# LEARNING BY DOING

# Field course in hydrogeology

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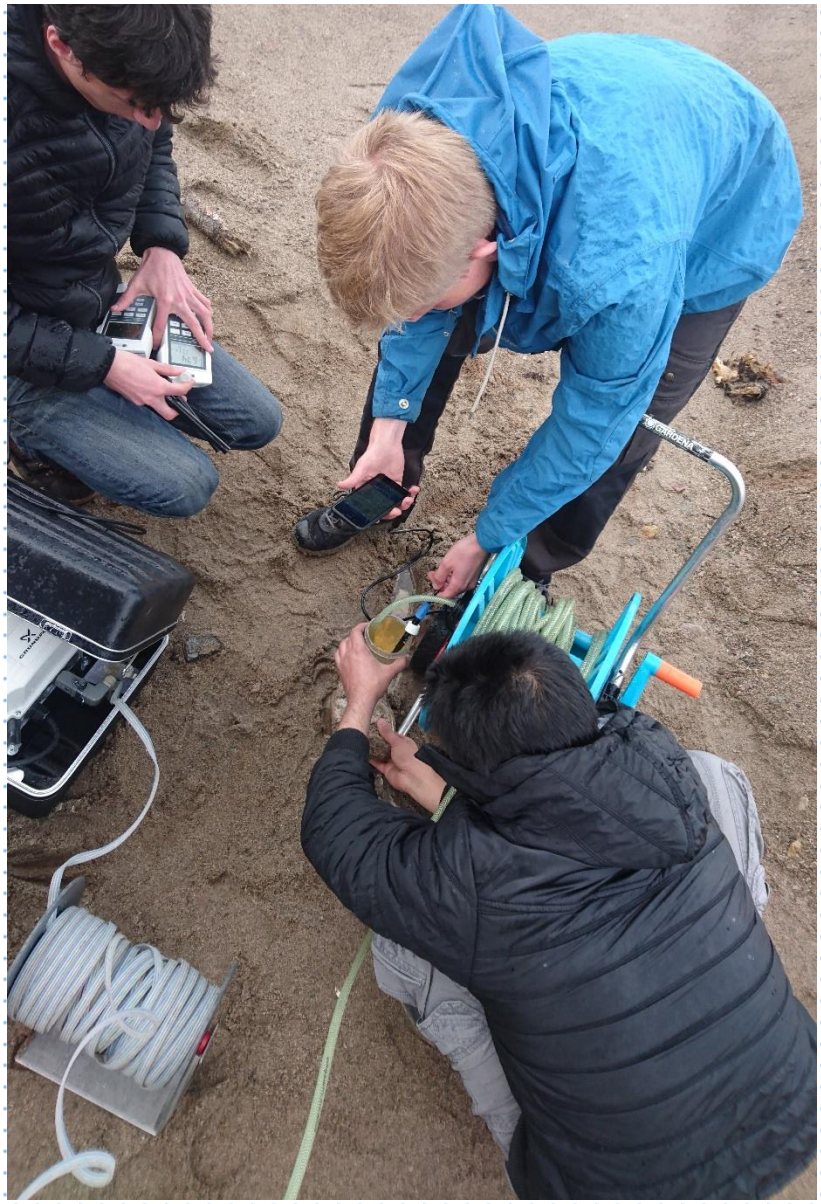
UiO : University of Oslo

Thanks to:
Helen French, Carlos Duque, Helge Hellevang, Gijs Breedweld, Leif, Asbjørn, Brit Lisa Skjelkvåle, Afonso Nogueira, Fabio Domingos & Per Aagaard

# Field course in hydrogeology

- **WHY**
- WHAT
- HISTORY
- IMPACT



# WHY ?

Hydrogeologists must be prepared for field work!!

→ *practical skills, independence, project planning*

# EVIRONMENTAL GEOLOGY PROGRAM, OSLO - NORWAY

HYDROGEOLOGY / GEOCHEMISTRY

**«GEO 4360 Field methods in hydrogeology»**

2 weeks in 2nd semester of M.Sc. studies

UiO : University of Oslo

# THE NEED FOR HYDROGEOLOGISTS

- Environmental remediation, sustainable development and management of energy and water resources
- Job oportunities: academia, private and public sectors
- Stable market for Hydrogeologists

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# METHODS (LEARNING GOALS)

1. Maps/GPS, field and lab work, project management, literature studies and communicating results

2. Drilling of groundwater wells, geotechnical sounding

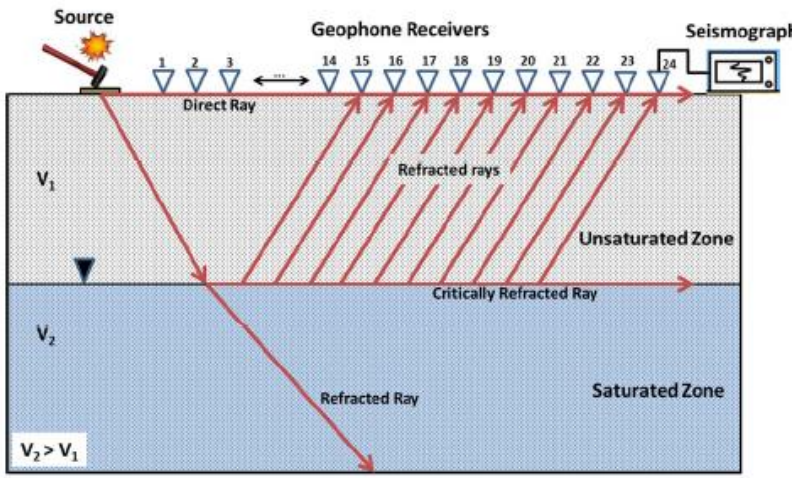
3. Ground- surface- and soilwater sampling:
   - field parameters, geochemistry, pollution

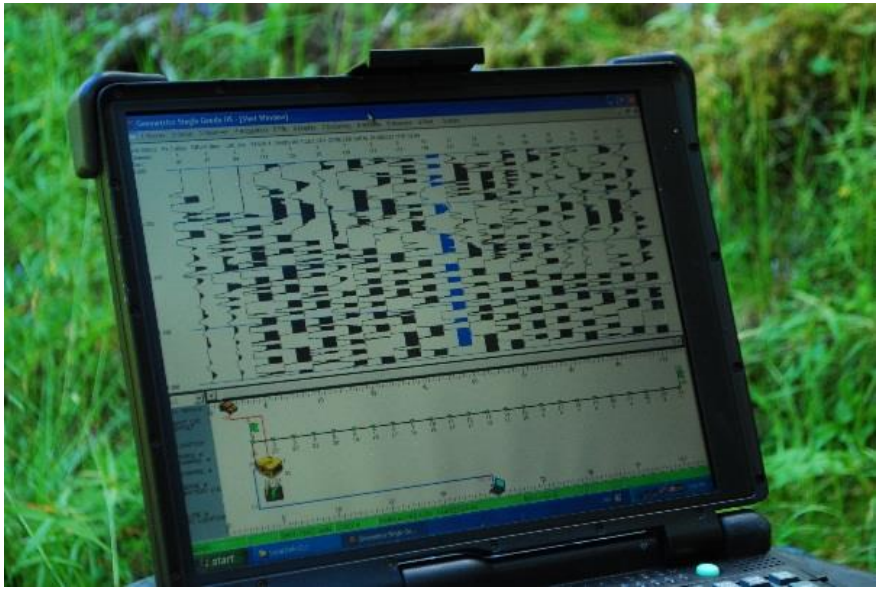
4. Field tests to estimate hydraulic properties and flux:
   - *saturated / unsaturated zones + rivers and catchment areas*

5. Geophysical methods:
   - *Electrical resistivity, Seismics, Georadar*

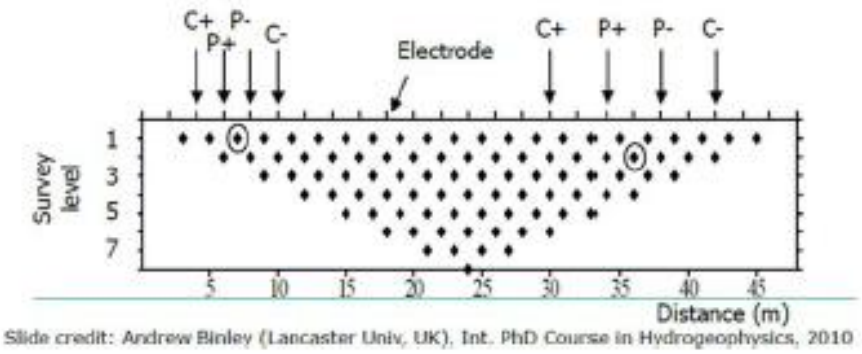
# Drilling and pumping groundwater wells


# Geophysical methods: seismics, ER, georadar



# Geophysical methods: seismics, ER, georadar




Slide credit: Andrew Binley (Lancaster Univ, UK), Int. PhD Course in Hydrogeophysics, 2010

Measure: electrical resistivity (ER)

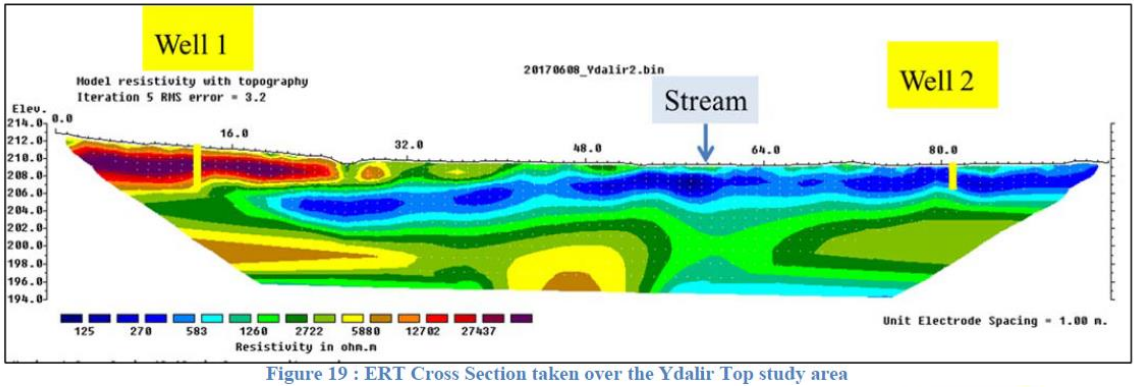
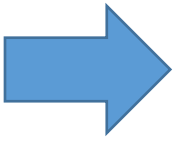


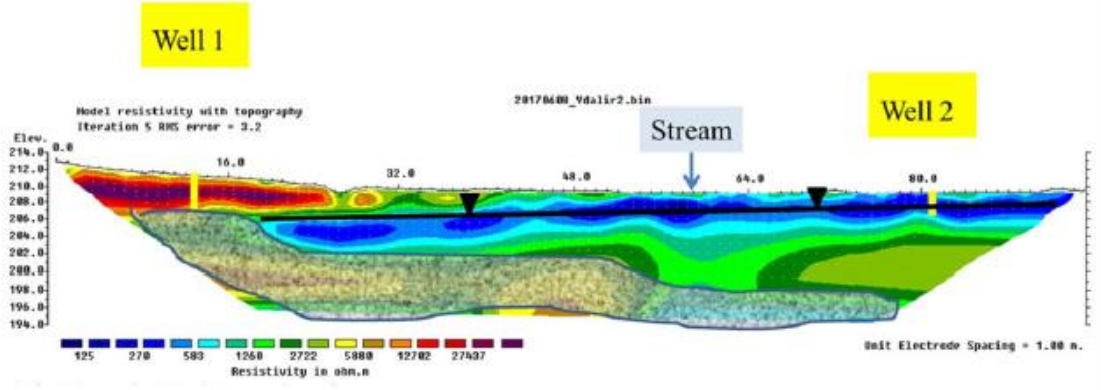

Figure 19 : ERT Cross Section taken over the Ydalir Top study area

Data: map of high and low Resistivity to electrical current inthe ground


Interpretation:

- Groundwater table
- Bedrock
- Unsaturated zone





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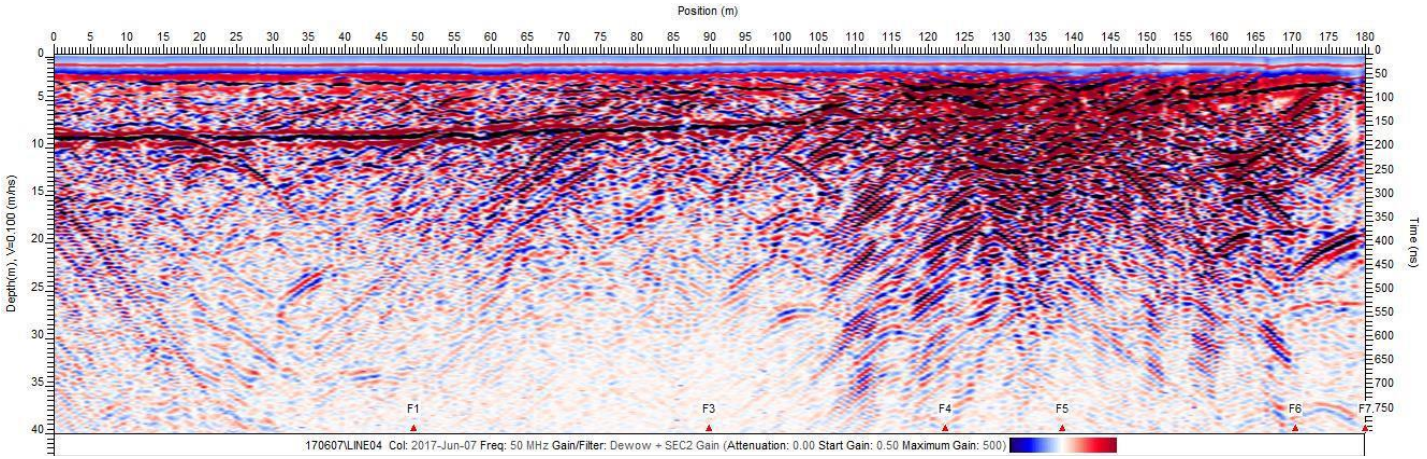
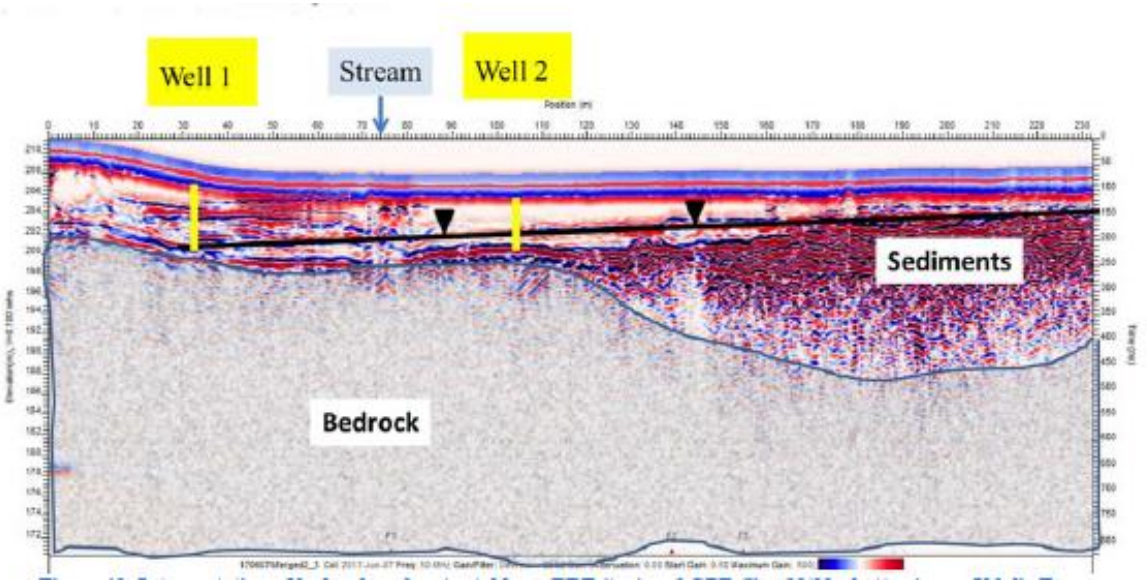
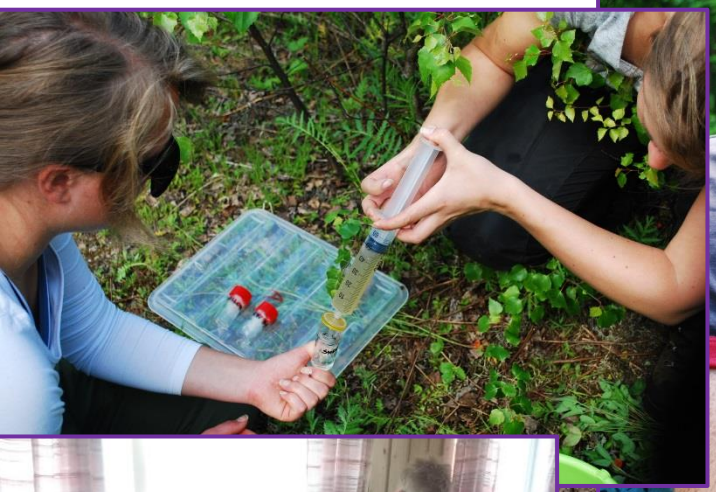


# Water sampling and chemistry:
*groundwater, lakes and rivers*

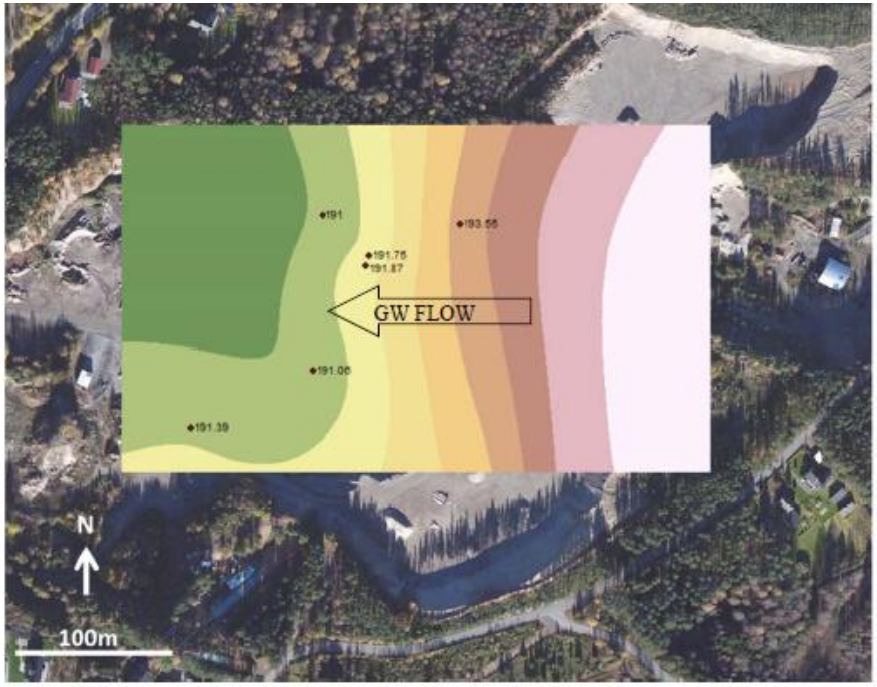


# Estimation of hydraulic properties:

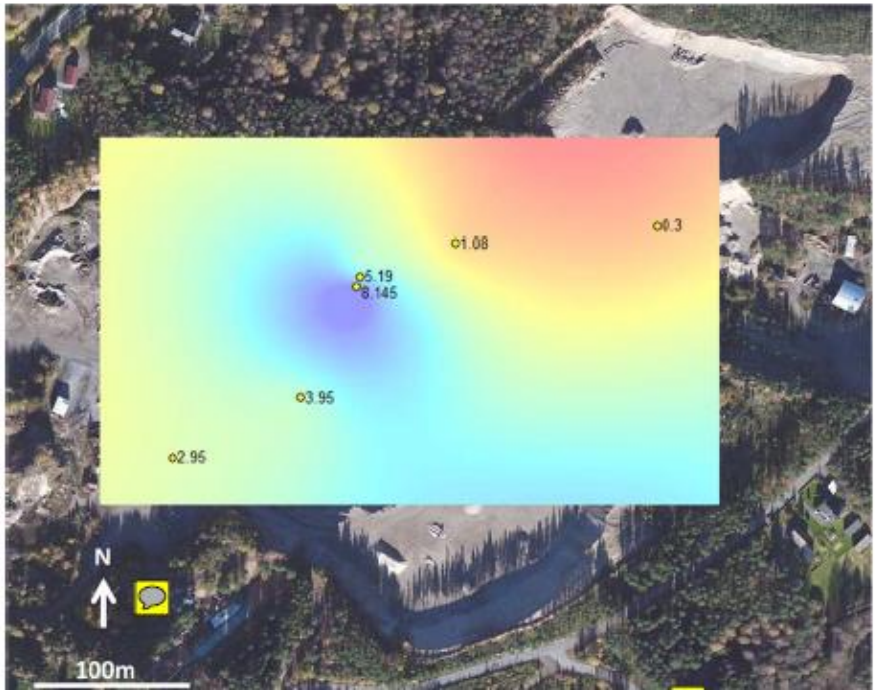
- *capillary sampling*
- *infiltration tests*
- *slug tests*
- *salt dilution*
- *flow meters*
- *slug tests*
- *pumping tests*

# THE END:

*The students prepare a regional interpretation of results and deliver a field report.*




GROUNDWATER TABLE




Chemistry (pH)

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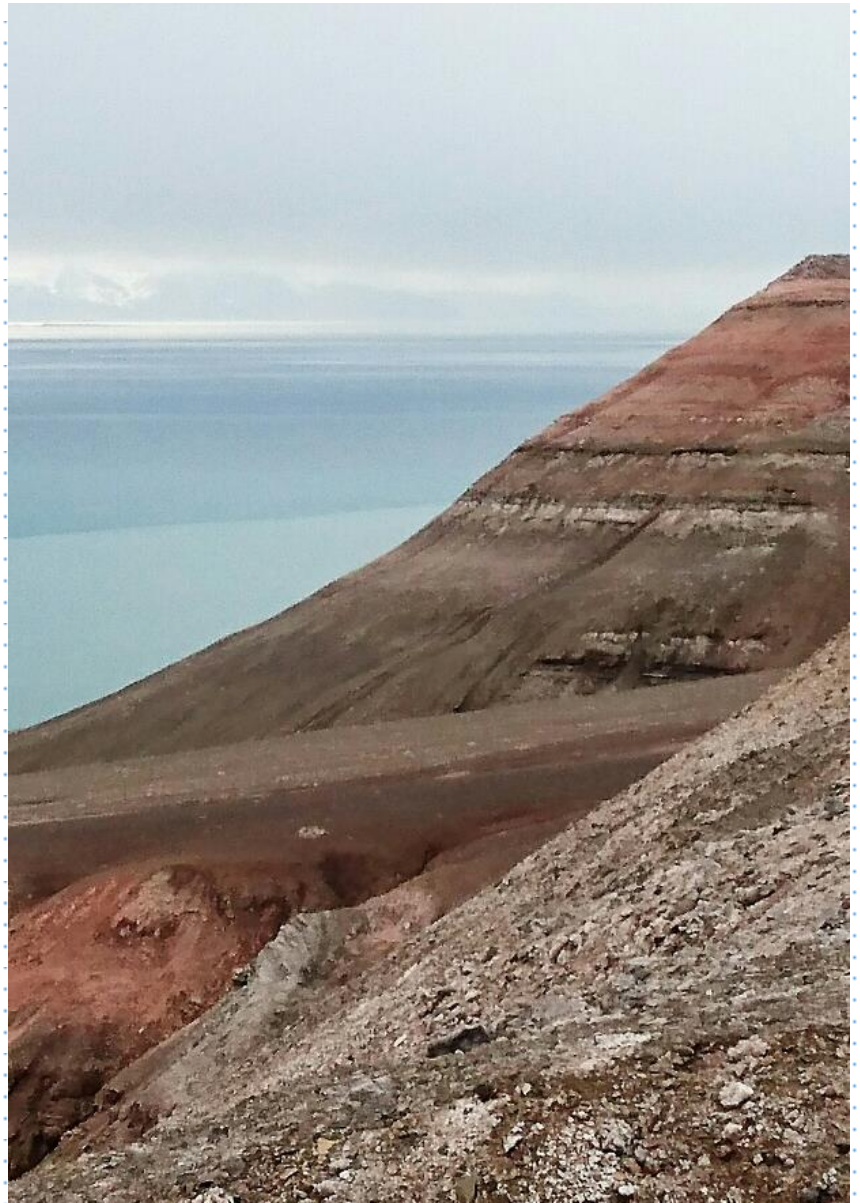


# *SINCE 1987 ….. !!!*

- 6 study areas in Norway
- Many international students
- Focus: water supply and/or pollutant transport

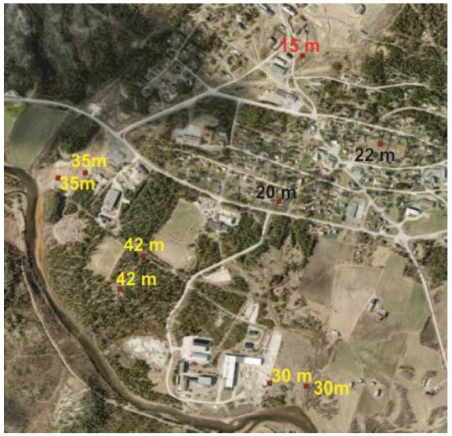
***FOLLDAL*** [2014, 2015, 2016]

***ELVERUM*** [2017 + 2018]

***GARDERMOEN*** [2010, 2011, 2012, 2013]

# ***FOLLDAL*** [2014, 2015, 2016]

- Focus: water quality, acid mine drainage → CHEM. MASS FLUX
- Results: 3 MSc and input to several scientific reports



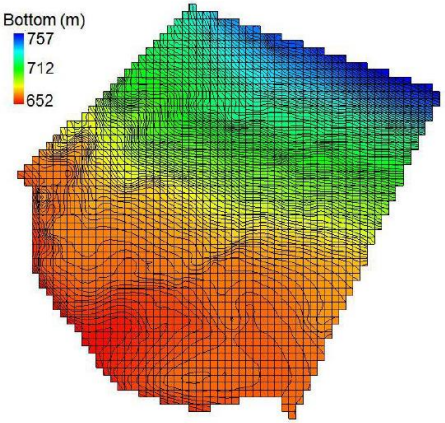
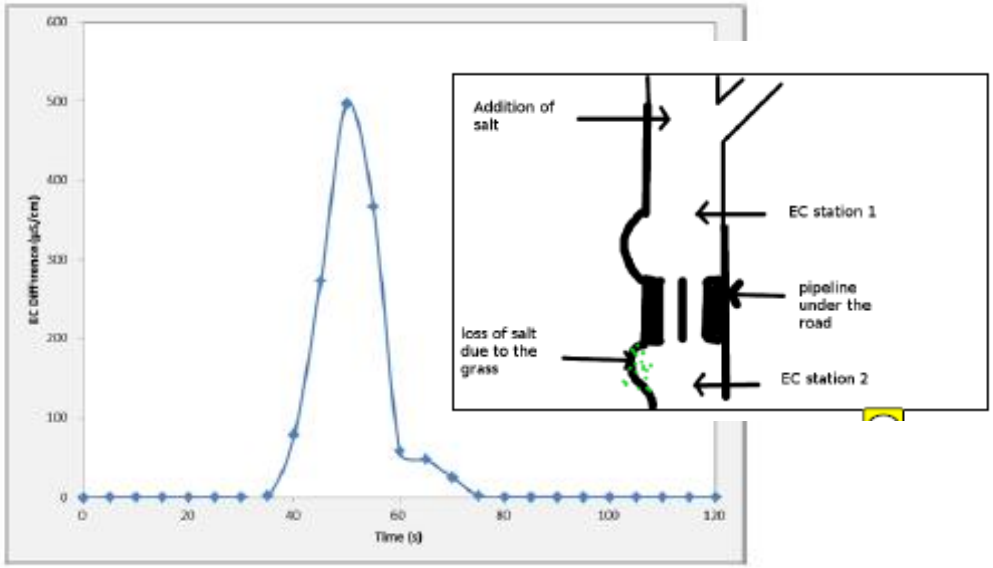




**Figure 4.18:** (a) Scatter points location and aquifer depth values. (b) Contour map of the bottom elevation, interpolated by the natural neighbor's method.

# *ELVERUM* [2017 + 2018]

Water supply for energy and drinking water in glaciofluvial sediments





**Lavvannskart**

| | |
|---|---|
| Vassdragsnr.: | 002.H5 |
| Kommune: | Elverum |
| Fylke: | Hedmark |
| Vassdrag: | GLOMMAVASSDRAGET |

| | |
|---|---|
| Middelvannføring (61-90) | 8.6 l/(s*km²) |
| Alminnelig lavvannføring | l/(s*km²) |
| 5-persentil (hele året) | l/(s*km²) |
| 5-persentil (1/5-30/9) | l/(s*km²) |
| 5-persentil (1/10-30/4) | l/(s*km²) |
| Base flow | -999.0 l/(s*km²) |
| BFI | |

| | | |
|---|---|---|
| Klimaregion: | | Ost |
| Årsnedbør | 666 | mm |
| Sommernedbør | 364 | mm |
| Vinternedbør | 302 | mm |
| Årstemperatur | 3.5 | °C |
| Sommertemperatur | 11.5 | °C |
| Vintertemperatur | -4.0 | °C |
| Temperatur Juli | 14.1 | °C |
| Temperatur August | 13.3 | °C |

| Feltparameter | |
|---|---|
| Areal (A) | 12.0 km² |
| Elvelengde ($E_L$) | 4.6 km |
| Elvegradient ($E_G$) | 1.3 m/km |
| Elvegradient$_{1085}$ ($G_{1085}$) | 1.0 m/km |
| Lengde($F_L$) | 4.8 km |
| $H_{max}$ | 212 moh. |
| $H_{10}$ | 219 moh. |
| $H_{20}$ | 221 moh. |
| $H_{30}$ | 221 moh. |
| $H_{40}$ | 231 moh. |
| $H_{50}$ | 230 moh. |
| $H_{60}$ | 245 moh. |
| $H_{70}$ | 261 moh. |
| $H_{80}$ | 289 moh. |
| $H_{90}$ | 327 moh. |
| $H_{max}$ | 0.0 % |
| Bre | 1.8 % |
| Dyrket mark | 19.0 % |
| Myr | 3.4 % |
| Sjø | 73.5 % |
| Skog | 0.0 % |
| Snaufjell | 0.8 % |
| Urban | |

Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene

med høy breprosent eller stor innsjøprosent vil tørrværsavrenning

# *GARDERMOEN AIRPORT* [2010, 2011, 2012, 2013]

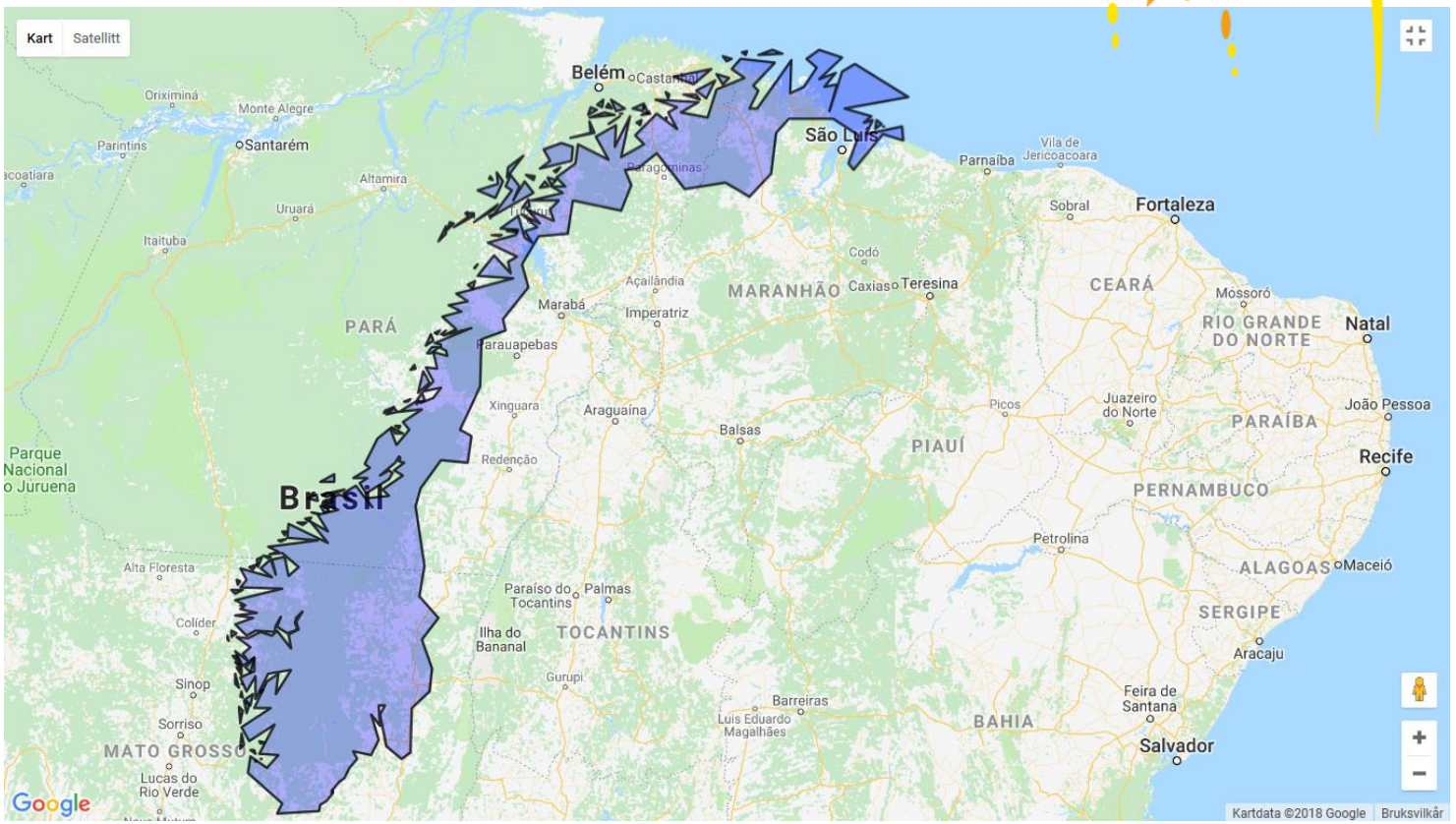
- *Oil, fuel, pipeline leaks*
- *Aviation and deicing*
- *Flame retardants (PFOS)*
- *Roads and salting*
- *Energy wells*
- *Construction work:*

→ *water level lowering, clay destabilization*


# -- 2020 & 2021 --

# HYDROGEOLOGY FIELD COURSE IN

# PARÁ !!! (Salinópolis)



# WATER RESOURCES IN NORWAY

- Mostly lakes for drinking water, agriculture and industrial use
- Abundant and good quality, cheap

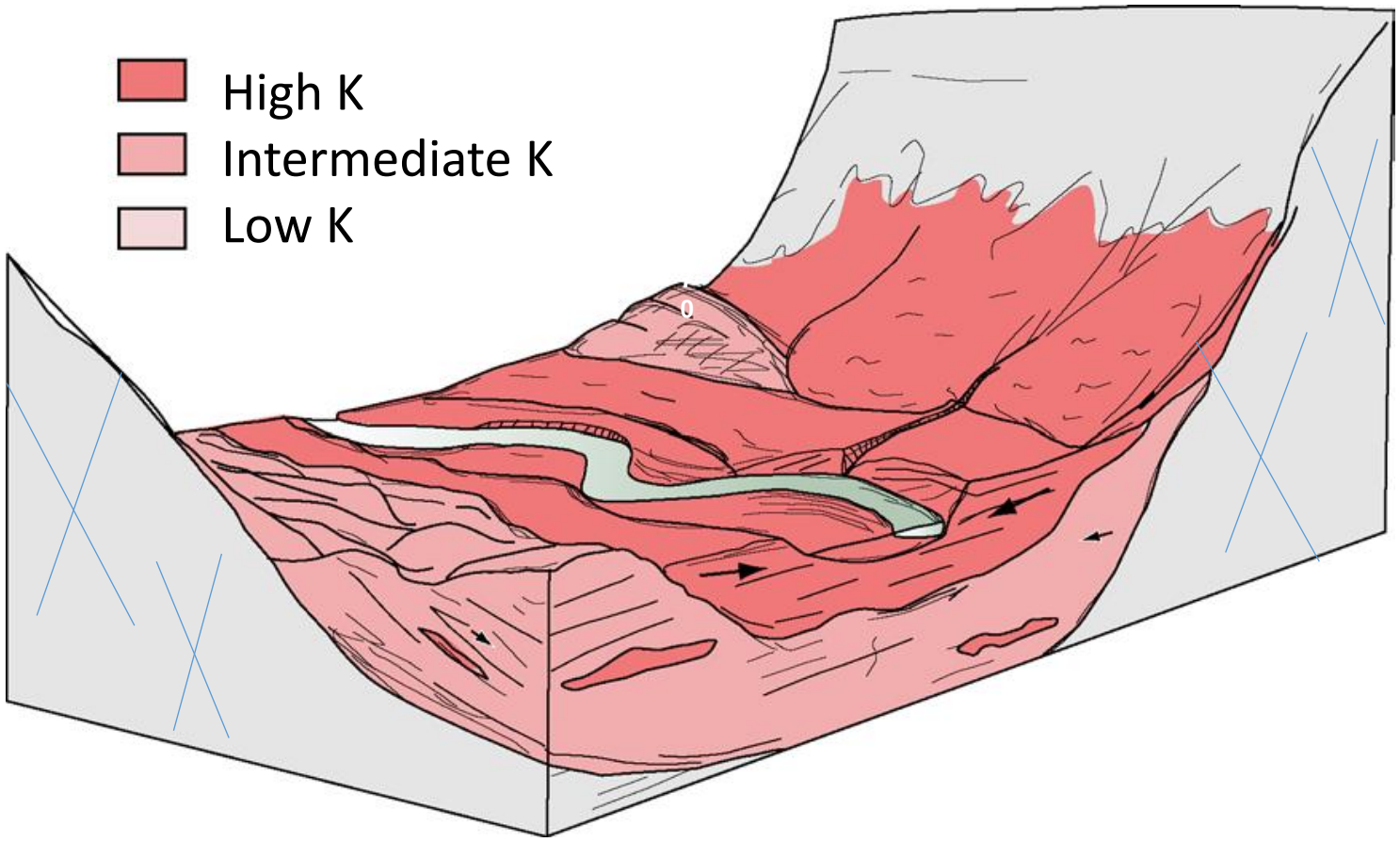


Maridalsvannet: filtering and UV treatment


*Norwegian landscapes – shaped by ice, filled with water*

# WATER RESOURCES IN NORWAY

Groundwater in fractures and in glacial deposits:
Mostly private and small scale consumption (20.000)

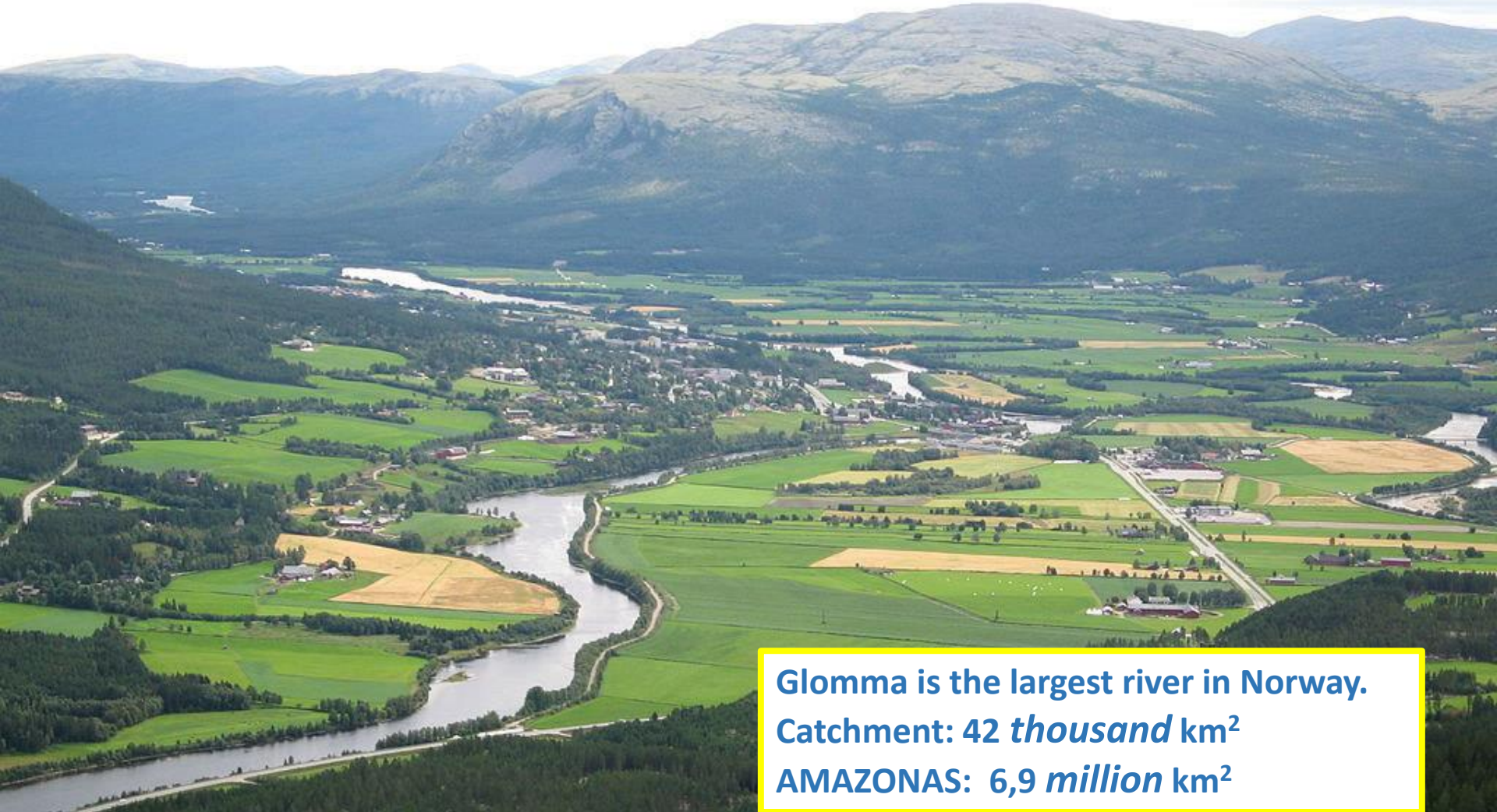


*Groundwater plays a vital role in protected biotopes, providing nutrious water, constant temperatures and stable water supply (flux)*


*Groundwater is also an energy resource for heating/cooling*

# HYDROGEOLOGY

**The science of water resources and groundwater –**
**Important to learn also about geography and demography**



**Glomma is the largest river in Norway.**
**Catchment: 42 *thousand* km$^2$**
**AMAZONAS: 6,9 *million* km$^2$**

# Preparing and learning (from the best) to work in Pará ☺

## with Afonso Nogueira, Fabio Domingos and Clovis Maurity







# *Salinas*

- Sand dunes
- Lagoons
- Estuaries
- Water works
- Urban areas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- WHY
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- **IMPACT**

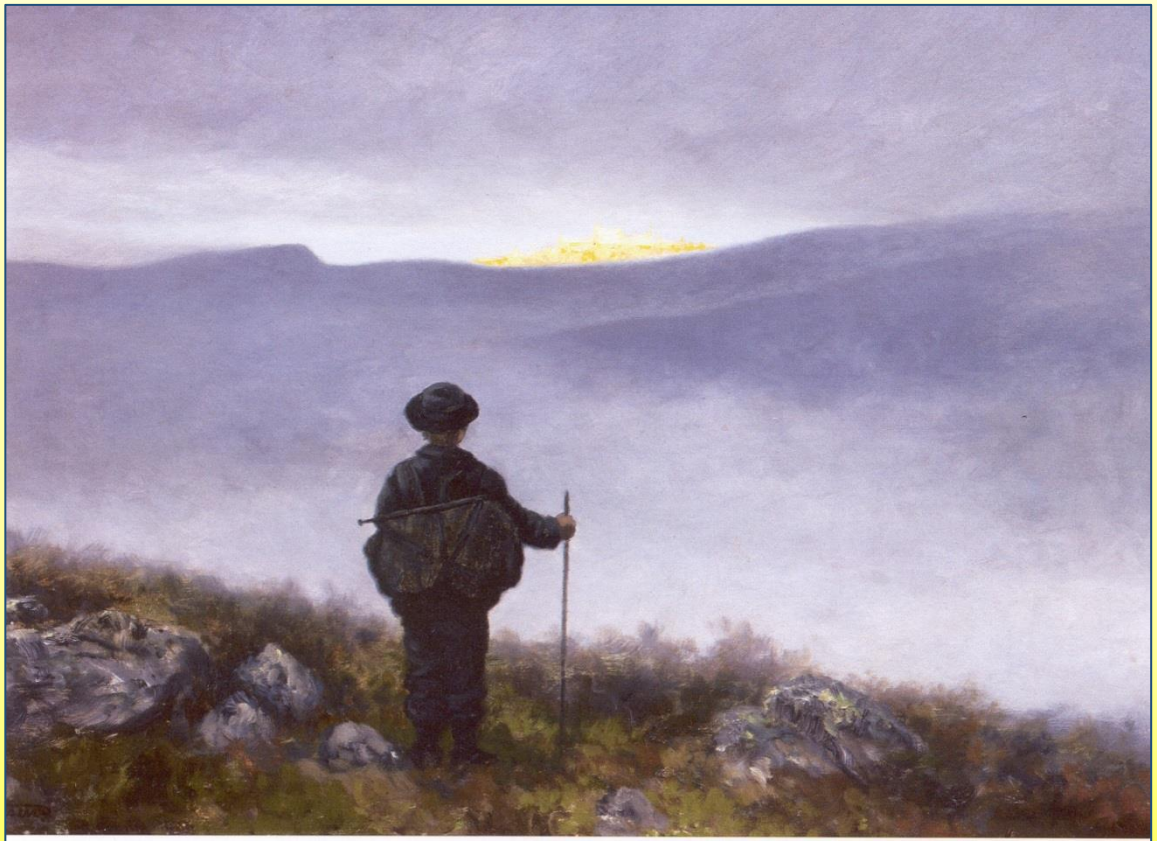
# SOCIETY

- *Data (groundwater flow, resources and water quality)*
- *Professional input to local authorities, government, and the private sector*
- *Collaboration with local communities*
- *Education (Master students, PhD students)*

→ ***A contribution towards better environmental awareness***

# OUTLOOK

- International cooperation, regional versus global challenges
- Public outreach: making science available and understandable



# OBRIGADA PELA VOSSA ATENÇÃO !