MAPPING AND MONITORING GROUNDWATER AND IMPLEMENTING THE GROUNDWATER DIRECTIVE IN NORWAY

Pål Gundersen, Anna Seither, Atle Dagestad, Øystein Jæger – Geological survey of Norway

GEOLOGICAL SURVEY OF NORWAY

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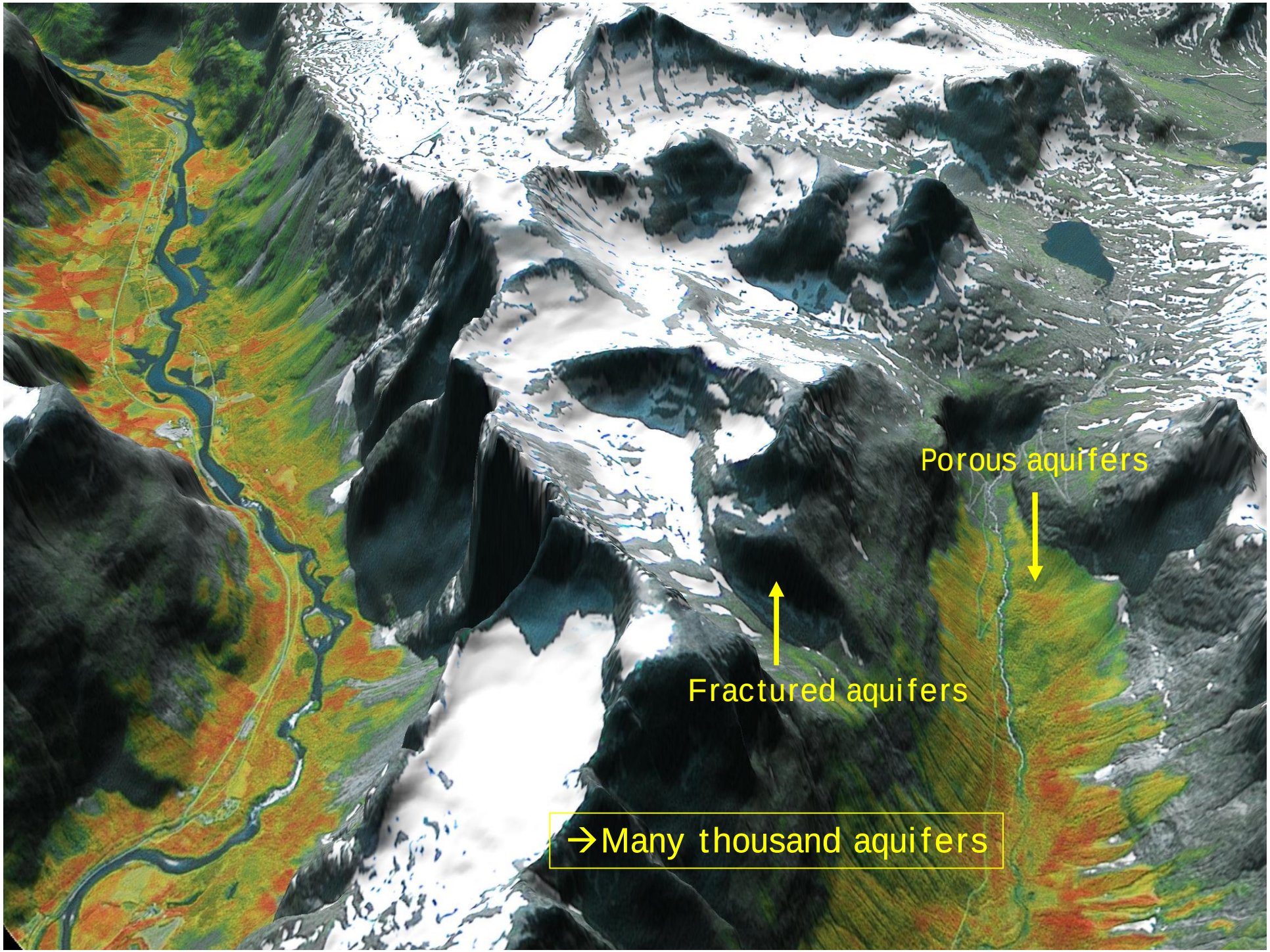

Porous aquifers
Fractured aquifers
→Many thousand aquifers

Groundwater monitoring

~15 % of Norwegian water supply

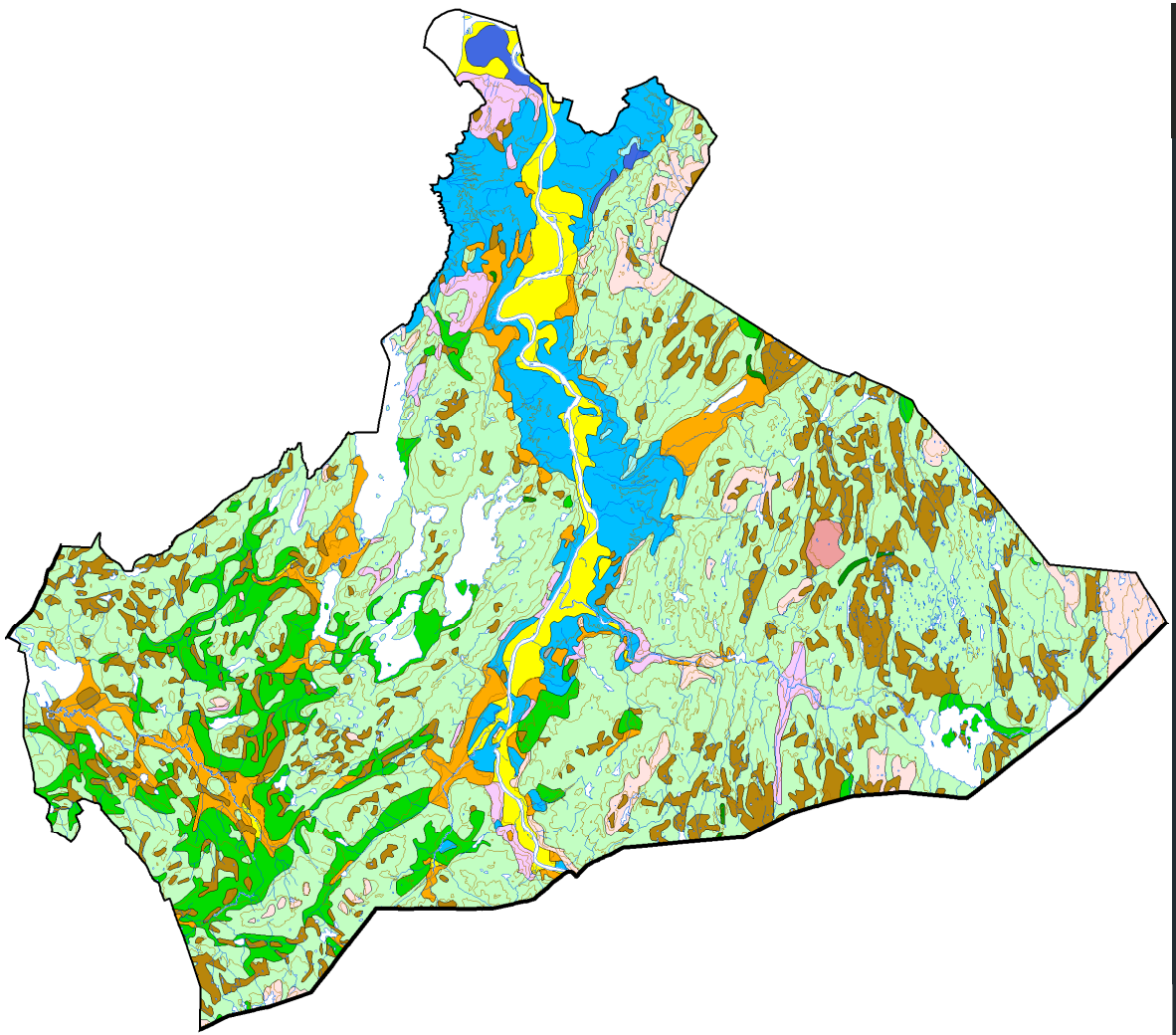
Feeding surface waters

Infiltration/ retention

Landslides – Subsidence

Climate change

….



Fluvial

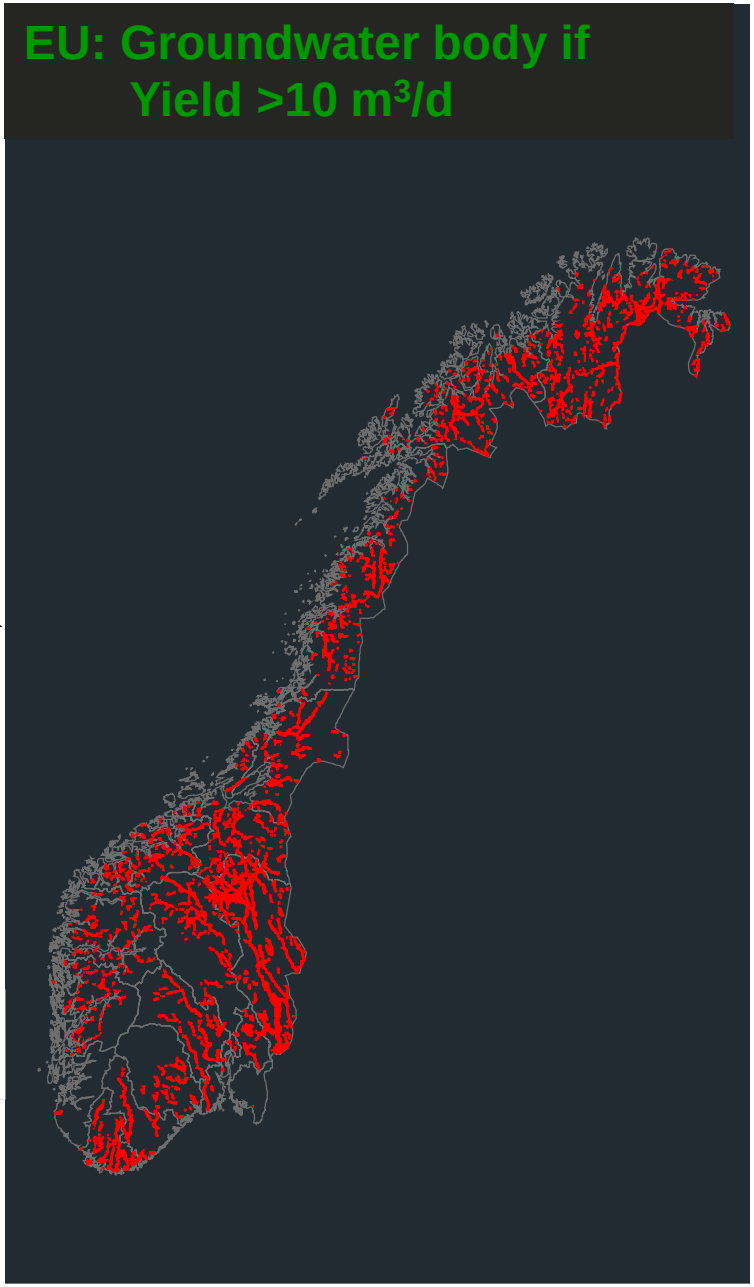
Glaciofluvial

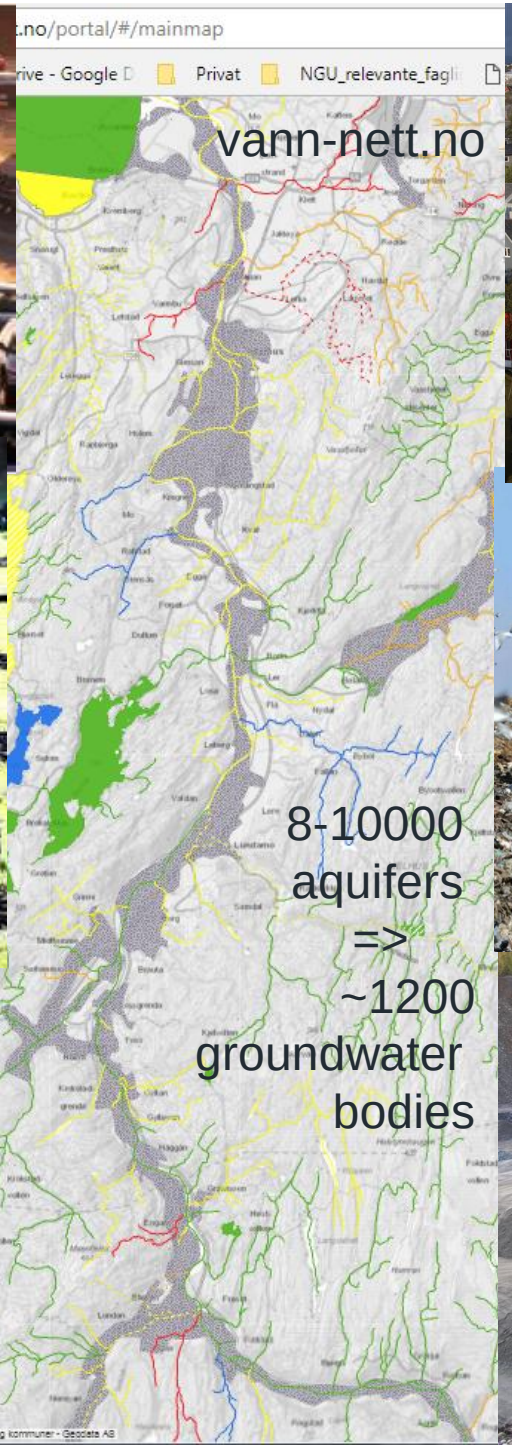
Marine

Till

Other

Bedrock/
mire

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aquifers
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groundwater
bodies


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National level - Norwegian Groundwater monitoring

"Natural background sites" (National groundwater an soil water network)

80 sites: Water levels, temperature

53 sites: Inorganic chemistry

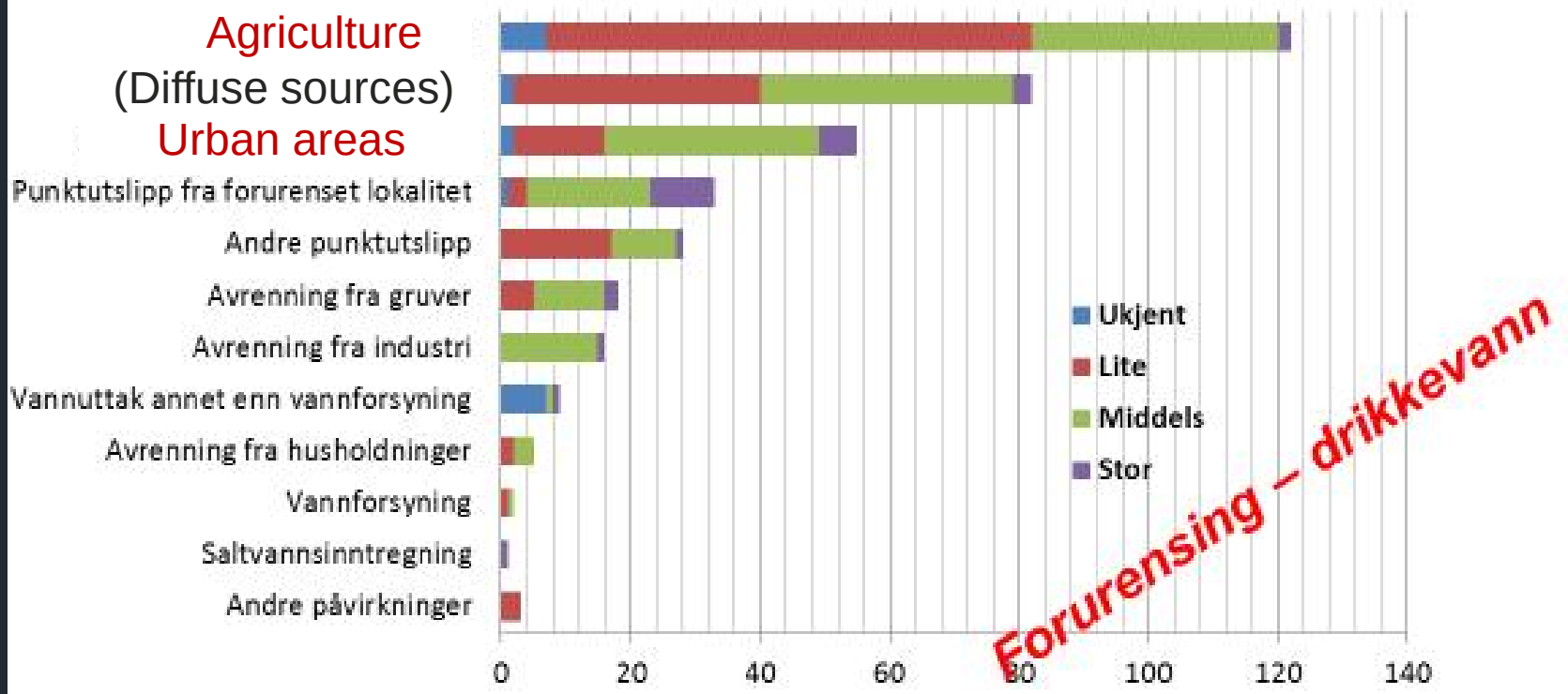
"Sites under local anthropogenic pressure"

14 typical sites (Urban and Agriculture)

Inorganic *and org. chemistry*

+ logging water levels, Conductivity, Temperature

Groundwater bodies influenced by different sources (2010)



vann fra fjell til fjord

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Project on monitoring selected groundwater bodies under anthropogenic pressure

Norwegian Environment Agency

The Norwegian Agriculture Agency

The Norwegian Water Resources and Energy Directorate Norwegian

Institute of Bioeconomy Research (NIBIO)

Geological survey of Norway

Foto: Roger Roseth, NIBIO

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Selected sites

- Urban
  - Orkanger
  - Mosjøen
  - Sunndalsøra
  - Elverum
  - Otta
  - Kongsberg
  - Gardermoen
  - Odda
- Agriculture
  - Overhalla
  - Grødal
  - Haslemoen
  - Rimstadmoen
  - Horpestad
  - Lærdal

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Groundwater sites under anthropogenic pressure

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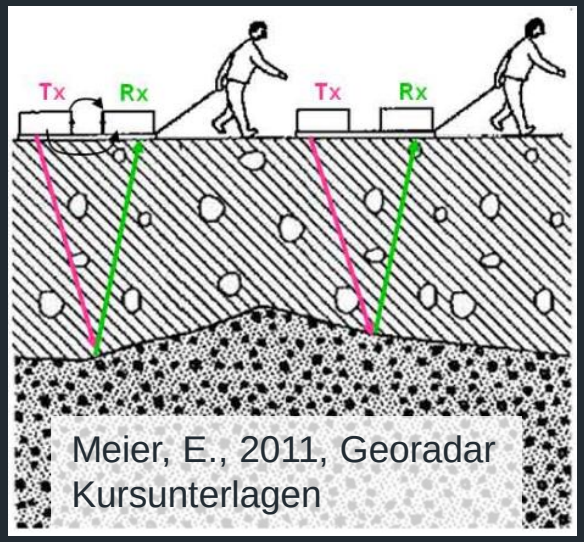
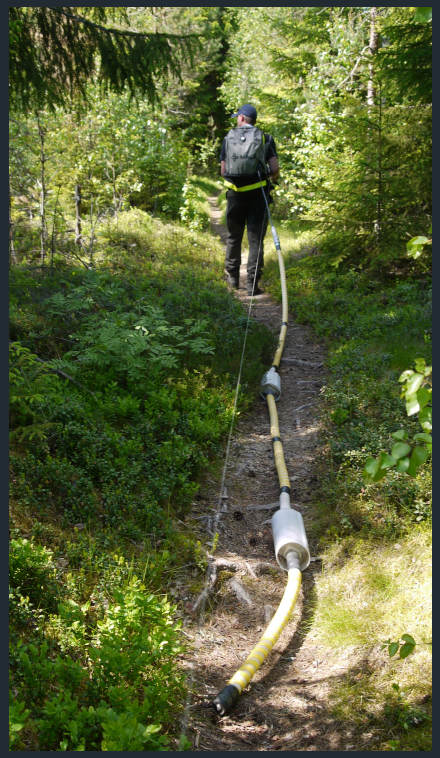
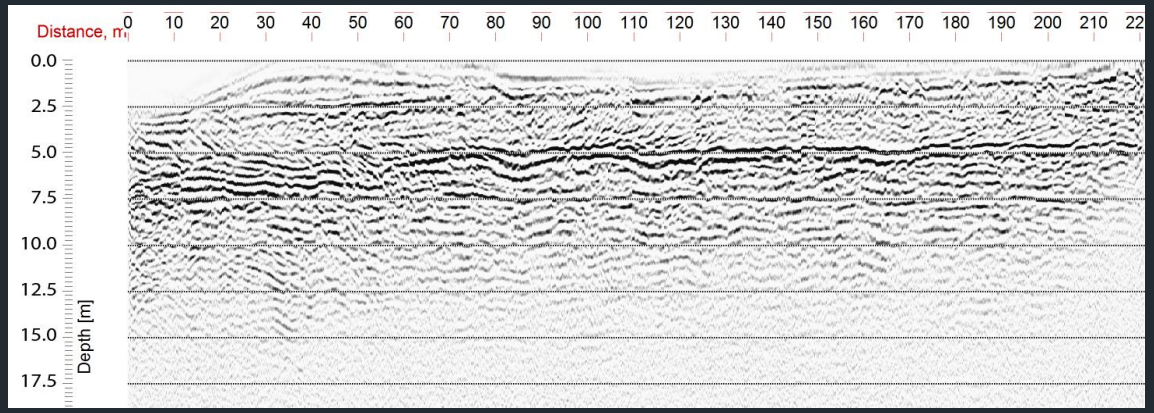
Mapping groundwater - geophysics



Meier, E., 2011, Georadar Kursunterlagen





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Mapping groundwater - drilling

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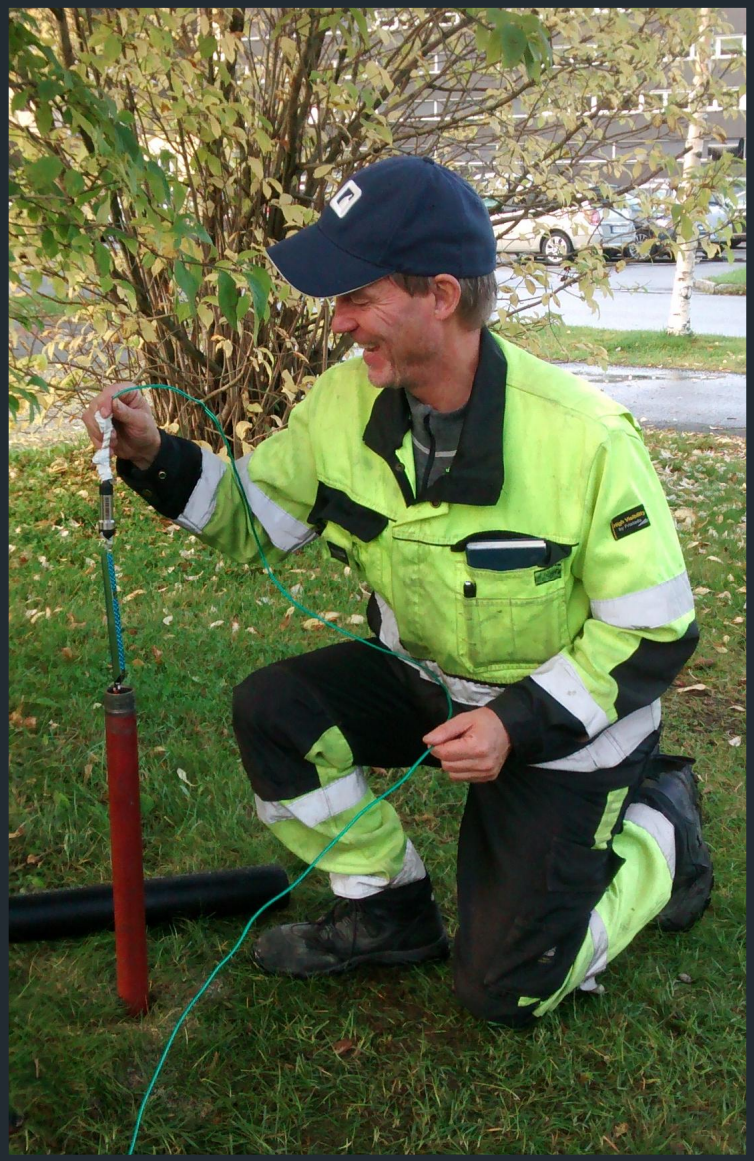
Mapping groundwater - sampling



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Mapping groundwater - analyses

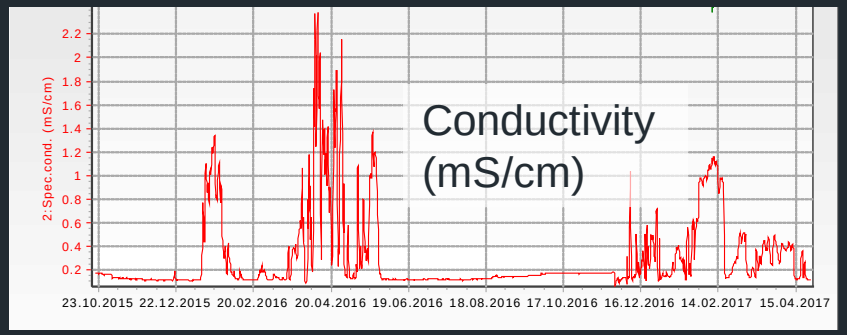
•Field: Conductivity, pH, Alkalinity, O2

Logging: Conductivity, Temp. Water level

Lab: Inorganic; NO_3,NH_4, anions, cations

+ Urban: Organic analyses

- Hydrokarbones (C5 – C35)
- PAH (16 EPA)
- BTEX
- PCB 7
- Volatile organic (VOC 9)



+ Agriculture:

Pesticides (Glyfosat, Metribuzin,...)

Urban sites

Lokalitet	NO_3^-	Heavy metals	THC	PAH	VOC	BTEX
Orkanger	X					
Mosjøen			X	X		X
Sunndalsøra						
Elverum	X					
Otta						
Kongsberg	X					
Gardermoen	X					
Odda	X		X	X		X

X enhanced

→ Enhanced on nitrate, but below threshold and turning point
→ Low on organic constituents
→ In general; good quality

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Agricultural sites

Lokalitet	NO_3^-	Metribuzin + meta-bolites	Glyfosat + meta-bolites	Multi-Meth-ode 15	Multi-Metho-de 101	Propi-kona-zole	Thia-benda-zole	Low dosis subst-ances
Overhalla	X				X	X		
Grødal	X	X				X		X
Haslemoen	X	X				X		X
Rimstad-moen	X	X				X		X
Horpestad	X		X			X		X
Lærdal	X	X						

X enhanced
X above turning point
X above treshold

→ Minorly enhanced on nitrate
→ Pecticides; proven occurrence on all sites, some above treshold

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Preliminary conclusions

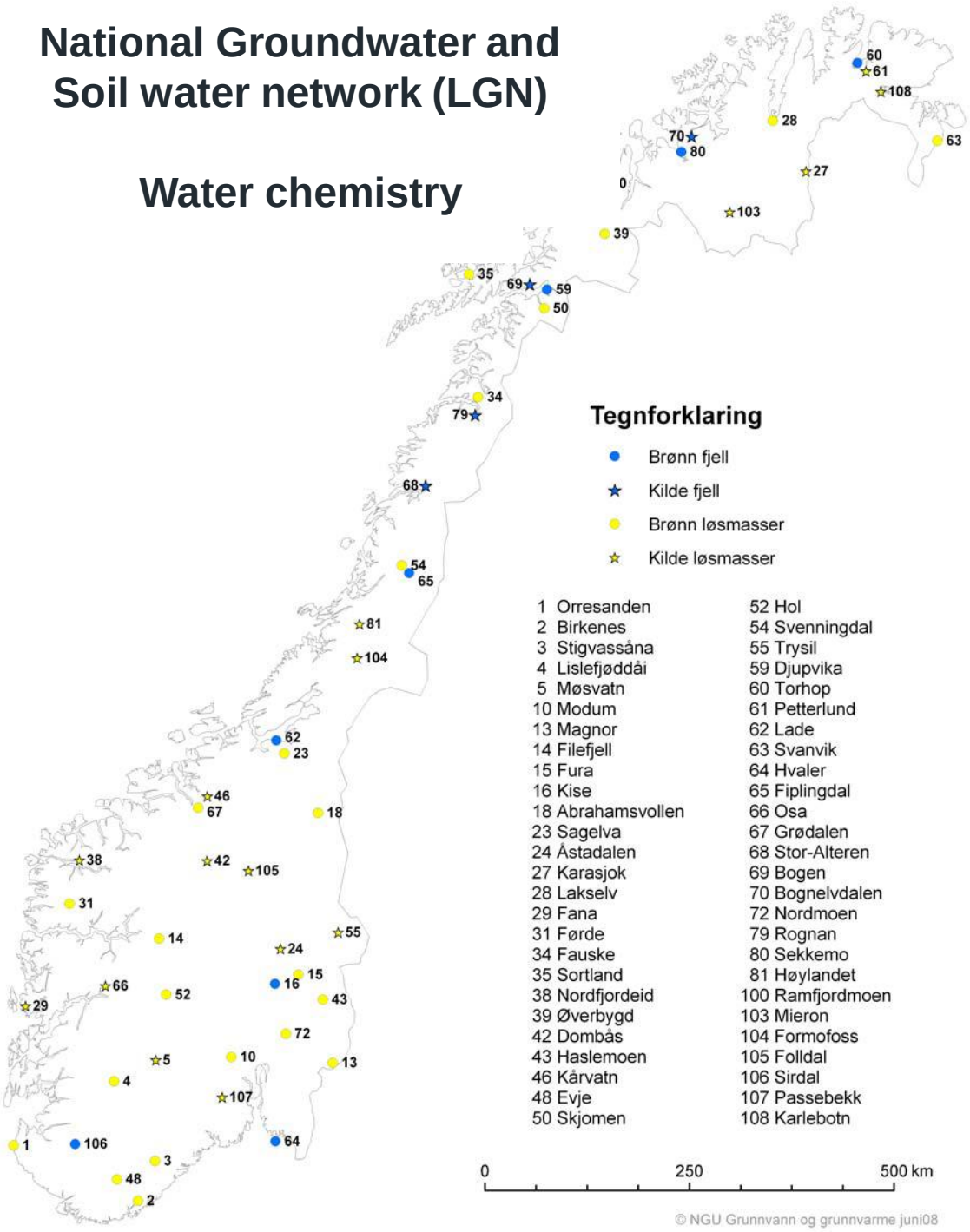
- Urban GW generally good quality
- Agriculture do affect GW (NIBIO)
- More monitoring needed

Difficult to fulfill WFD-obligations within todays

- geological frames
- pollution pressure
- financially

National Groundwater and Soil water network (LGN)

Water chemistry



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National Groundwater and soil water network

Norwegian groundwater;

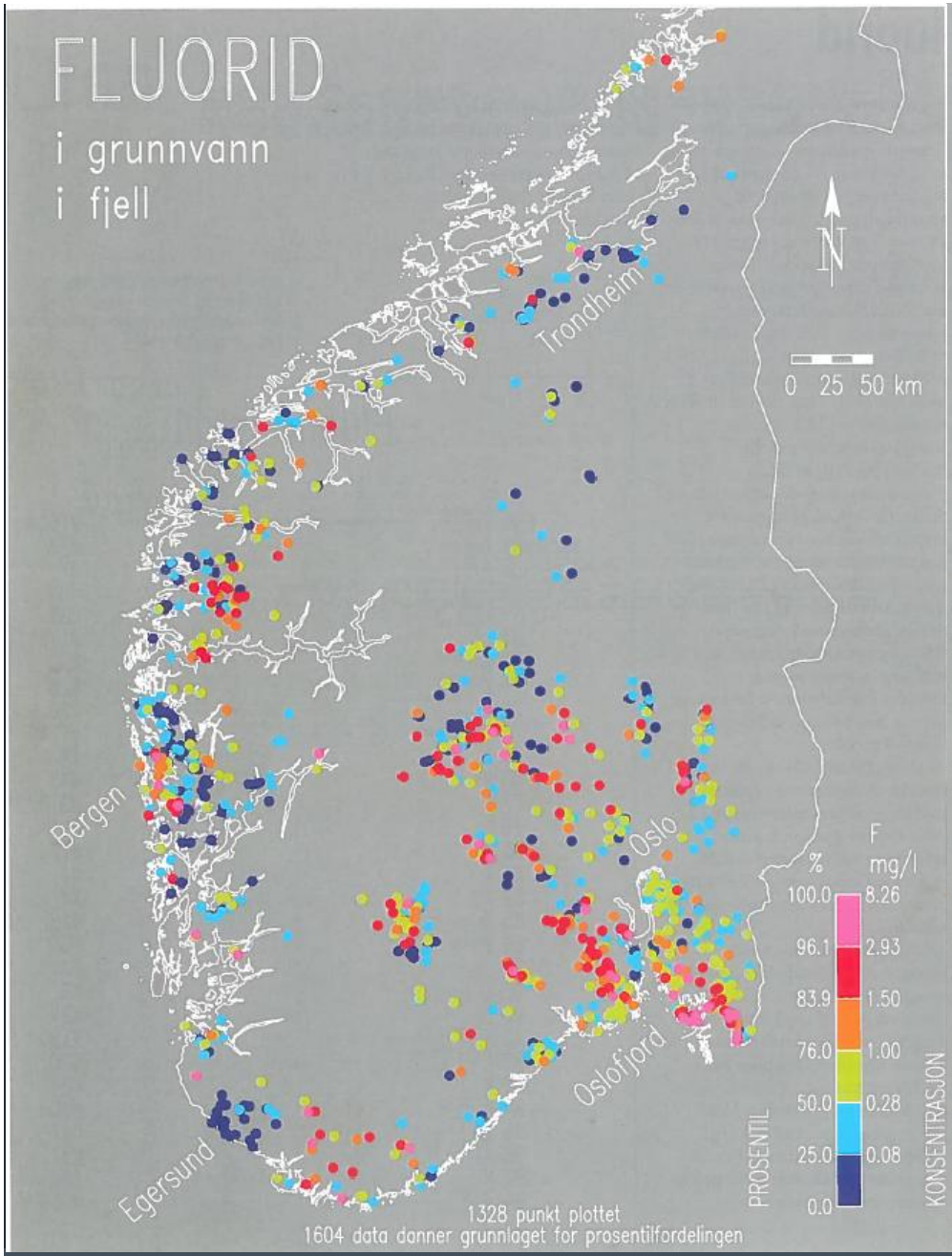
generally of good chemical quality

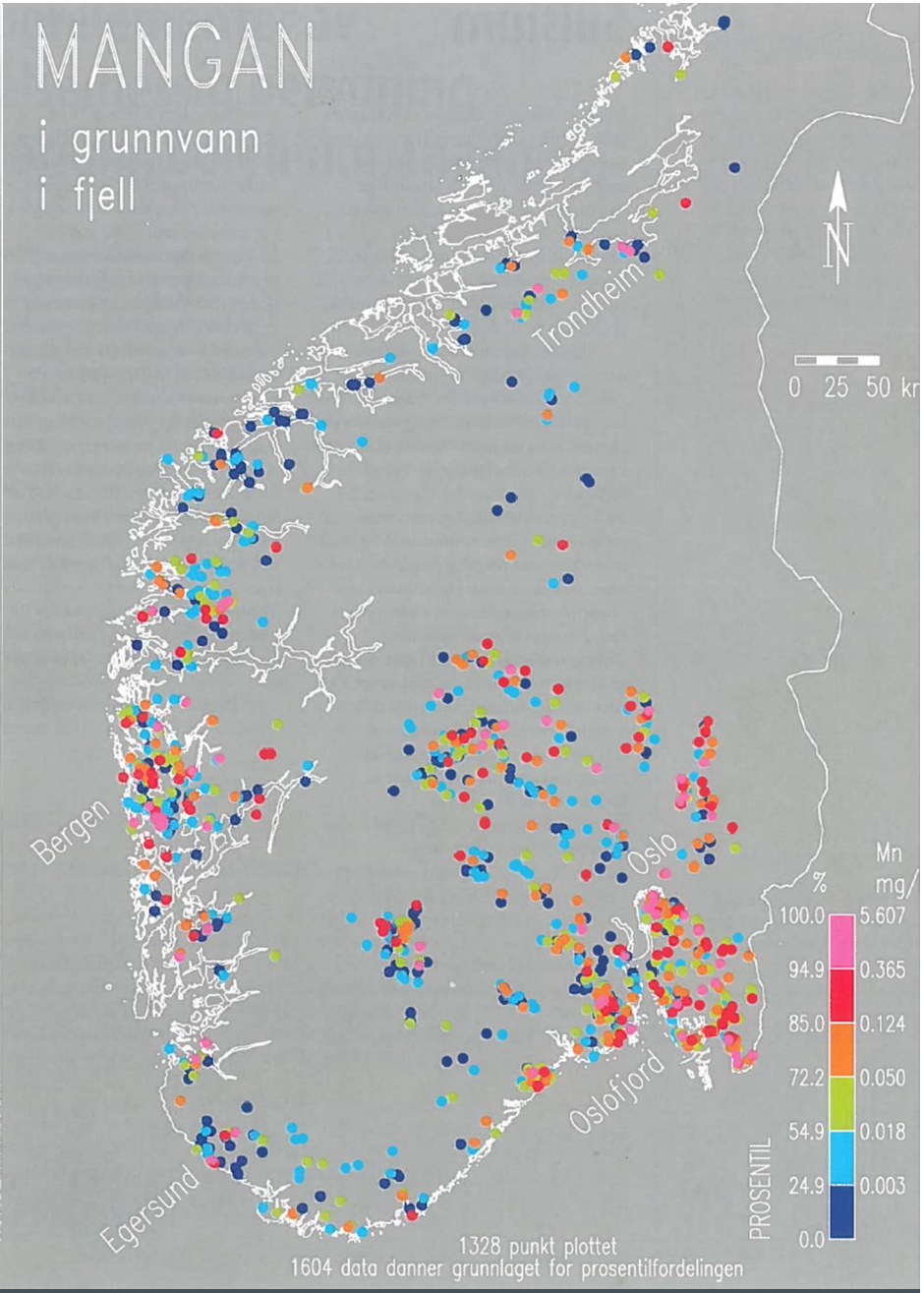
issues on natural levels (e.g. fluoride)

Southern region; long range atmospheric pollution

=> buffer exhaustion => pH decrease in ground water

Need to extend number of monitoring sites


FLUORID
i grunnvann
i fjell
N
0 25 50 km
Trondheim
Bergen
Oslo
Oslofjord
Egersund
% F mg/l
100.0 8.26
96.1 2.93
83.9 1.50
76.0 1.00
50.0 0.28
25.0 0.08
0.0
PROSENTIL
KONSENTRASJON
1328 punkt plottet
1604 data danner grunnlaget for prosentilfordelingen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Trondheim
Bergen
Oslo
Oslofjord
Egersund
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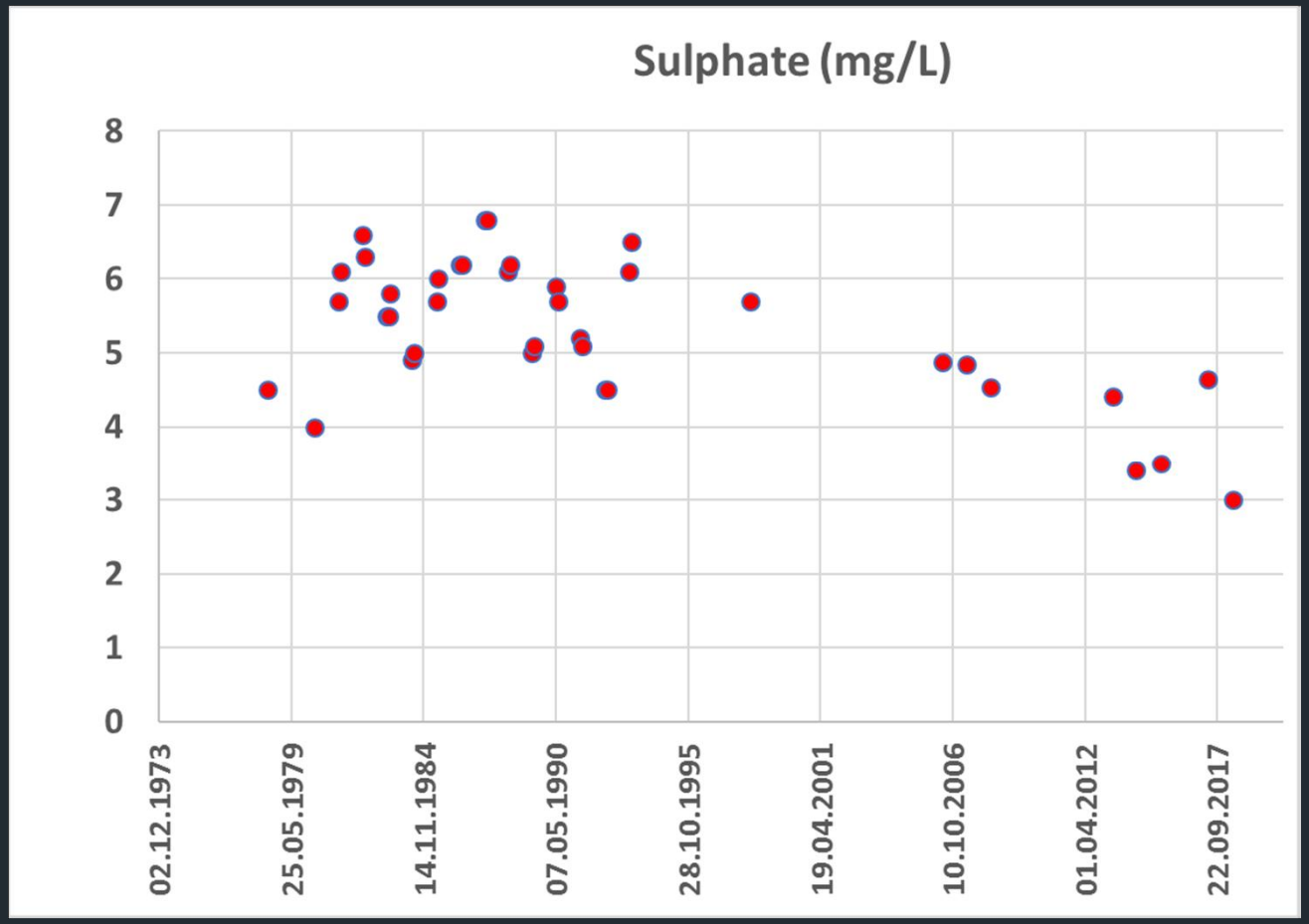
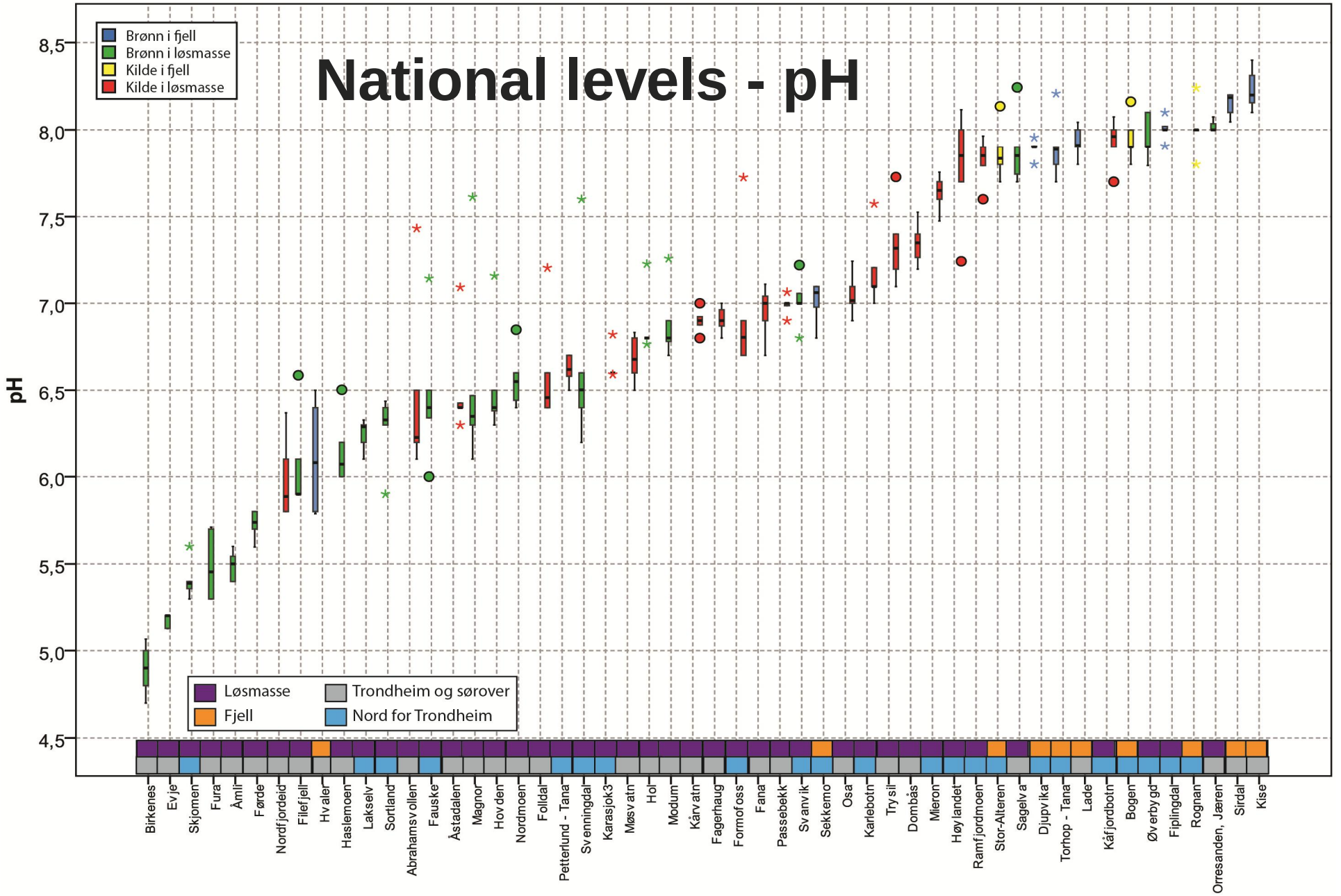
100.0 5.607
94.9 0.365
85.0 0.124
72.2 0.050
54.9 0.018
24.9 0.003
0.0
PROSENTIL
1328 punkt plottet
1604 data danner grunnlaget for prosentilfordelingen

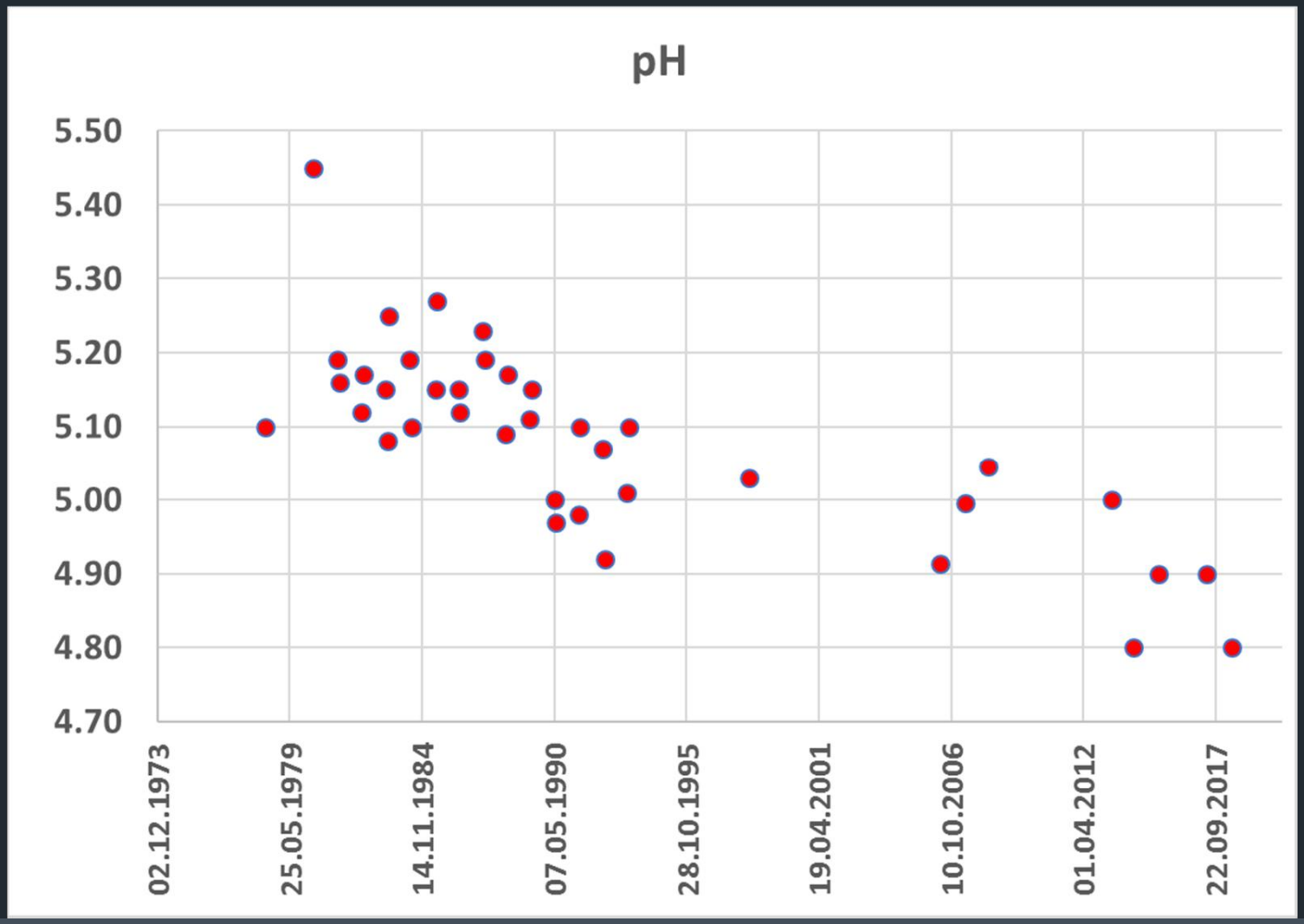
Sulphate at Birkenes



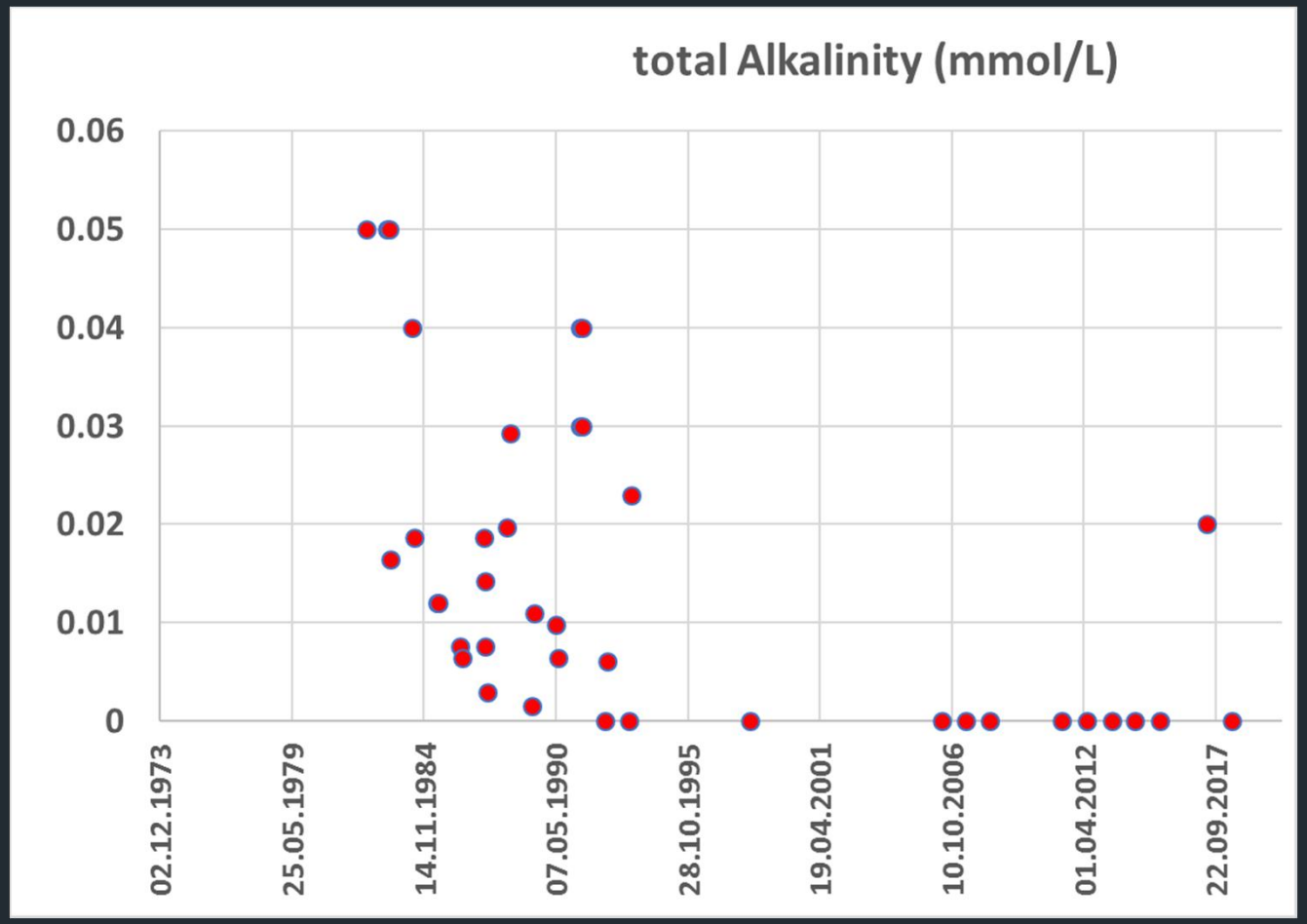
National levels - pH



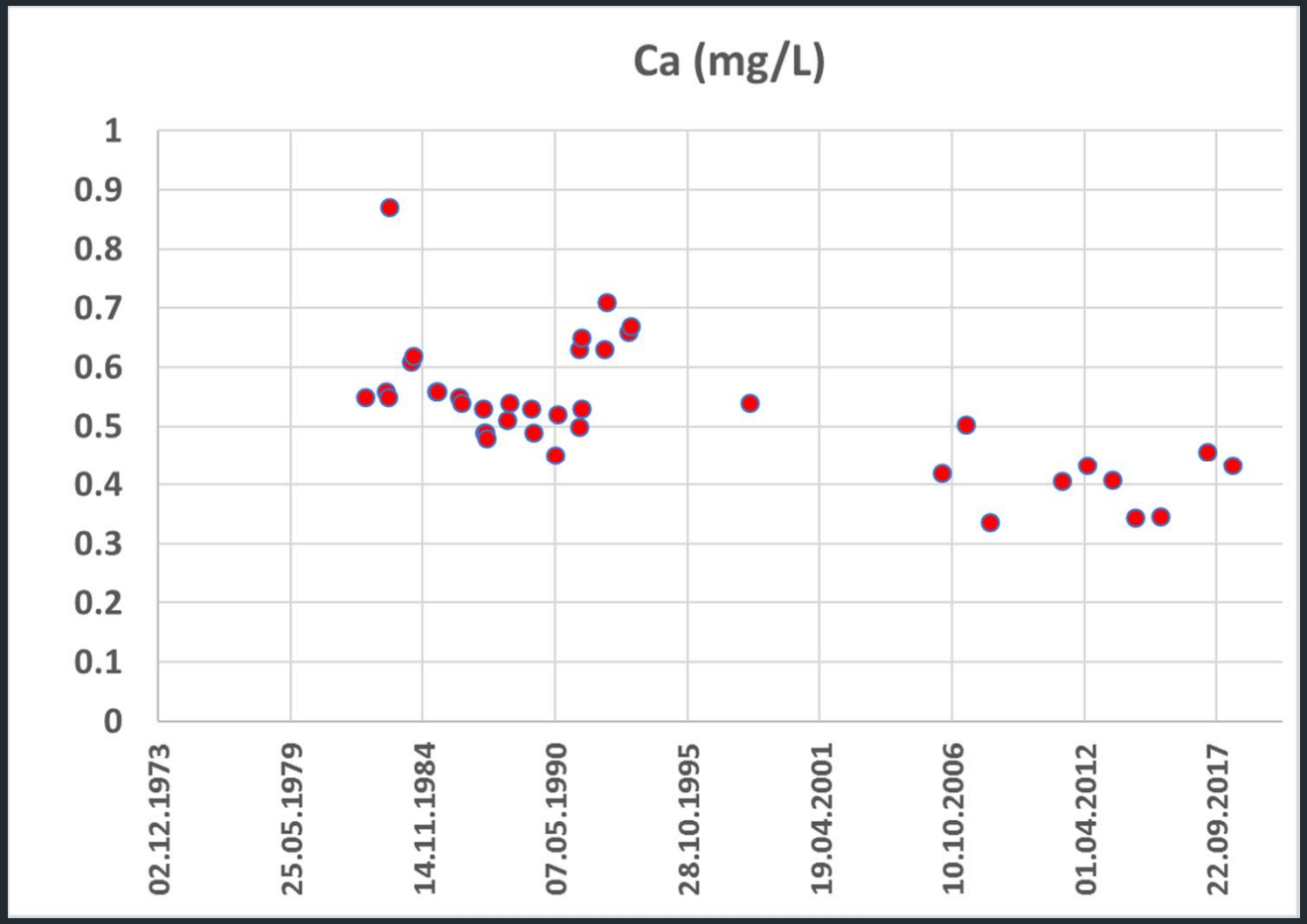
pH at Birkenes (South Norway)



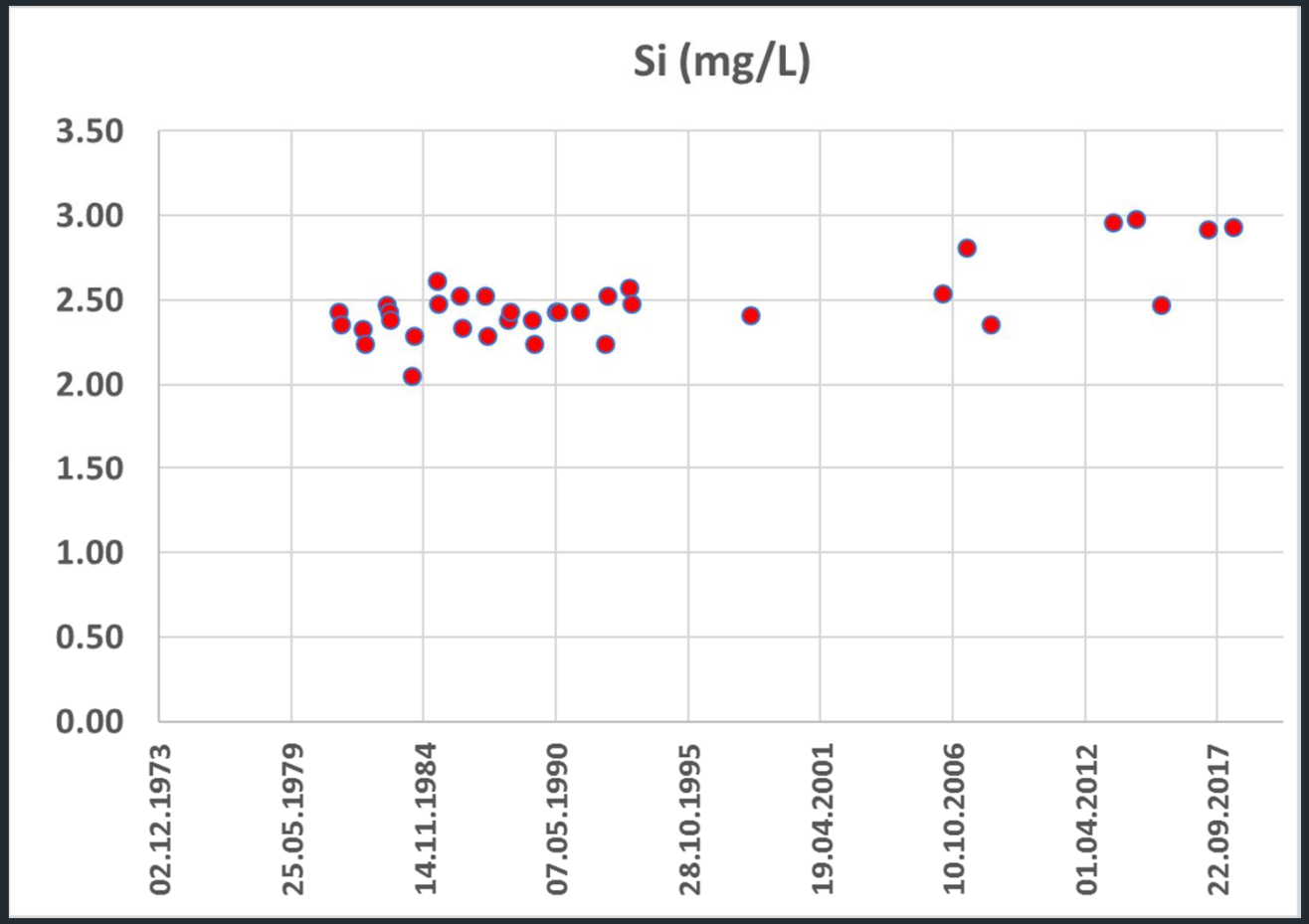
Alkalinity (mmol/L) at Birkenes



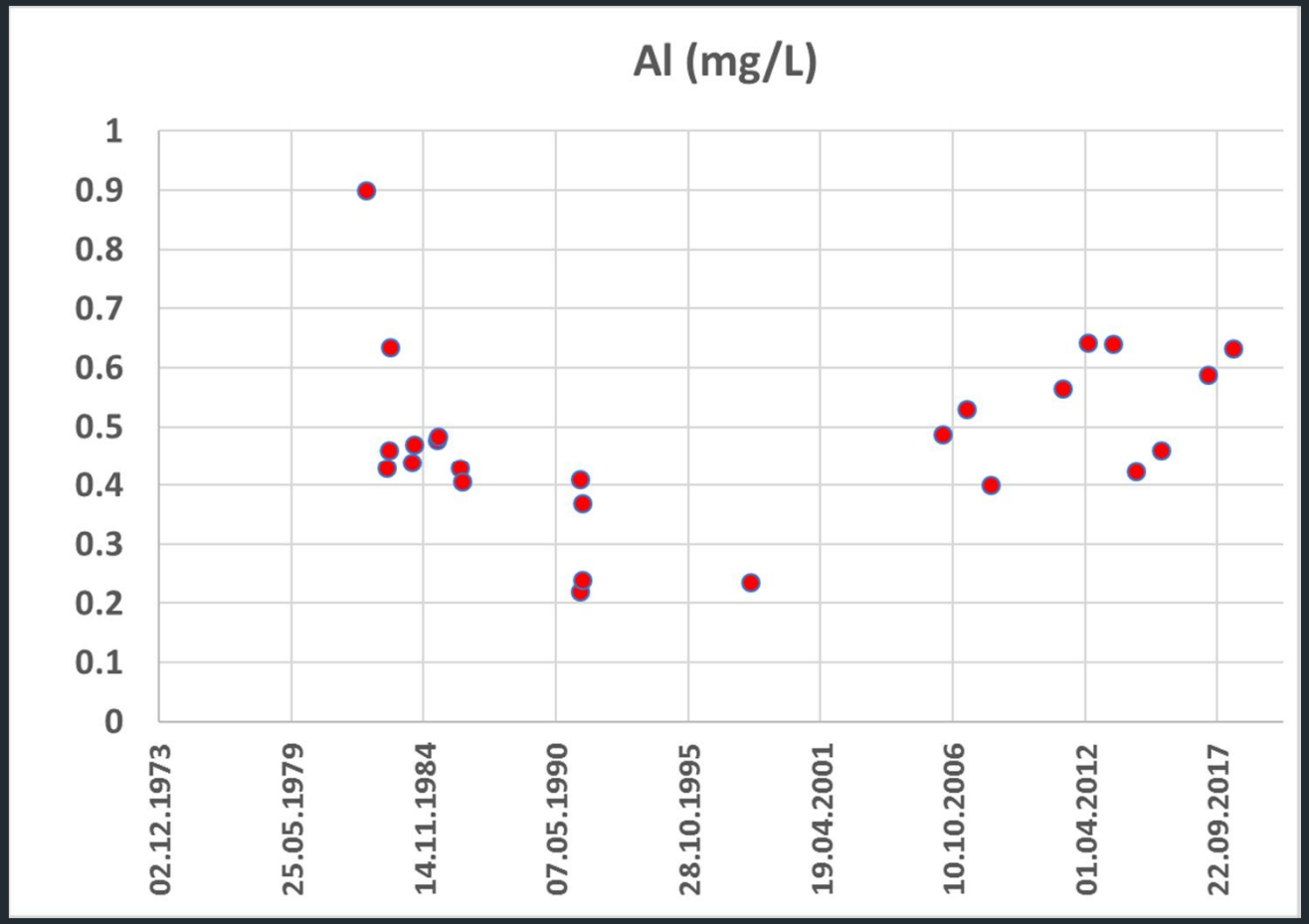
Ca at Birkenes



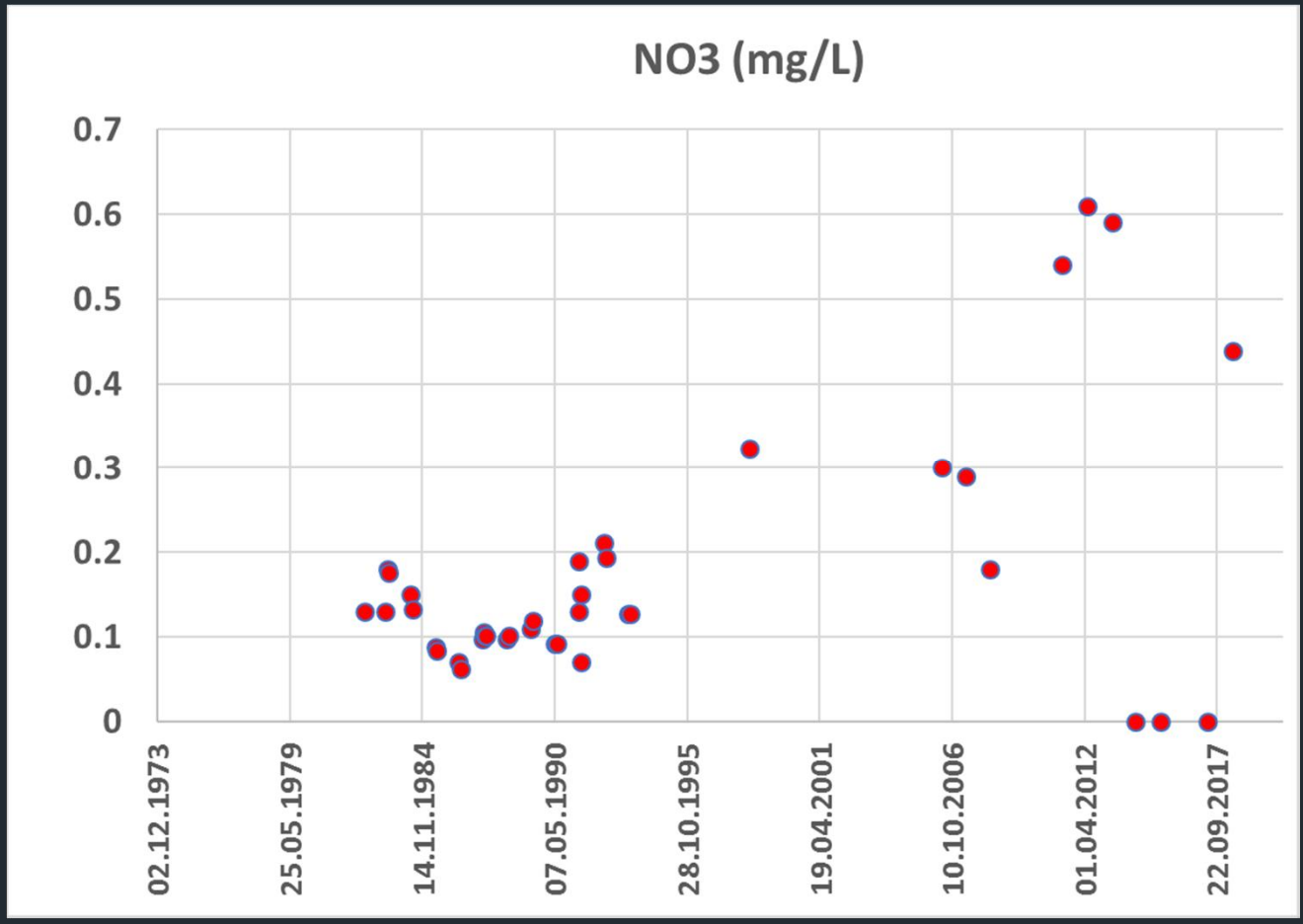
Si at Birkenes



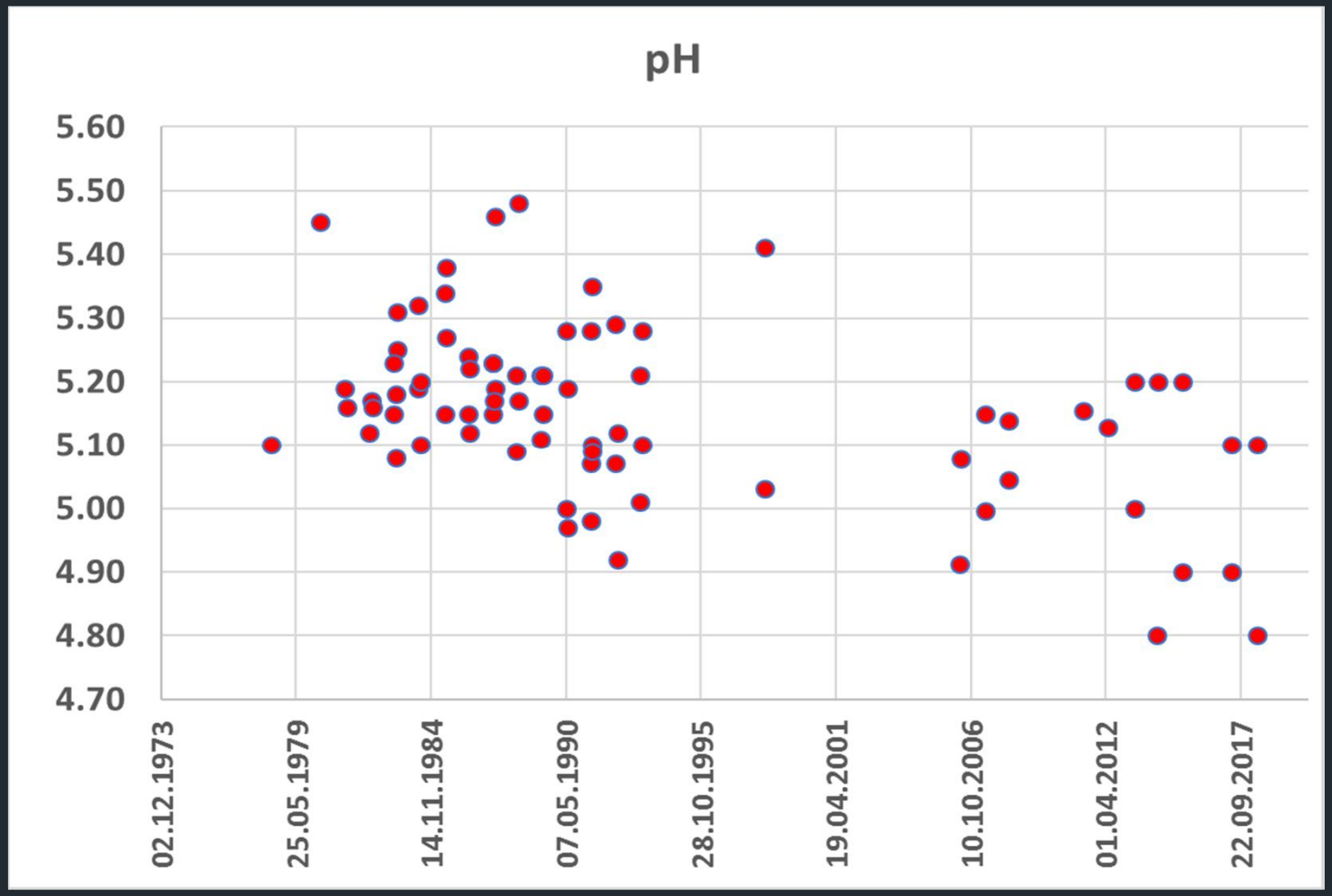
Al at Birkenes



Nitrate at Birkenes



pH at Evje (South Norway)



National Groundwater and soil water network

Norwegian groundwater;

generally of good chemical quality

issues on natural levels (e.g. fluoride)

Long range atmospheric pollution

=> buffer exhaustion => pH decrease in ground water

Need to verify trends and status

and predict consequences

Thanks for listening

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