UNIVERSITY OF LATVIA

Groundwater research methods

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Virtual seminar for experts

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Interreg Estonia-Latvia
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EUROPEAN UNION

WaterAct

Joint actions for more efficient management of common groundwater resources

Content

- General introduction - conceptualization
- Desk research
- Site-specific investigation:
  - Springs, existing wells
  - Installation of new wells
  - Groundwater level
  - Groundwater sampling
  - Sample handling
- A brief glimpse on alternative methods

Definition of objective

There are many things to look for therefore we **need a clear question** we want to address so we can focus on the most important aspects. That, in turn, impact the methods we choose.

Some questions can be answered even from office, while typically visiting the site and gathering field data is required.

Geological cross section across the Baltic states

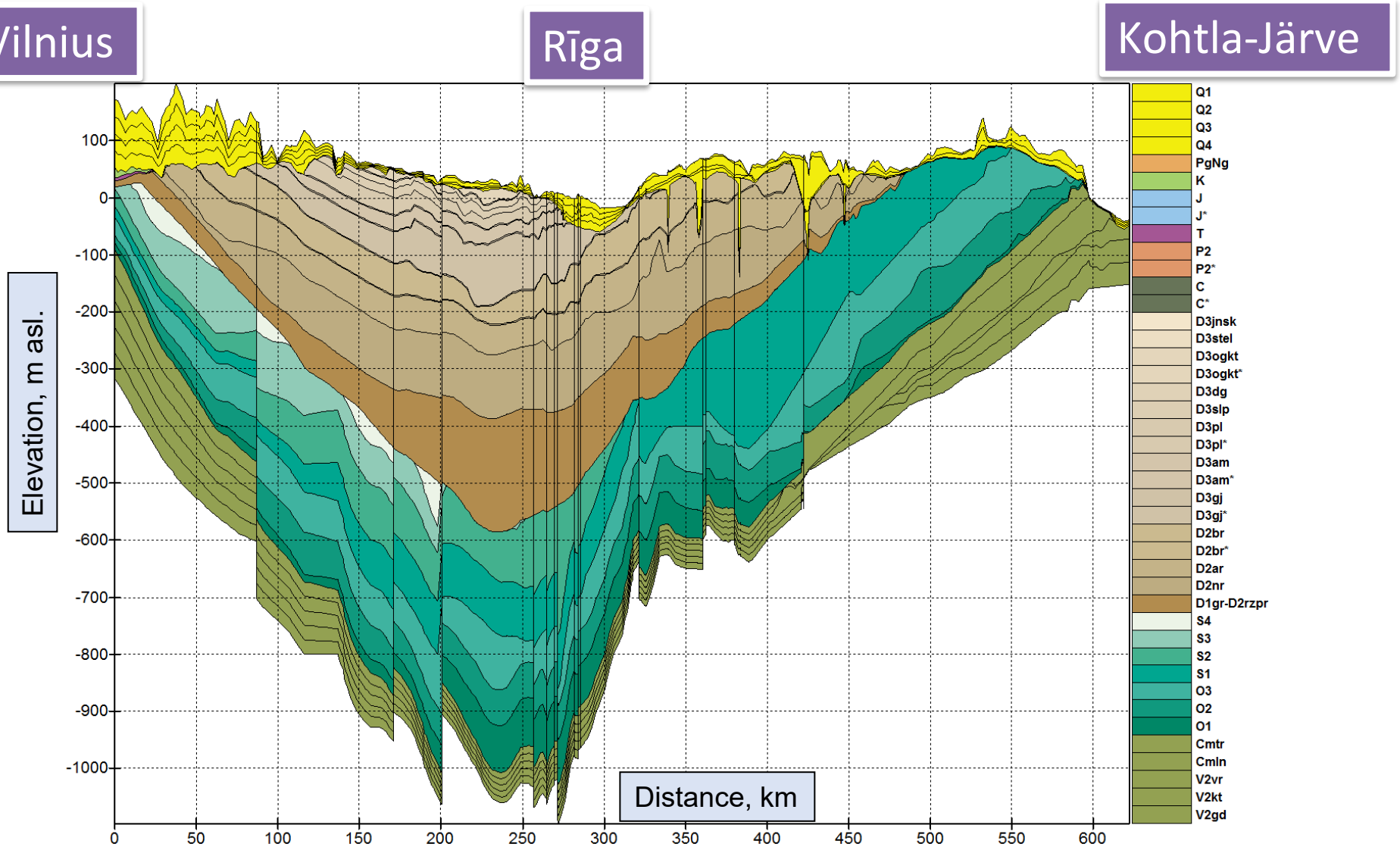
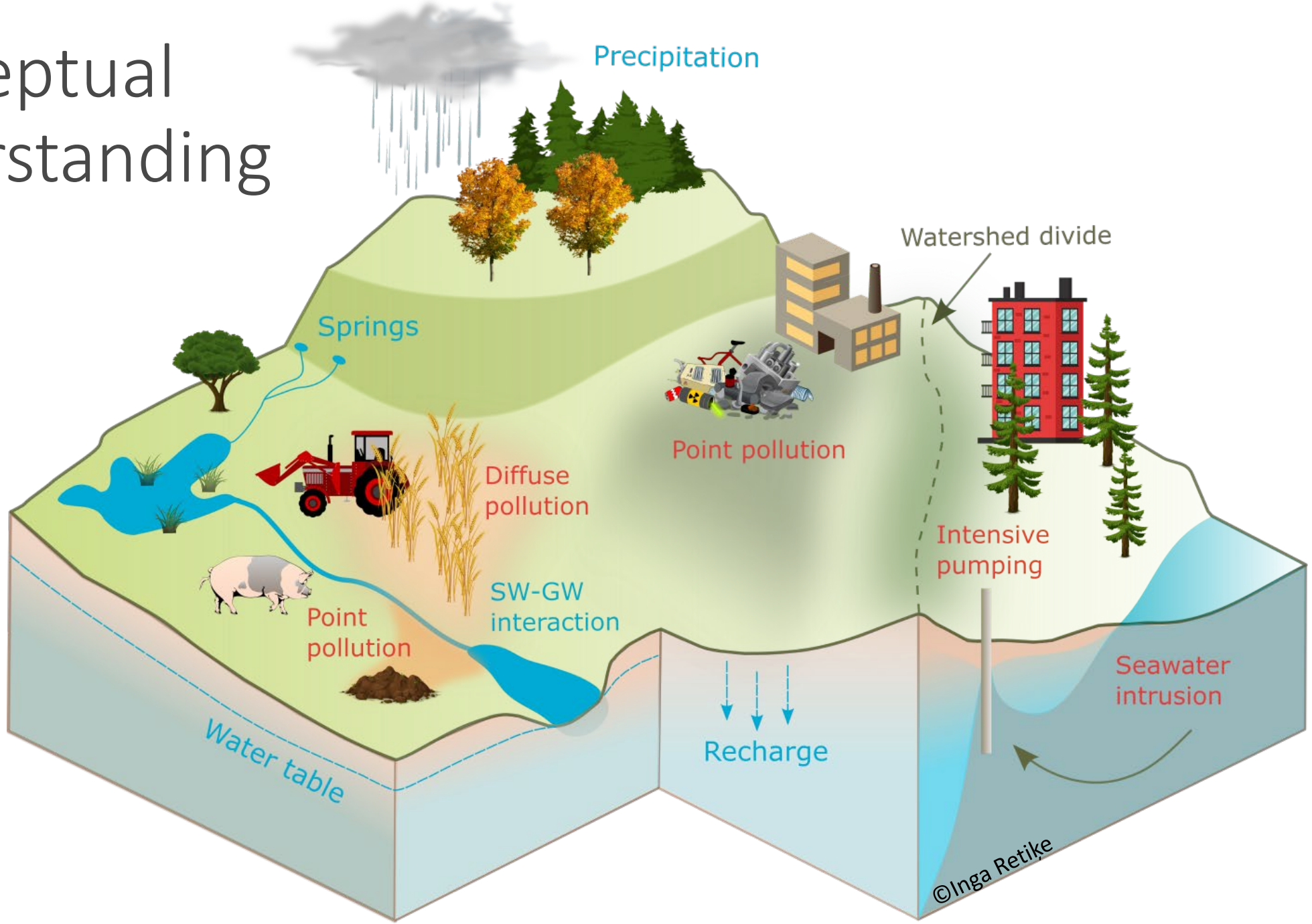


Image: Seņņikovs, J. 2012. Baltijas artēziskā baseina datormodelis. ESF projekta „Starpnozaru zinātnieku grupas un modeļu sistēmas izveide pazemes ūdeņu pētījumiem" noslēguma konference (puma.lu.lv)

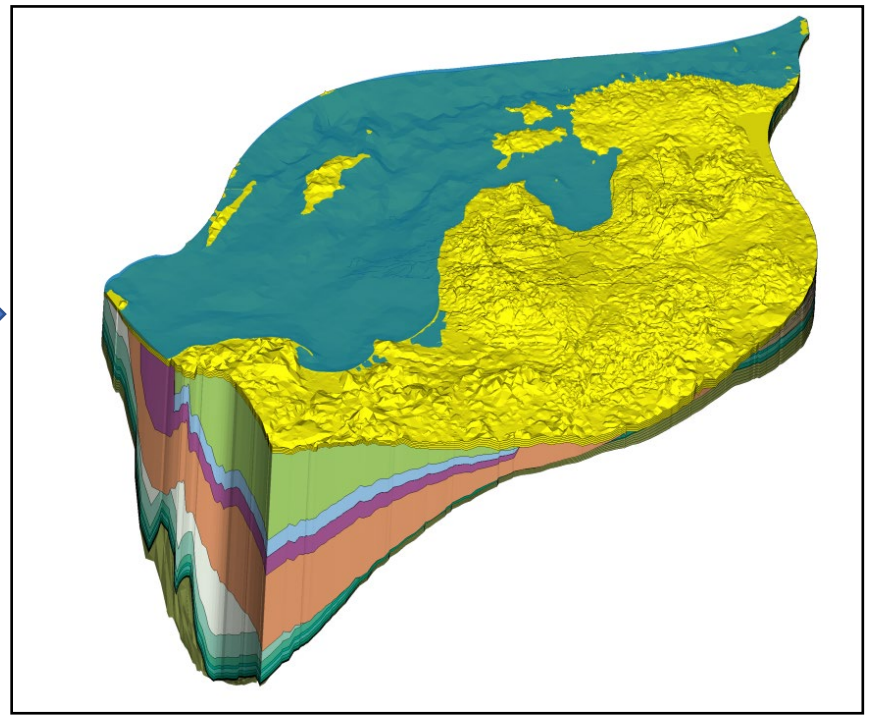
Conceptual understanding



Desk research

Already collected data can be of great value for initial site assessment:

- Maps (geological, orthophoto, topographic) e.g. LV: https://www.lvmgeo.lv/kartes
- Groundwater monitoring network, historical chemistry/level data
- Hydrogeological model data. The Baltic states: https://www.puma.lu.lv/



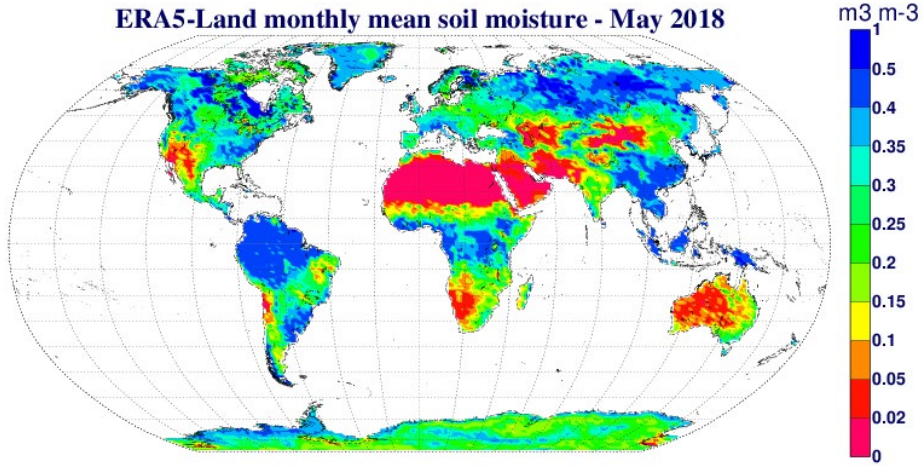
Desk research

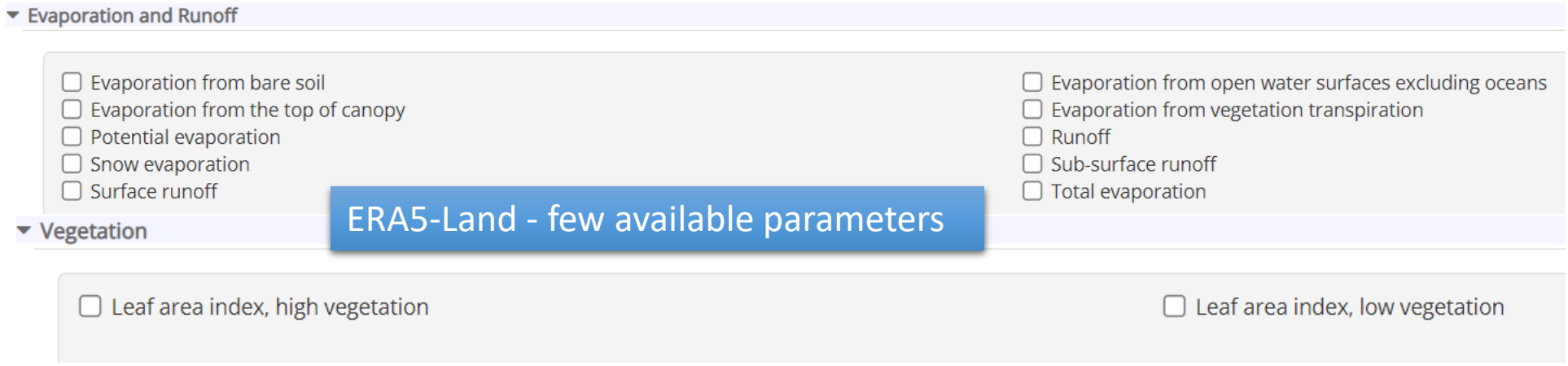
- Meteorological observations.

LV: https://www.meteo.lv/meteorologija-datu-meklesana/?nid=461
Europe: https://www.ecad.eu/download/ensembles/download.php ~11km grid

- Reanalysis data. Global: ERA5 (~30km) and ERA5-Land (~11km grids) – have many globally modeled parameters since 1950, hourly/monthly.

ERA5, ERA5-Land available: https://cds.climate.copernicus.eu/





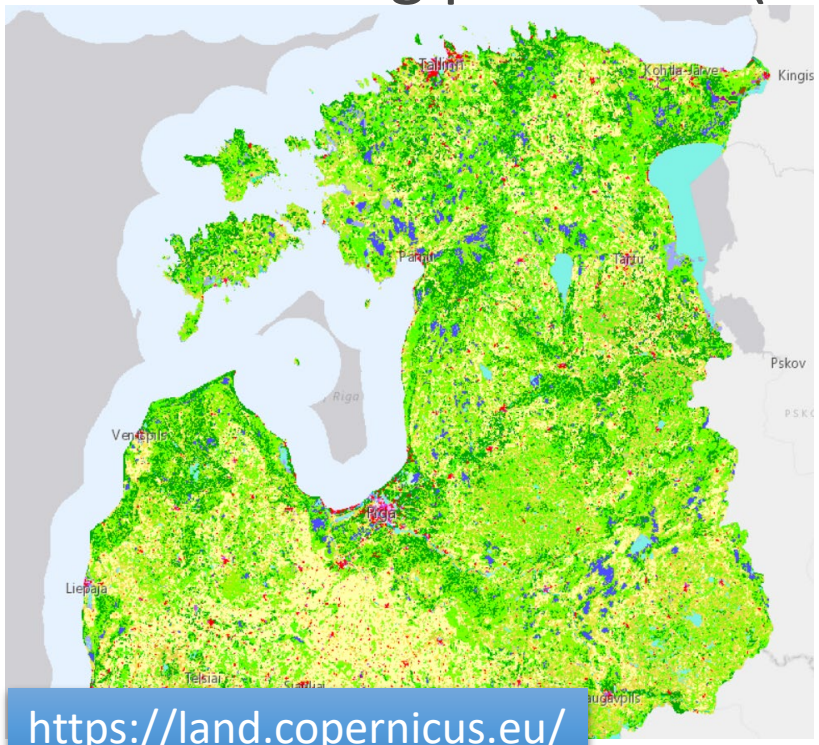
https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land-monthly-means

Desk research

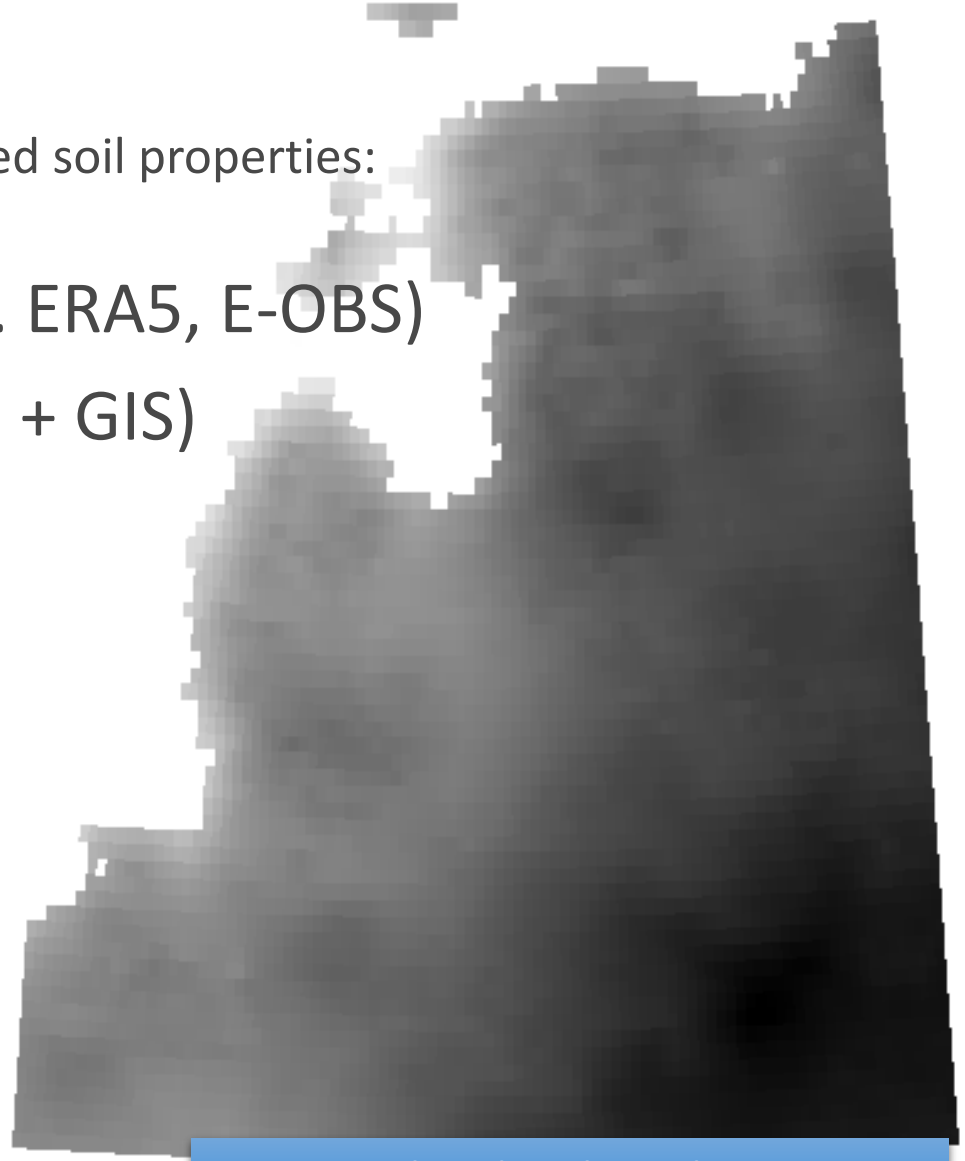
- Land use, soil properties.

CORINE Land Cover: https://land.copernicus.eu/ Globally modeled soil properties: https://soilgrids.org/

- Gridded data usually in NetCDF4 format (e.g. ERA5, E-OBS)
- Skills in data handling preferred (R or Python + GIS)

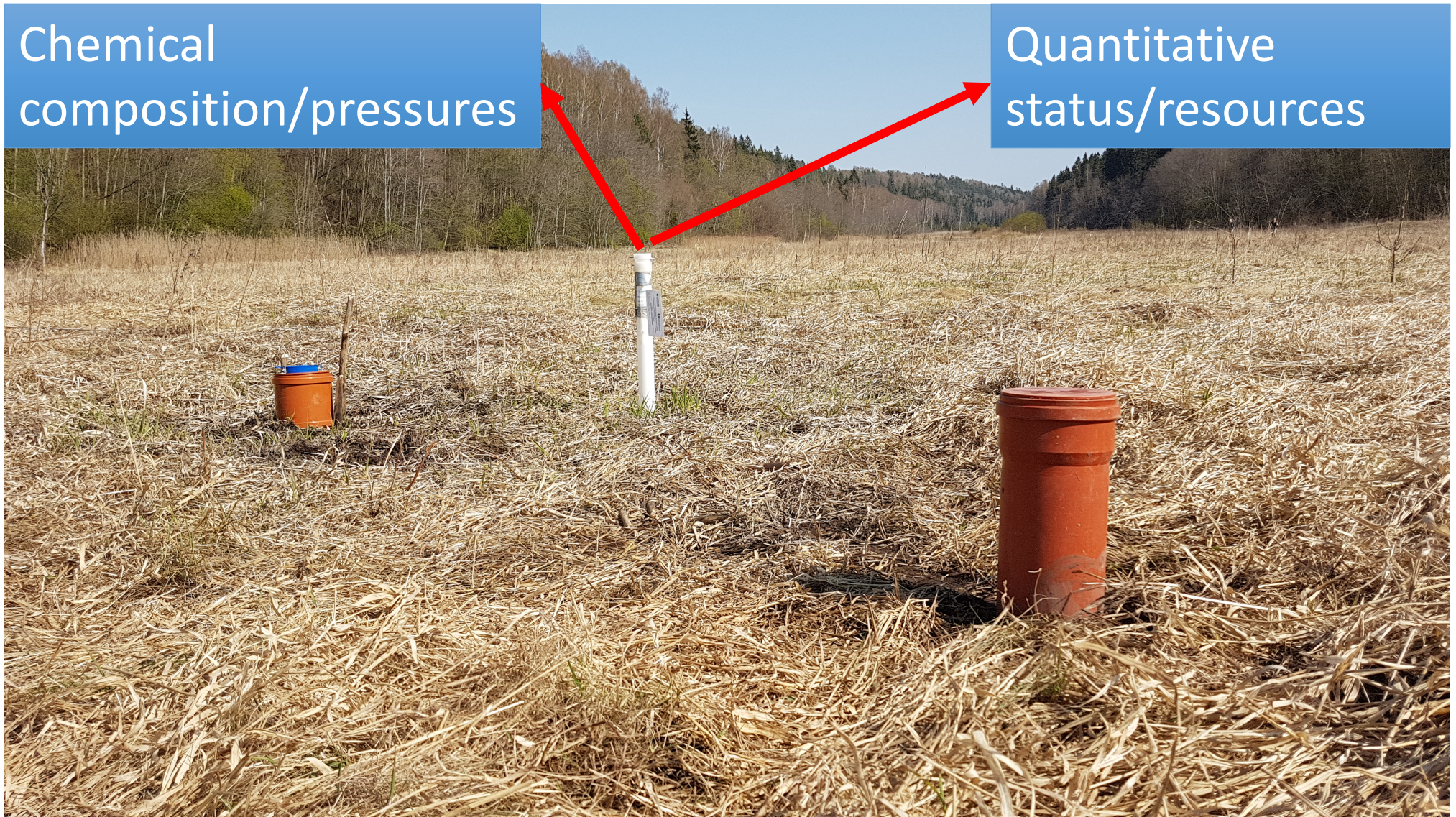


https://land.copernicus.eu/



ERA5-Land grid in the Baltic states

Site-specific investigation



On site research

- A number of activities can be performed on the site that depends on available groundwater sources:
- **Springs** – relatively easy to sample, measure. No direct data on groundwater level, but discharge as a significant parameter
- **Existing wells/dug wells** – information on groundwater level, a little bit tricky to get groundwater sample, but screen depth/interval must be known (might be a problem)
- **Installation of new well/piezometer** – Much more labor, but can drill in point of interest + fresh information on geology

Springs

- **Measurements and samples** can be taken instantly since a fresh groundwater is provided by spring outflow.
- Sample/measure **close to the outflow –** some parameters can change quickly along the flow path (e.g. dissolved oxygen, iron);
- Measurements of **discharge** might be a challenge, but it gives valuable information on groundwater resources, especially if measured multiple times in different seasons.

Existing well/dug wells

Great source for groundwater level and even chemical composition:

- Groundwater level must be measured before pumping and sampling.
- Be cautious if the well/nearby well is used for abstraction – the level can be impacted due to pumping.

However, old, abandoned wells can be blocked, broken or can represent unknown aquifer

Installation of a new well

+ Can install a well in almost any place where needed

- Extra work and specific equipment needed

https://www.eijkelkamp.com/images/articles/1003/5663df17fd0c80bf788cf4d91e9d5852.jpg

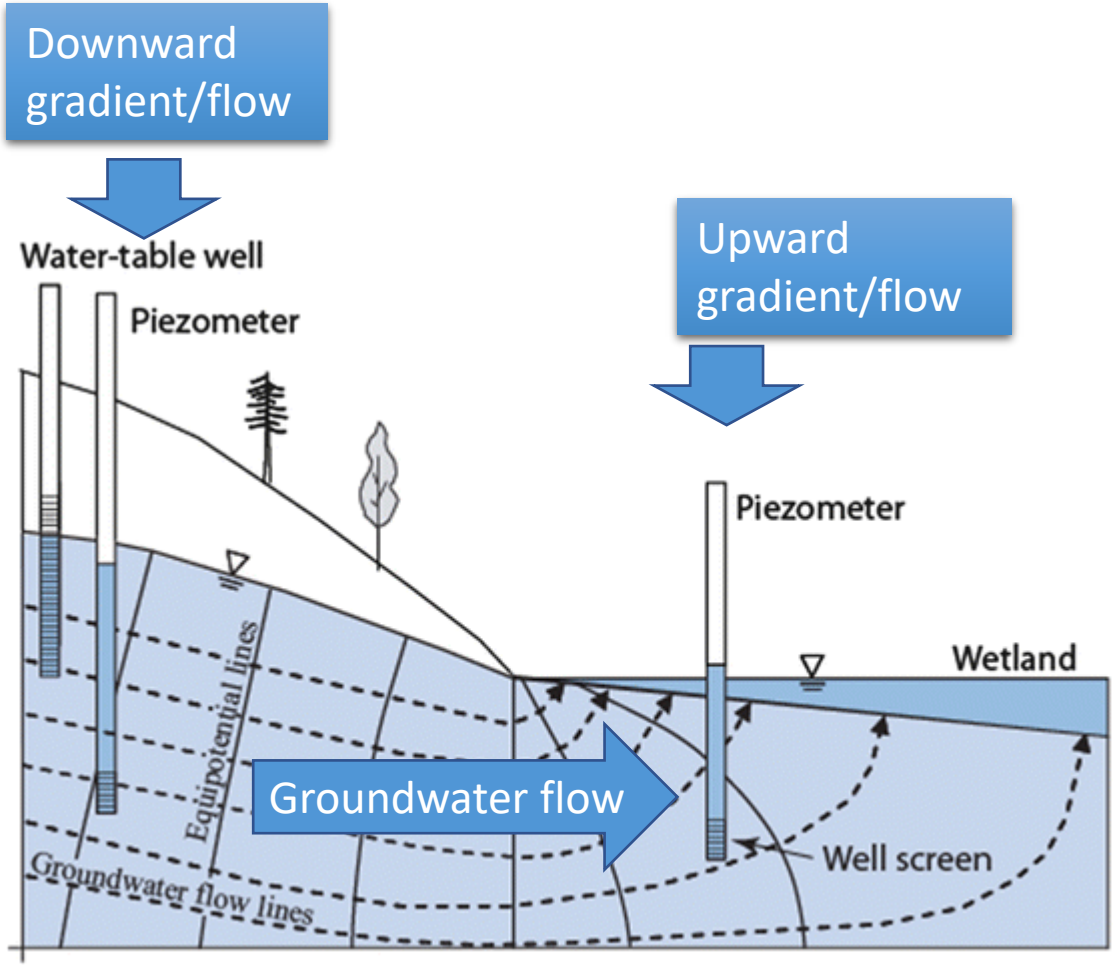
Photo: Aija Dēliņa

Installation of a new well

Also, small, simple DIY wells can be useful for low volume sampling in shallow depths (e.g. for nitrate screening)

Installation of wells – the setup plan

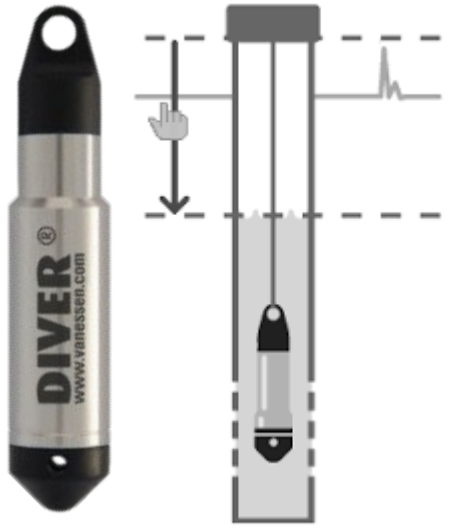
- Groundwater always flows from higher pressure (altitude) to lower pressure.
- Also, vertically groundwater can flow upwards or downwards according to pressure gradient.
- 3 distant wells are required to understand groundwater flow in flat area.
- Precise coordinates and elevation must be known! RTK GPS preferred



https://media.springernature.com/original/springer-static/image/chp%3A10.1007%2F978-94-007-6860-4_3/MediaObjects/312569_1_En_3_Fig24_HTML.gif

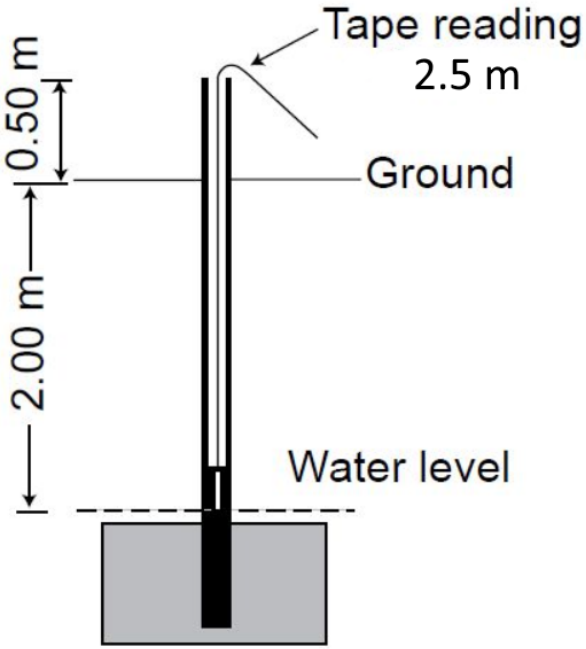
Groundwater level measurement

- It must be measured before pumping and sampling.
- Be cautious – nearby abstraction wells can impact the level due to pumping.



Automatic level loggers are expensive, but provides large amount of valuable data

https://diver-water-level-logger.com/images/articles/142/TD-Diver_water_level_logger_website.png



Measure the height from water level to the well head and the height from well head to the ground.

https://www.agric.wa.gov.au/soil-salinity/monitoring-groundwater

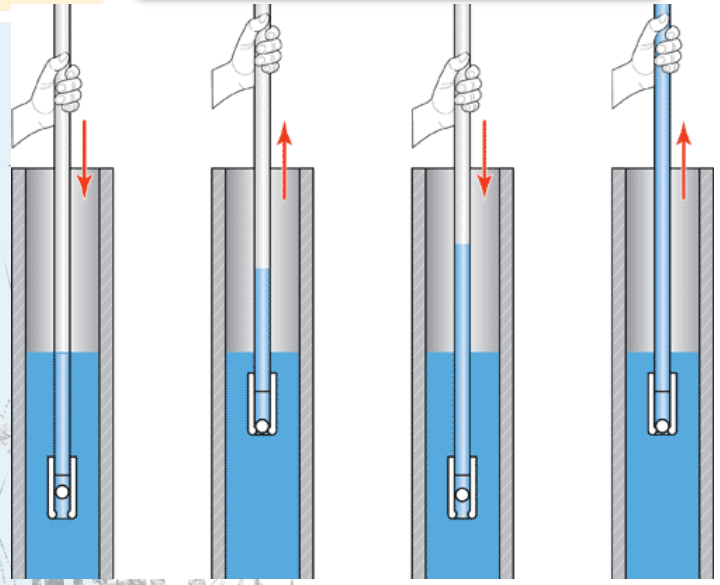
Groundwater sampling - general

- Before sampling, **pump the well of two to three well volumes**, so a fresh groundwater enters the well casing and the sample you take is a groundwater from aquifer and not a stagnant water that sits in the well for long time.
- Alternatively, pump the well and look for field parameters (any or combination of: SEC, pH, temperature, ORP, O_2) – **if they don't change significantly for 5 minutes**, a sample can be taken.
- Dug wells are impractical to purge, but if water is abstracted on a regular basis, the sample from a dug well can help.

Groundwater sampling - pumping

- Submersible pump is the preferred type.
- Peristaltic pump can also be used, especially, in narrow wells, but degassing might occur.
- Manual footvalve pump is the cheapest alternative for shallow wells

Manual footvalve pump



https://www.solinst.com/products/groundwater-samplers/404-inertial-pump/images/Operating-Instructions/Inertial-Pump-Operation.gif

Small submersible pump (typicall 12v or 24v)

https://www.fondriest.com/media/catalog/product/cache/ae8a6bc677e17d25017855202e90e7e0/p/r/proactive_cyclone.jpg

Peristaltic pump (typically 12v)

https://www.solinst.com/products/groundwater-samplers/peristaltic-pump.php

Groundwater – field parameters

The most common parameters, measured by multimeters:

- Temperature
- pH
- Specific electric conductivity (SEC) and total dissolved solids (TDS)
- Dissolved oxygen (DO or O_2)
- Oxidation-reduction potential (ORP)

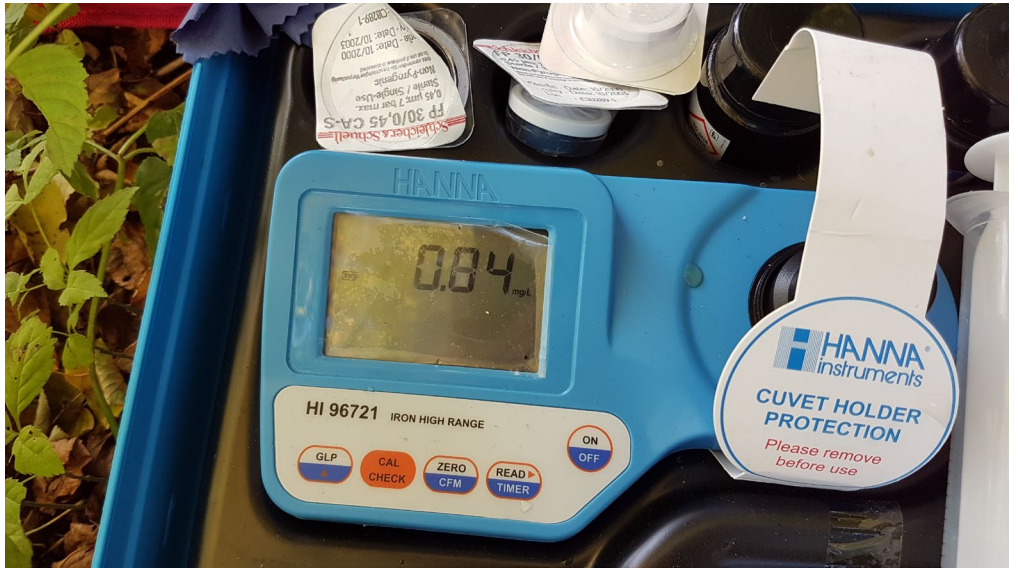
Groundwater sampling – field parameters

In addition, few more parameters are useful to detect on field:

- Alkalinity
- Nitrate (NO_3^-)
- Dissolved iron

High dissolved iron content typically indicates that there will be no nitrates

https://assets.fishersci.com/TFS-Assets/CCG/product-images/1408100NITRATE-NITRITE-NI-12-CLR-DSK-LZ.JPG-650.jpg



Groundwater sampling - bottling

A sample size depends on the laboratory method – the minimal sample volume/bottle must be known for each analysis.

A dedicated bottle for each analysis type (e.g. metals, anions, cations, DOC, stable isotopes).

Really clean bottles must be used (especially for metals, even acid-rinsed)

Common practice – rinse the bottle with sample before sampling.

Single spring sample for different analysis

Groundwater sampling - bottling

Label each bottle (sample No., date, location, analysis type, etc.).

Often samples must be filtered on field (0.45µm cellulose acetate filter) to remove non-dissolvable particulates.

Ask laboratory for sample handling/labelling requirements

Sample handling

Many chemical species undergo changes when sampled (e.g. when exposed to oxygen, different temperature) and the results from laboratory can yield wrong interpretations. Sample preservation is needed for:

- Metals – they must be kept at pH ~2 by addition of pure nitric acid;
- Nitrates – must be kept at 4°C and analyzed within 24 hours after sampling. Alternatively, sulfuric acid can help to prolong the period
- Typically all samples are kept at ~4°C in cool box

Thermal imaging

Can be used to identify/verify springs that are not visible to naked eye

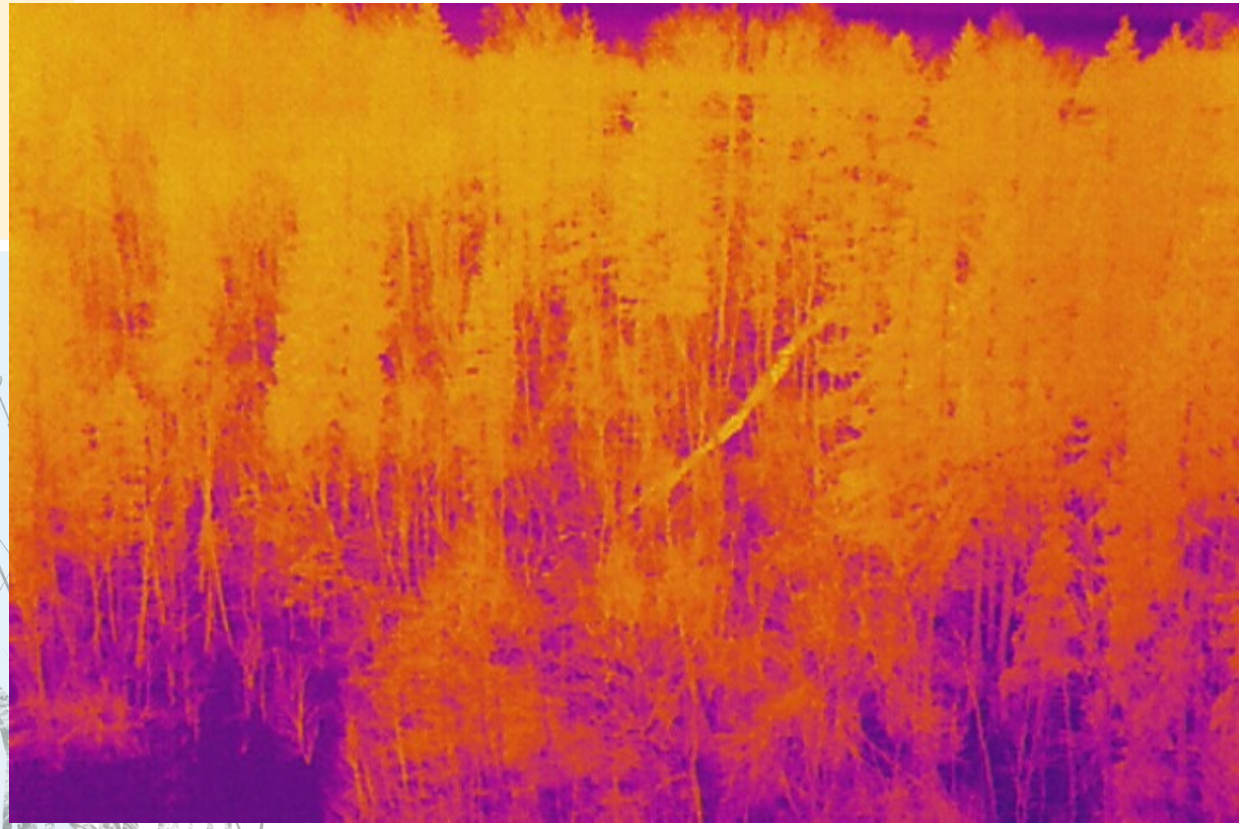


Photo: GroundEco project

Tracer tests

Useful to test connection between sinkholes, springs, sometimes even wells

Groundwater flow velocity can be estimated

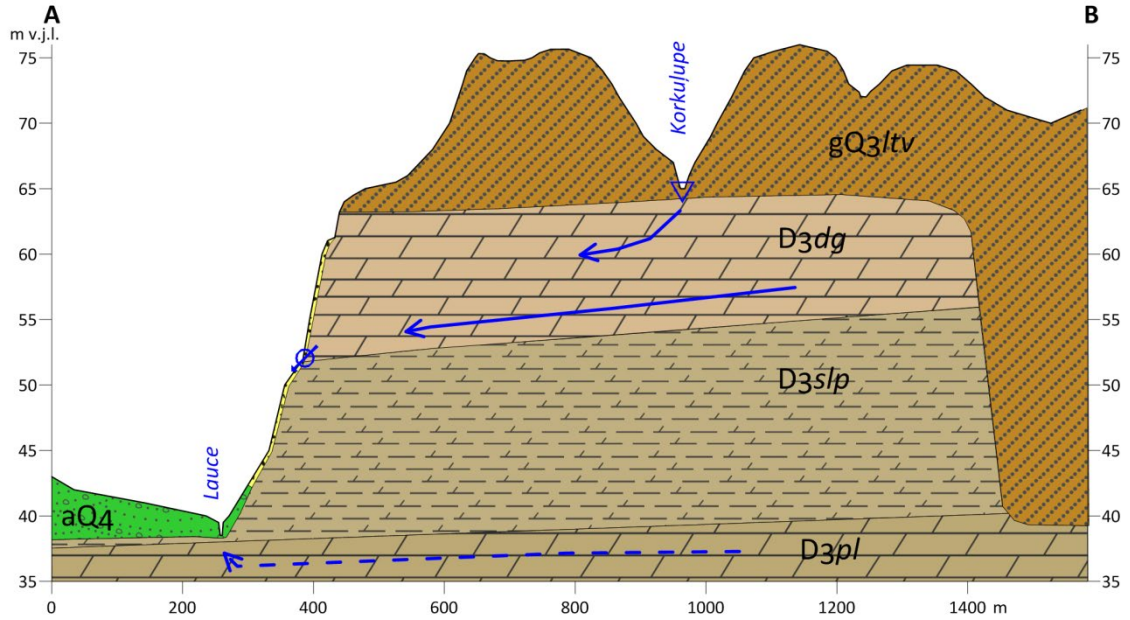


Photo: A. Grīnbergs and J. Metums (Latvijas Petroglifu centrs)

- Thank you for the attention!

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bit.ly/WaterAct-project

bit.ly/WaterAct-Researchgate

LATVIJAS VIDES, ĢEOLOĢIJAS UN METEOROLOĢIJAS CENTRS

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