Monitoring groundwater quality for the Water Framework Directive

C.R. Meinardi, RIVM
The European Water Framework Directive; groundwater quality; pitfalls at assessment

- Relation GWB delineation and quality indicators;
- Arithmetic averaging of all available observations;
- Groundwater quality trends at various depths;
- Observing groundwater quality in upper layers;
- Hydrological effects on yearly observations;
- Discussion and conclusions.
ACTUAL SOIL AND GROUNDWATER MONITORING NETWORKS AND THEIR USE

• 1 Soil: national soil quality monitoring, LMB
• 2 Upper groundwater (down to 1m below grw. level)
  – Agriculture: LMM (Monitoring the effectiveness of the Dutch minerals policy)
  – Natural vegetation TMV (ditto for natural vegetation)
• 3 Shallow groundwater (ca. l.s. - 10 m): LMG; PMG
  – National and Provincial Groundwater Quality Networks
• 4 Intermediate groundwater (ca. l.s. - 25 m):
  – National and Provincial Groundwater Quality Networks
• 5 Deep groundwater (at depth of abstraction):
  – Data on raw water from water supply companies
• Monitoring levels 3), 4), 5) for compliance checking
Upper groundwater sampling in the sandy regions

- **Sampling probe**
- **Collar**
- **Borehole** Ø = 70 mm
- **Screen**
  - PVC
  - Øin = 13 mm
  - Øout = 16 mm
  - Split width = 0.3 mm
- **Tube**
  - PVC
  - Øin = 4 mm
  - Øout = 6 mm

- **Groundwater level** 0.5 m
- **Tube** 0.3 m

**Number of boreholes per farm**

- 1995-2000: 16
LMM Ex-post monitor programme

- Regions
- Types of agriculture
- Monitoring on farm of:
  1. Farm management (290 farms)
  2. Water quality (160 farms)
- ‘Moving sample’ 15% replacement

National Monitoring Programme for effectiveness of the Minerals Policy
Participating farms in the 1997-1999 period

Dominant soil types
- peat
- sand
- clay
- loess
- cities

Map showing distribution of farms on different soil types in the Netherlands.
Groundwater quality monitoring networks

- National and provincial monitoring systems at varying levels in the soil; groundwater quality characterisation

Land surface

Parameters analysed each year:
- Major components:
  - Ca; Cl; HCO$_3$; K;
  - Mg; Mn; Na;
  - NH$_4$; NO$^-$; O$_2$;
  - P; SO$_4$
- Trace elements:
  - Al; As; Ba; Cd; Cr;
  - Cu; Ni; Pb; Sr;
  - Zn

Parameters

- LMM, TMV, LMB
- LMG, PMG; scr. 1
- LMG, PMG; scr. 2
- LMG, PMG; scr. 3

Water supply wells.
Observation wells of the National Groundwater Quality Monitoring Network
Nitrate in groundwater in sandy areas (agriculture) and surface waters

**Groundwater**
- Leaching (0-5 m)
- Groundwater (5-15 m)
- Groundwater (15-30 m)
- Groundwater (ca. 45 m)

**Surface water**
- Agricultural stations
- Regional surface water
- Main surface waters

**NO₃ (mg/l) and % > 50 mg/l**

- mg/l NO₃
- % > 50 mg/l
Nitrate in the upper groundwater 1992-2002

- Sandy regions, measurements
- Clay regions, measurements
- Sandy regions, index
- Peat regions, measurements
The flux of water and chemicals from soil to draining surface water in sandy areas

*NPKRUN MODEL WITH DETERMINATION OF*

- long-year averages of precipitation and actual evapotranspiration
- surficial flow components, overland flow and interflow
- groundwater recharge and travel times
- average flux from varying routes to surface water

**rivm**
Average nitrate concentrations in 1990-2000 as a function of travel times in the soil

- Travel times
- computed with tritium ($^3$H)
- year of infiltration = sampling year - travel time
- Conclusion: denitrification is only predominant in upper layers
Groundwater quality in upper groundwater (1m below land surface) in sandy areas

- Extrapolation of measured data to cells of 500 by 500 m$^2$;
- periode 1998-2002
- agricultural data: from LMM
- data natural vegetation: from TMV

nitrate concentrations (loes-bodemvocht, zand-put, klei-drain en veen-sloot water) in natural and agricultural land.

nitrate (mg/l)
- not relevant or no data
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- > 150
Using modules for the description of groundwater qualitative aspects

- groundwater quality in the upper 1m in rural areas based on extrapolation of monitoring data to 500*500 m² cells;
- shallow groundwater quality (10-25m) based on extrapolation of monitoring data to larger areas (see Figure);
- deep groundwater quality (travel time t> 50a) fresh groundwater = basic values, plus abstraction data;
- brackish groundwater by mapping the fresh/brackish interface
- urban groundwater specific description

Gemiddelde concentratie van nitraat in grondwater per waarnemingsfilter over de periode 1998-2002 en ecodistrictgroep, getekend op een kaart van de stroomgebieden in Nederland (Experimenteel 040122Do).
Discussion/ conclusions

- Large groundwater bodies are distinct water masses and are in line with technical and administrative boundaries;
- Quality stratification depends on travel times in many cases; no separate GWB needed for quality variations;
- Three compliance checking levels proposed:
  - land surface minus 10 m
  - land surface minus 25 m
  - abstraction levels for public supply
- Early warning level at land surface -1m, to be used for:
  - risk assessment
  - trend analysis