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Joint management of Latvian – Lithuanian transboundary river and lake water bodies (TRANSWAT)

Importance of spring water monitoring:
from drinking water source to integrated water management tool

Inga Retiķe | *Latvijas Universitāte*

Riga, September 6, 2022

LATVIJAS VIDES, ĢEOLOĢIJAS UN METEOROLOĢIJAS CENTRS

LITHUANIAN ENERGY INSTITUTE

BIOR
INSTITUTE OF FOOD SAFETY, ANIMAL HEALTH AND ENVIRONMENT

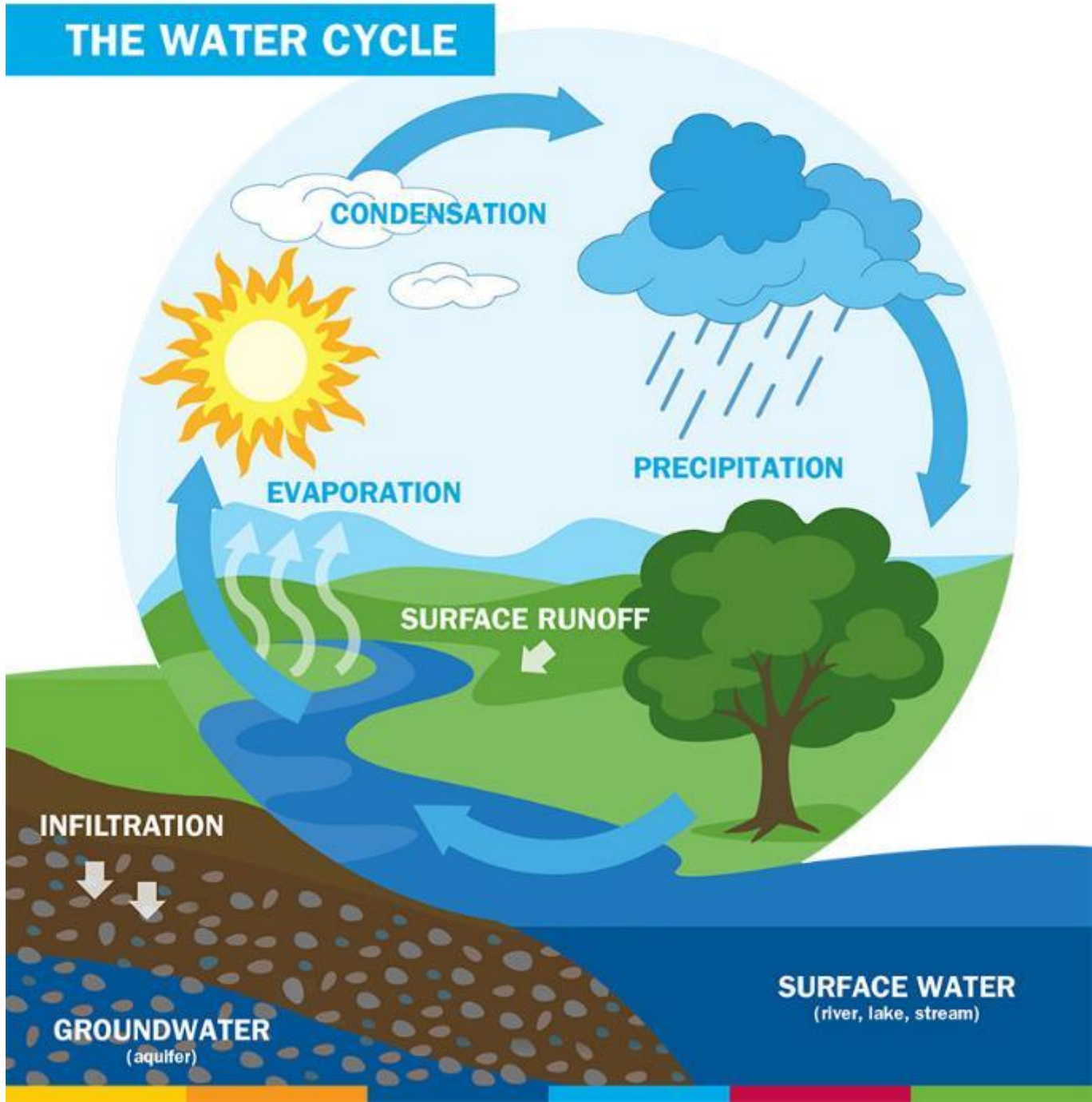
UNIVERSITY OF LATVIA

Groundwater (GW) represents about 30% of world's fresh water.

Drinking water source – on average GW supplies up to 50% of drinking water in the world (LV – 53%, LV – 57% *Nils-Otto Kitterød et al., 2022*).

GW serves as **water purificator** and reduce pollution (e.g., via denitrification) *(Kalvāns et al., 2021).*

GW keeps the water level and **flow into rivers, lakes and wetlands** → sustains ecosystems and acts as climate change mitigation *(Koit et al., 2021).*



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Europe's rivers run dry as scientists warn drought could be worst in 500 years

Crops, power plants, barge traffic, industry and fish populations devastated by parched waterways

REUTERS

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Europe

Europe facing its worst drought in 500 years - study

By Philip Blenkinsop

2 minute read

A man walks on the dry riverbed of the Sangone river, Italy
Photograph: Massimo Pinca/Reuters

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Europe's rivers run dry as scientists warn drought could be worst in 500 years

Crops, power plants, barge traffic, industry and fish populations devastated by parched waterways

People sitting on a dry portion of the Waal riverbed, the Netherlands
Photograph: Romy Arroyo

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News website of the year

Europe's rivers run dry as scientists warn drought could be worst in 500 years

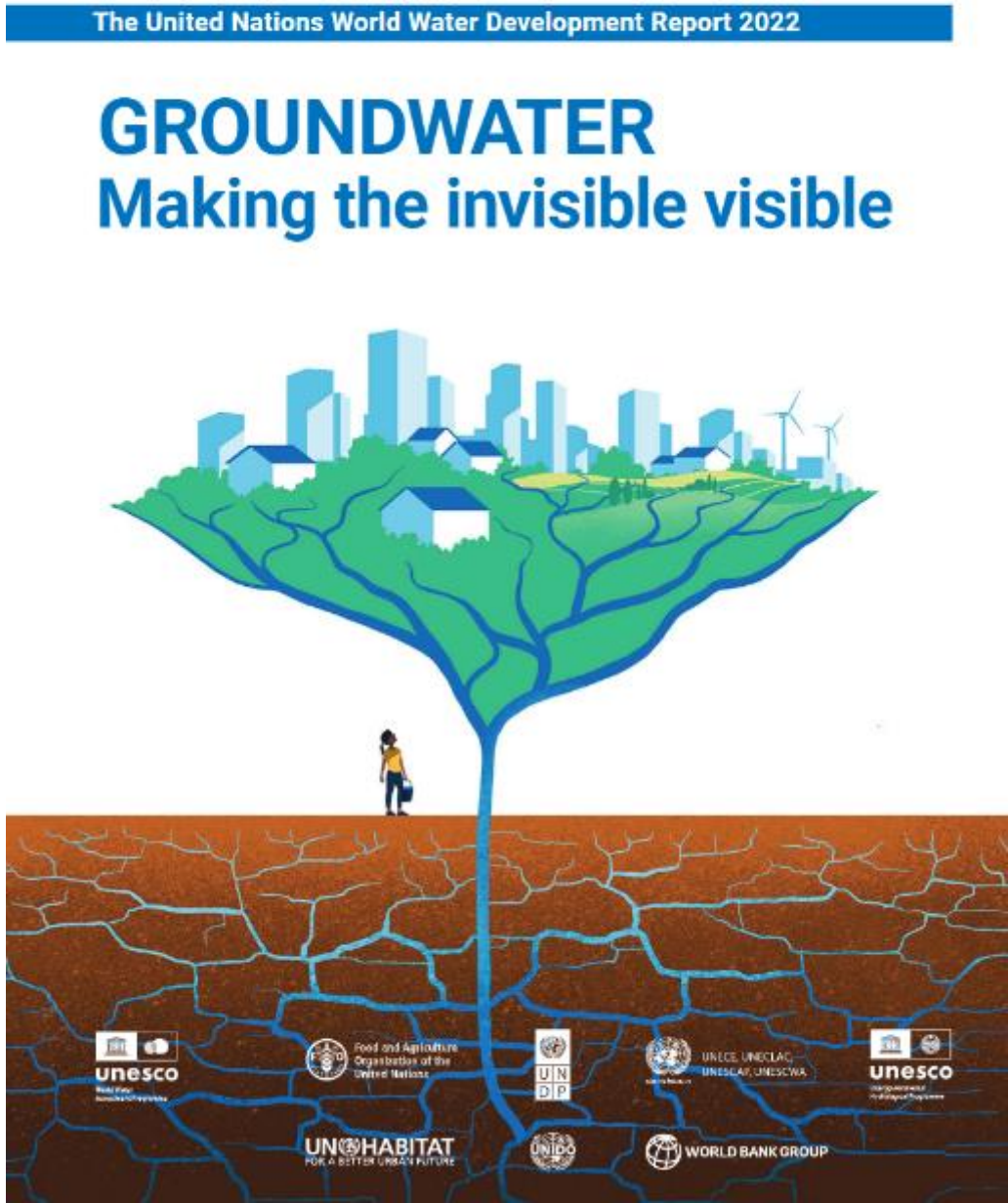
Crops, power plants, barge traffic, industry and fish populations devastated by parched waterways

San River, transboundary river between Poland and Ukraine
Photograph: eu.waterres.eu

The UN World Water Development Report 2022 “Groundwater: Making the invisible visible”
https://unesdoc.unesco.org/ark:/48223/pf0000380721/PDF/380721eng.pdf.multi

"As the planet adapts to a changing climate and rising population, **groundwater will play an essential role in meeting the growing demand for food and drinking water.** Yet this essential resource faces serious risks – including inadequate protection and sometimes irreversible pollution."

Audrey Azoulay
Director-General of UNESCO



Springs
(groundwater outflows)

Springs are natural conduits through which groundwater flows from aquifers into surface water bodies *(Weber & Kubinot, 2022).*

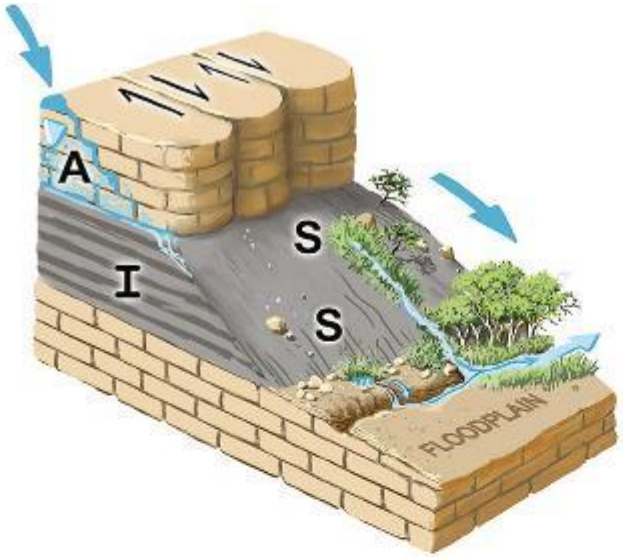
Spring – the point where water emerges from the ground *(Averis, 2003).*

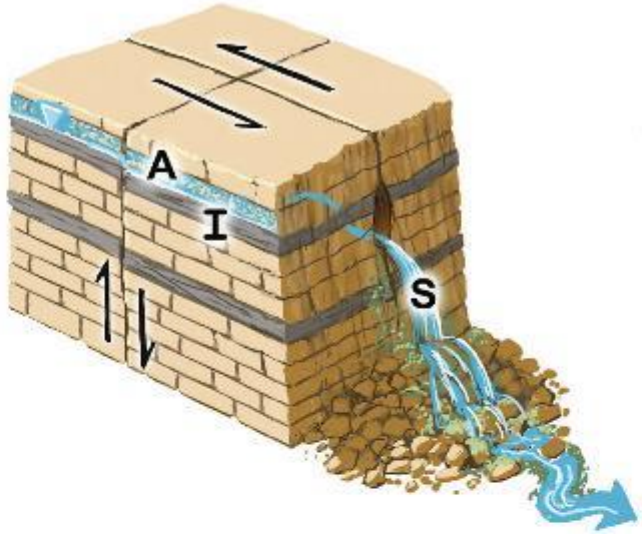
Springs are characterized by a continuous flow of cold water, uniform in temperature and rich in oxygen and minerals *(Blaus et al., 2020).*

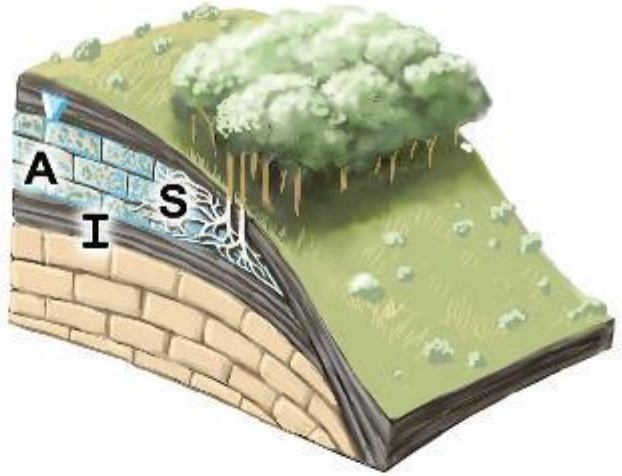
Kazu gravas avots, Vidzeme

Pantenes avots, Vidzeme

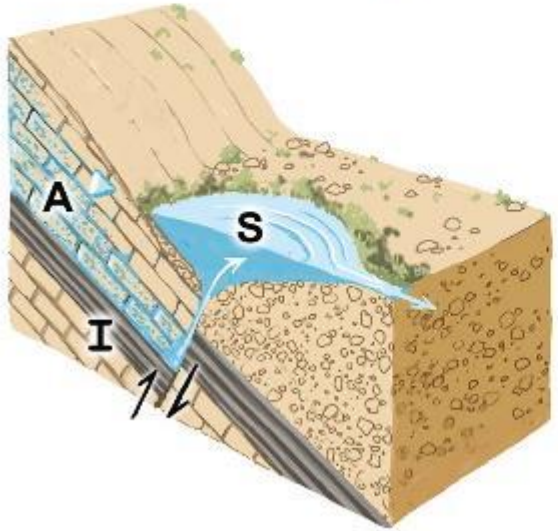
Springs and where to find them?

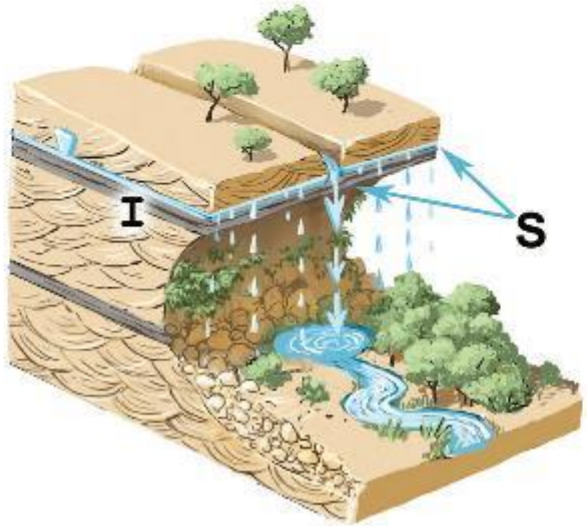


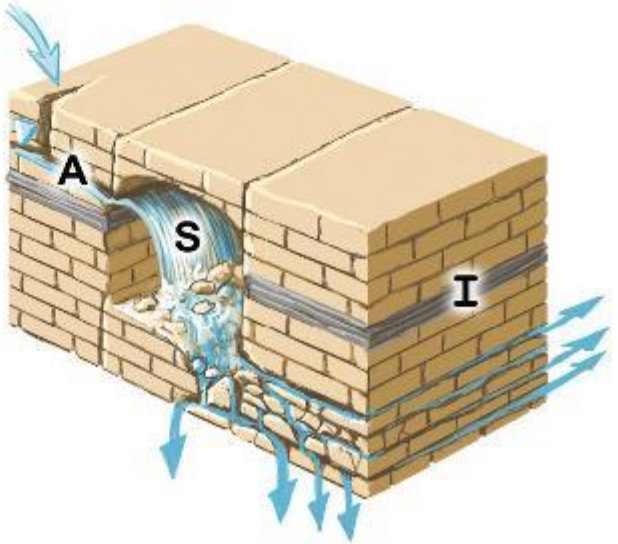


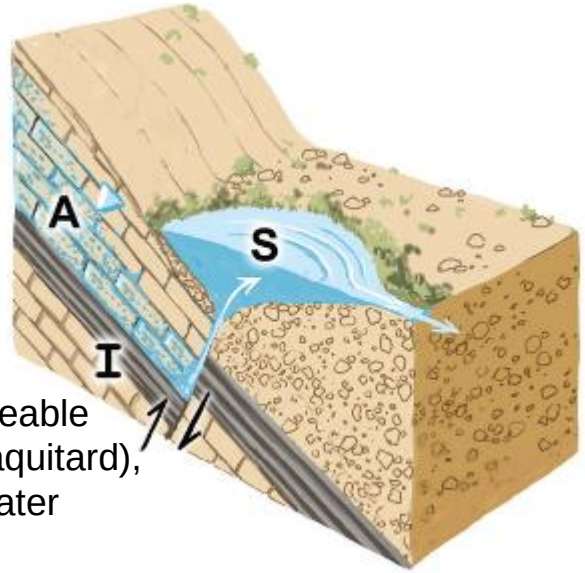


Stevens et al., 2021









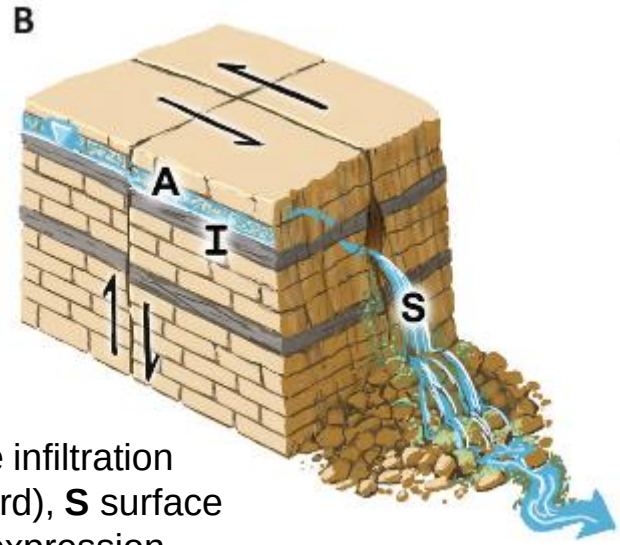
A aquifer, **I** impermeable infiltration barrier (aquitard), **S** surface groundwater expression

Limnocrene springs – emerge into an open pool of water as confined or unconfined GW aquifers.

Sēra dīķis (Sulfuric pond), Ķemeri, Raganu mire

Sulphide-rich GW seeps underwater and precipitates sulfur sediments on the bottom of ponds.

Sulfide is formed due to the presence of **gypsum** sediments in the Devonian aquifer that releases high sulphate content and **organic-rich** shallow GW. Sulfide concentration can exceed 50 mg/l.



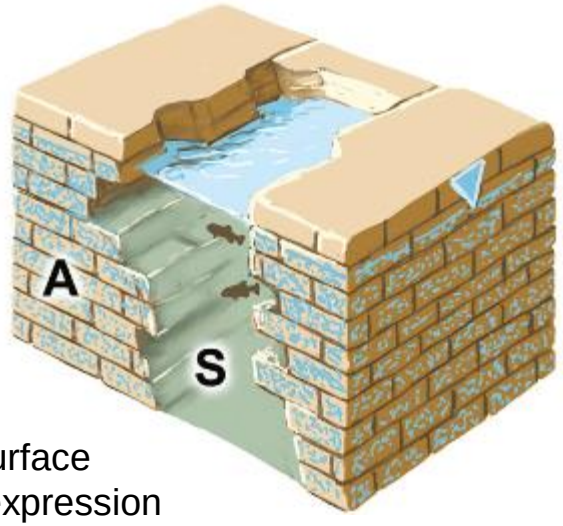
A aquifer,
I impermeable infiltration barrier (aquitard), **S** surface groundwater expression

Gushet springs emerge as focused GW flow cascades from nearly vertical cliffs.

They discharge from perched, unconfined aquifers, often along the fractures.

In long term such springs can form large cave systems.

Līču-Laņģu klintis (Līču-Laņģu clif), Vidzeme



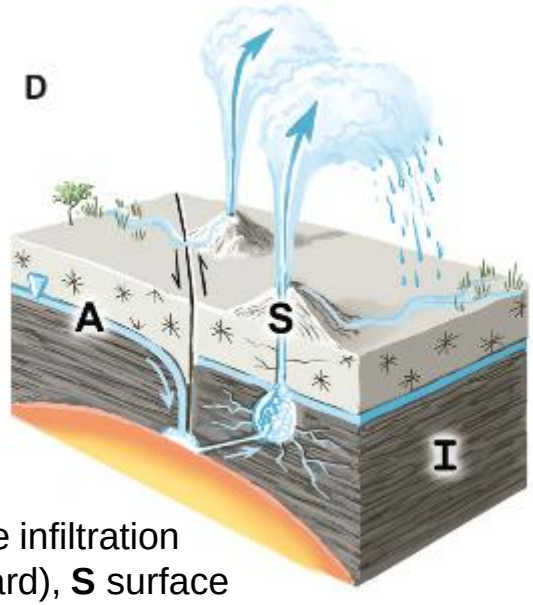
A aquifer, **S** surface groundwater expression

Semi-lotic fountain springs - occur where a water table is exposed, without flowing, at the Earth's surface.

Kulšēnu sēravots, Zemgale

Probably one of the largest by discharge springs in Latvia – up to 138 l/sec (measurement in 2011).

Can be extremely seasonal.



A aquifer,
I impermeable infiltration barrier (aquitard), **S** surface groundwater expression

Geyser - gas (steam or CO2) or geothermally driven eruption of groundwater.

Springs flow emerges explosively, driven either by geothermally derived or gas-derived pressure.

Lotic conditions prevail but pools also commonly occur.

Old Faithful - eruption ~ once in 90 minutes and lasts 1.5-5 minutes. Up to 500 l/sec.

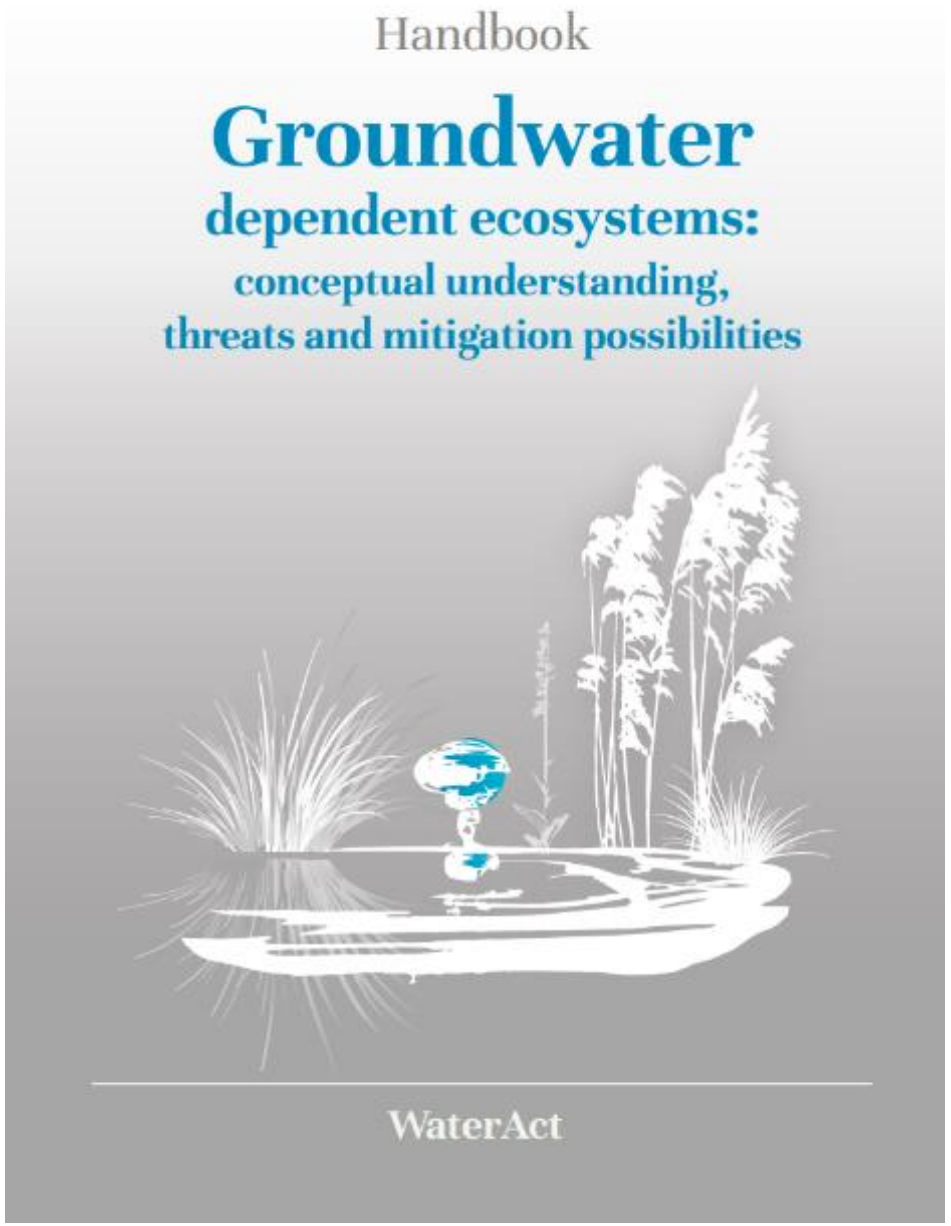
Old Faithful, Yellowstone's Famous Geyser

More about springs from ecohydrology perspective:

Stevens L.E., Schenk E.R., Springer A.E. (2021) ***Springs ecosystem classification.*** *Ecological Applications, 31 (1) , art. no. E2218.* *https://doi.org/10.1002/eap.2218*

Priede A., Strazdiņa L. (eds.) 2022. ***Groundwater dependent ecosystems: Conceptual understanding, threats, and mitigation possibilities.*** *Nature Conservation Agency, Latvia, Sigulda*

https://www.daba.gov.lv/lv/media/15541/download?fbclid=IwAR1XXdrEtrv6ulnk25xFY2O0kMTyL2nRTULsdErU8NkkaRPH0XAu3hFmNZU

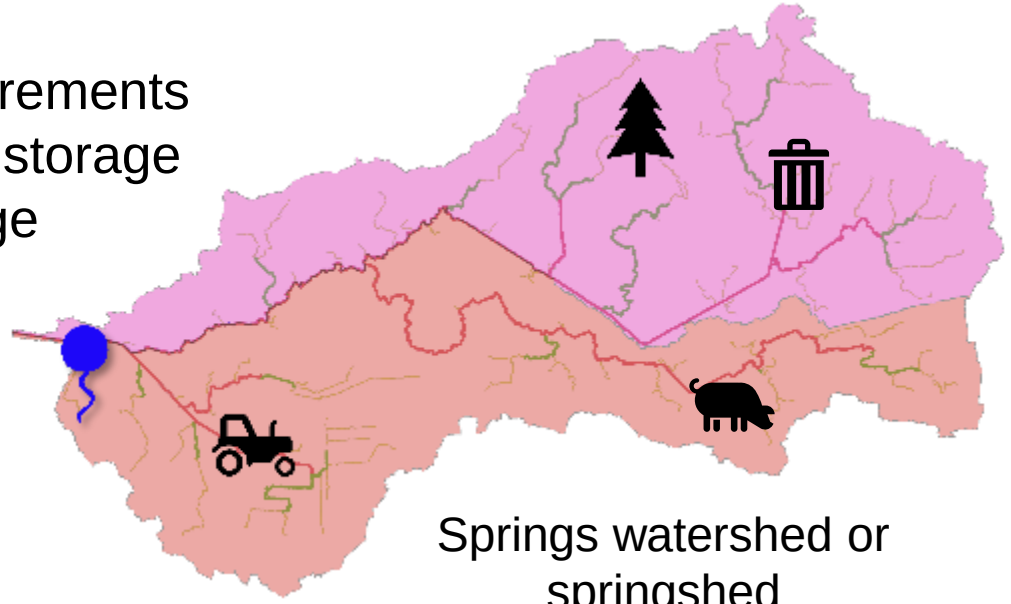


Springs – valuable monitoring points

The chemical composition of spring water provides an approximation of the pollutant load of the body of GW that feeds it.

Indicators and trends of the pollution level of the GW can therefore be demonstrated using longer term monitoring programs at springs.

GW discharge measurements show changes in GW storage and are climate change indicators.



Springs watershed or springshed

Spring discharge measurements sometimes can be tricky

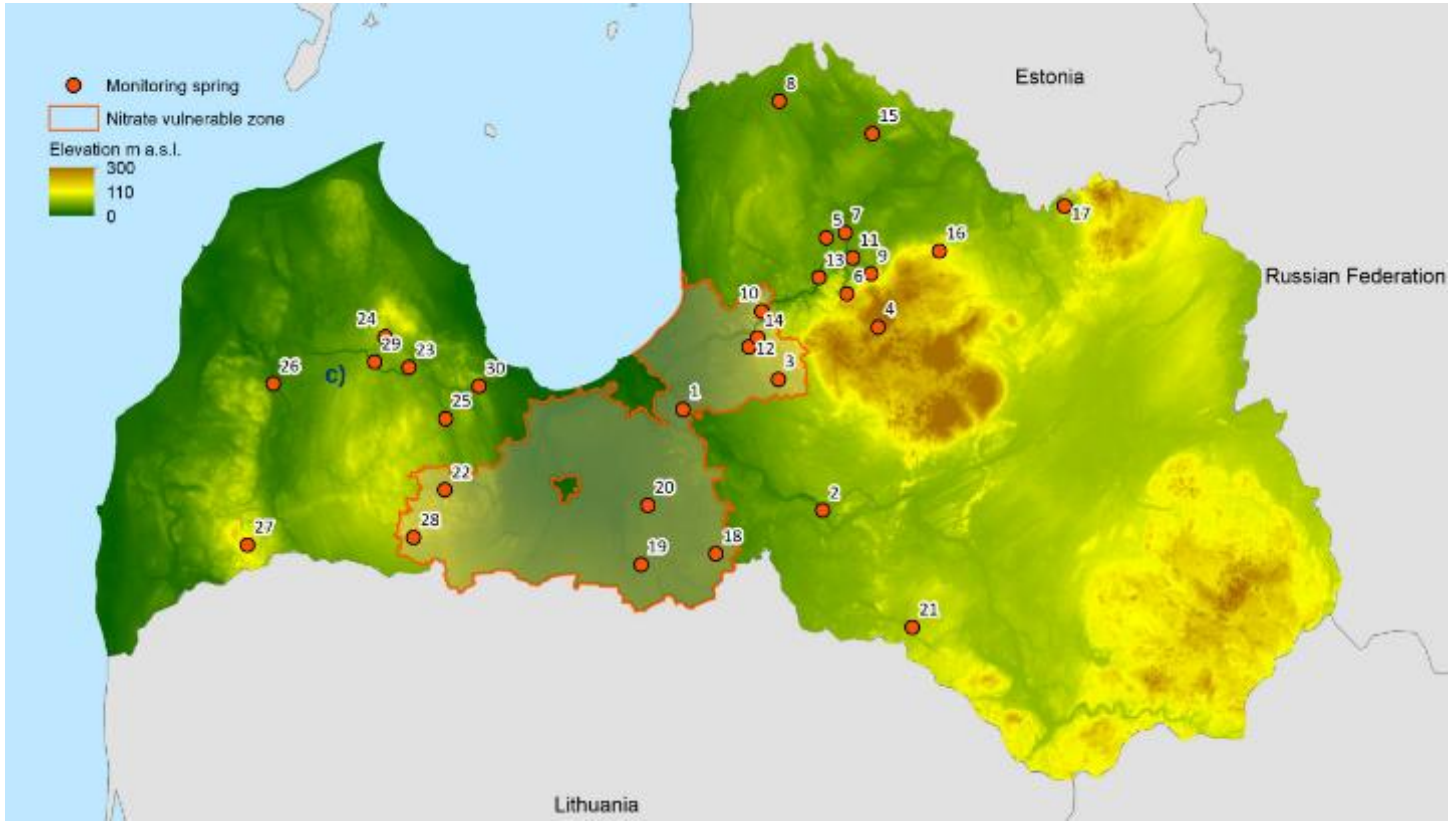
What to consider before including spring in the monitoring network?

PROS +

- No need for installation (?) and maintenance
- No need for pumping
- Can benefit both – GW body and popular drinking water sources monitoring

CONS –

- Locations does not always complement monitoring needs
- Investigations needed to delineate watersheds and assess the representative sampling periods (seasonality)
- Installation costs for discharge measurements in some cases

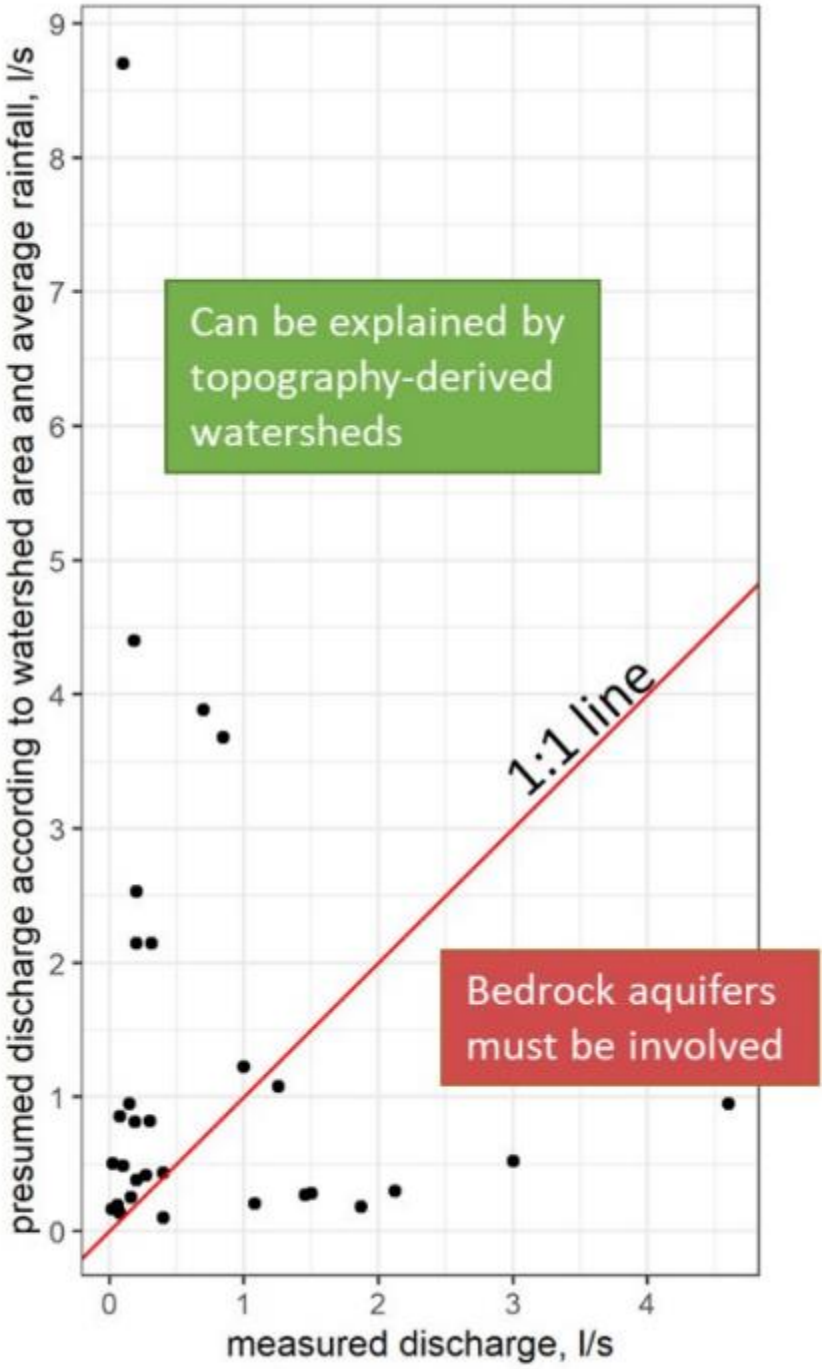


30 springs are included into Latvian GW monitoring network since 2004

Some insights into the spring catchments

Spring watersheds are calculated whether from a) topography or b) bedrock aquifer modelling (results often do not overlap).

The verification is based on (1) seasonal spring sampling, and (2) discharge measurements comparison with precipitation data from satellites.

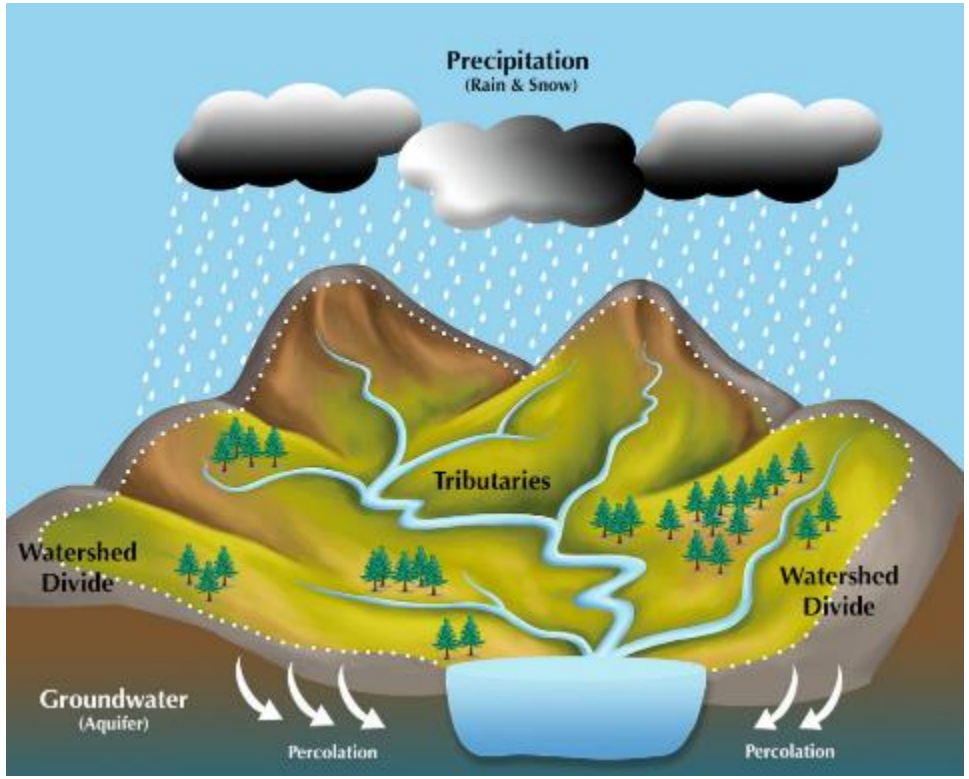


Spring watershed/ drainage basin/ catchment

Spring watershed – the area from which all precipitation flows to a single stream or set of streams.

Benefits of knowing the watershed:

- Understanding the representative catchment area (conceptual model).
- Understanding groundwater origin: Geology, rock types, land use, interaction with surface water.
- Identify pressures/impacts: agricultural load, point source pollution.



1. An appropriate monitoring strategy

2. Correct interpretation of monitoring results and assessment of GW body status

3. Integrated and sustainable management of GW and SW bodies

Spring seasonality? Yes!

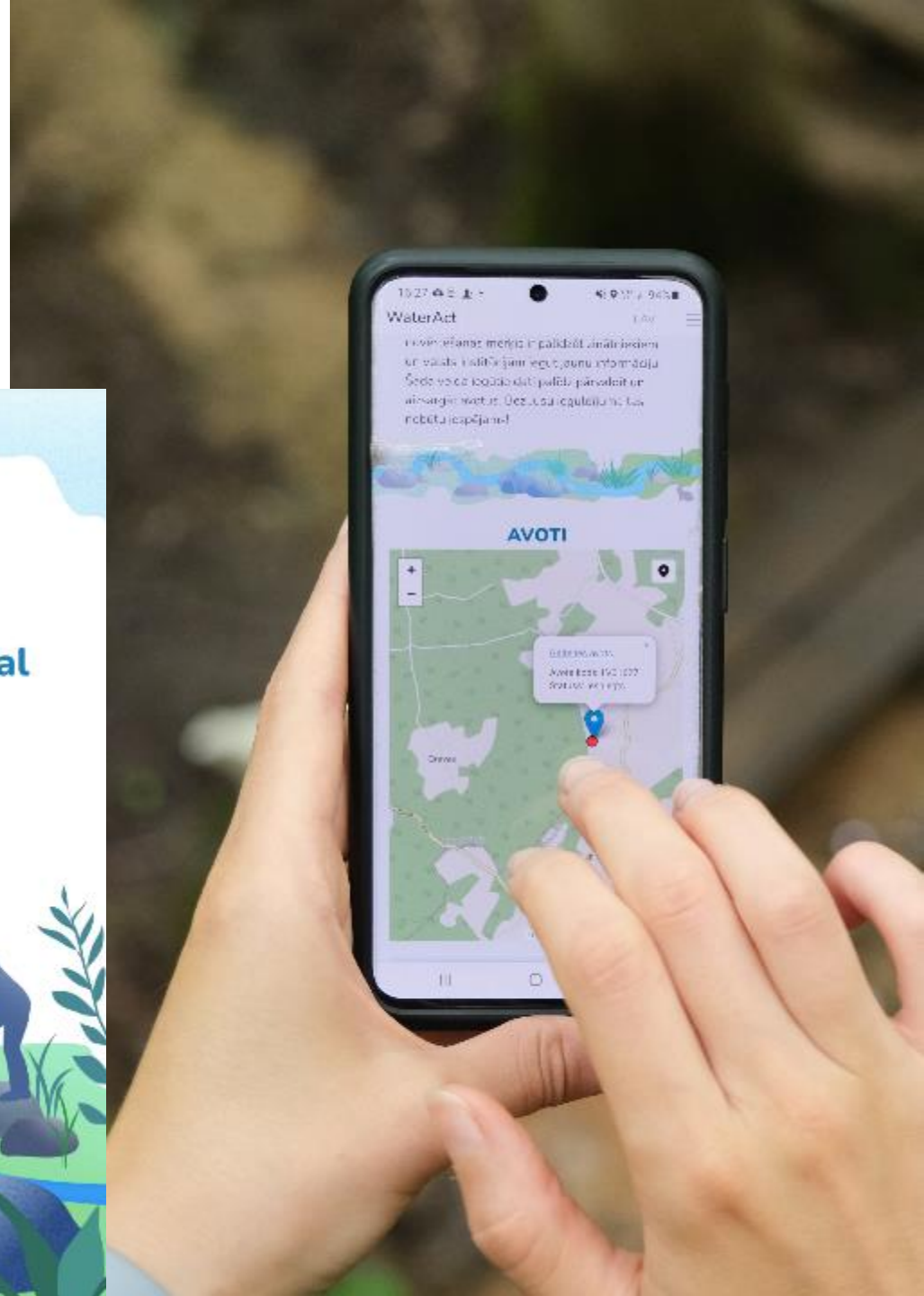
Kazu grava spring in
April 2022

Kazu grava spring in
July 2022

Super exited about springs?
Become a volunteer and monitor springs!

https://avoti.info/

https://avoti.info/instructions



References and some good reads!

Kalvāns et al. (2021) Nitrate vulnerability of karst aquifers and associated groundwater-dependent ecosystems in the Baltic region. Environmental Earth Sciences, 80 (18) , art. no. 628. https://doi.org/10.1007/s12665-021-09918-7

Koit et al. (2021) Contribution of local factors to the status of a groundwater dependent terrestrial ecosystem in the transboundary Gauja-Koiva River basin, North-Eastern Europe. Journal of Hydrology 600 (2021) 126656. https://doi.org/10.1016/j.jhydrol.2021.126656

Nils-Otto Kitterød et al. (2022) Hydrogeology and groundwater quality in the Nordic and Baltic countries. Hydrology Research Vol 53 No 7, 958 https://doi.org/10.2166/nh.2022.018

Weber & Kubinot (2022) Spring waters as an indicator of nitrate and pesticide pollution of rural watercourses from nonpoint sources: results of repeated monitoring campaigns since the early 2000s in the low mountain landscape of Saarland, Germany. Environmental Sciences Europe (2022) 34:53. https://doi.org/10.1186/s12302-022-00632-0

Averis, 2003. Springs and flushes. https://www.nature.scot/sites/default/files/2017-07/Publication%202003%20-%20Springs%20and%20Flushes.pdf

Blaus et al. (2020). From bog to fen: palaeoecological reconstruction of the development of a calcareous spring fen on Saaremaa, Estonia. Vegetation History and Archaeobotany volume 29, pages 373–391. https://doi.org/10.1007/s00334-019-00748-z

Thank you!

Ready to collaborate?

inga.retike@lu.lv

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