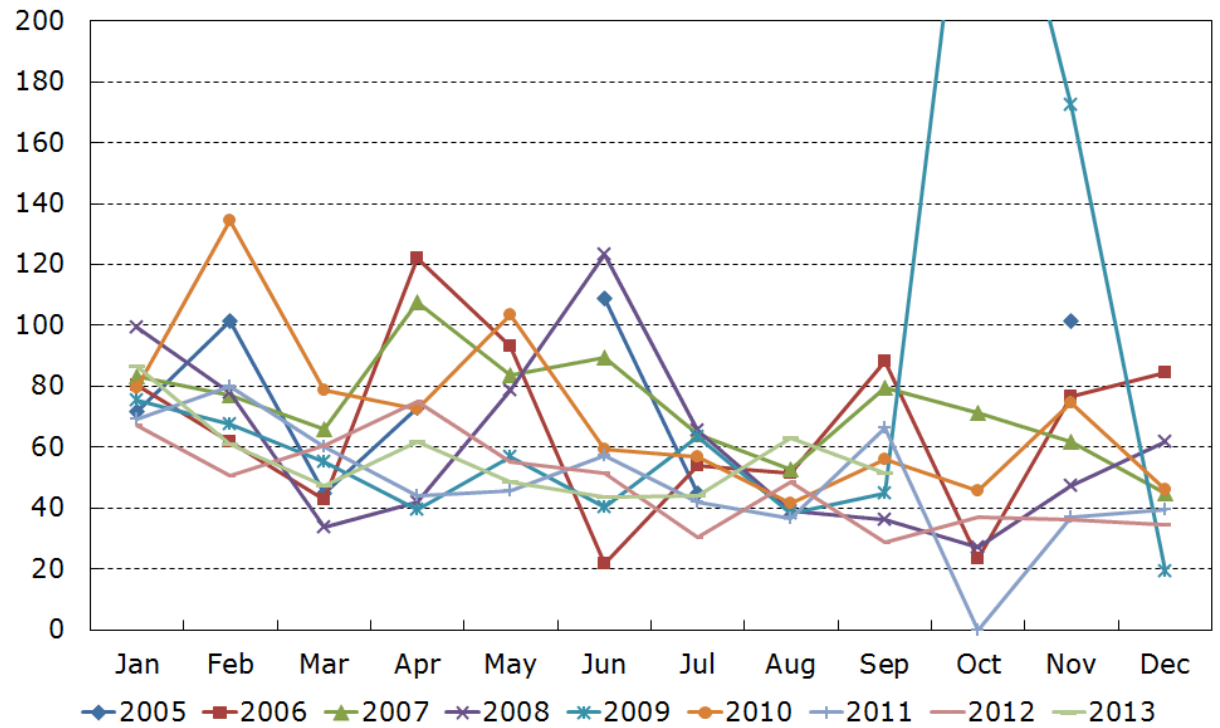


- Fluctuations different per year, depending on leaching and denitrification
- No fixed moment in time



5 Discussion

[NO₃] (mg/l) average on sub-set



- General tendency for peak in begin year and lowering up to September
- Which farm(s) is/are sampled in a month, can have big effect

Nitrogen concentration per month and per year for all farms in programme for drained areas



6 Conclusions

- In shallow groundwater we see seasonal fluctuations in water quality, which differ each year
- Therefore:
 - When assessing effects of policy measures on water quality, next to several other factors as weather fluctuations, effects of groundwater level and effects of difference in sample population, moment of sampling should be taken in account
 - When using low-frequency monitoring data, understanding of intrinsic periodicity of trends are essential



Questions?