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Basin Water Balance Modeling with the Aim to Make Transboundary Groundwater Flow Visible

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Republic of Estonia
Geological Survey

SPR: source-pathway-receptor relationship:

Why the groundwater is important for us?

Receptor

- Water use
- Industry
- GDES
- ...

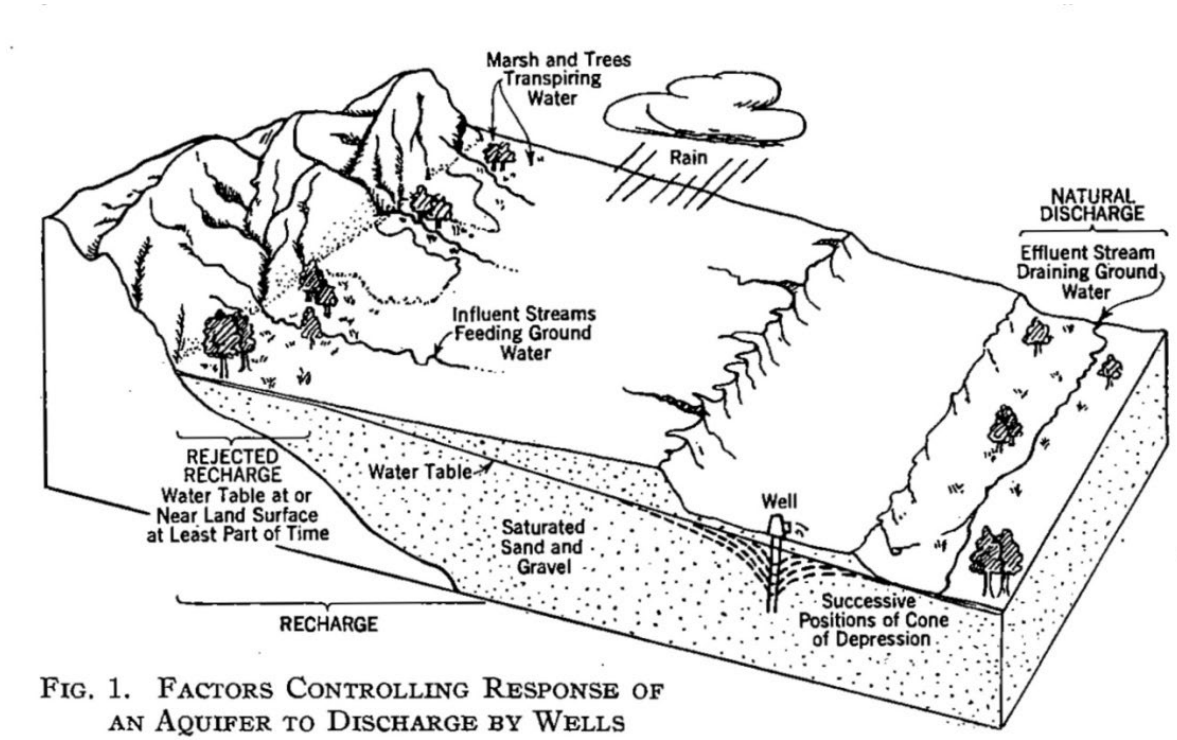


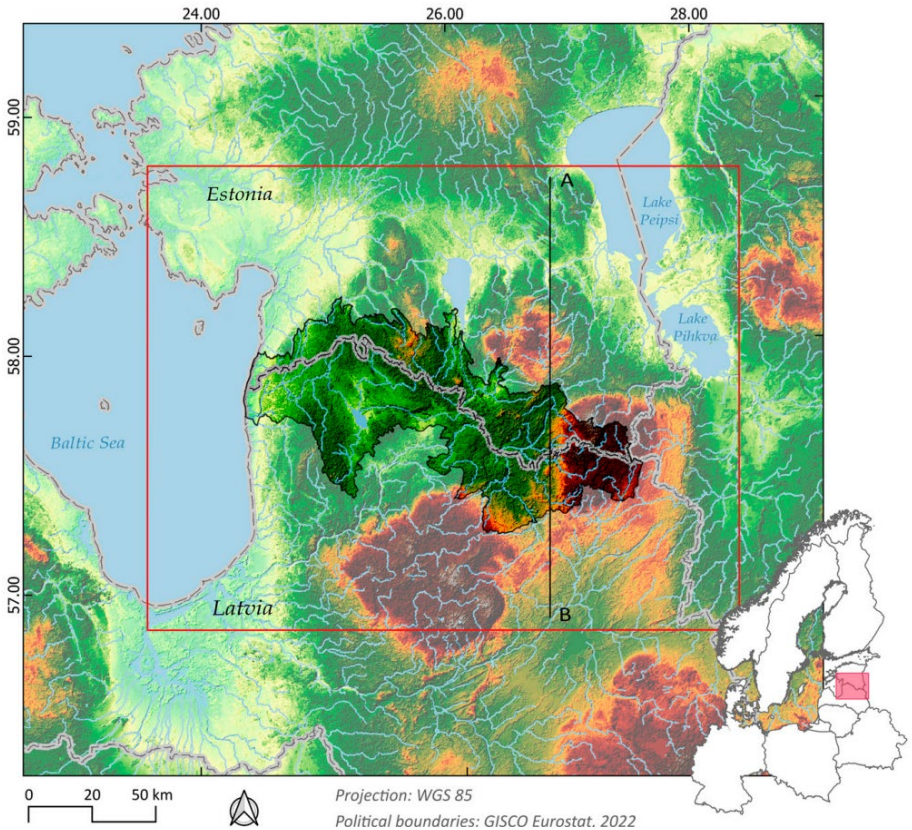
FIG. 1. FACTORS CONTROLLING RESPONSE OF AN AQUIFER TO DISCHARGE BY WELLS

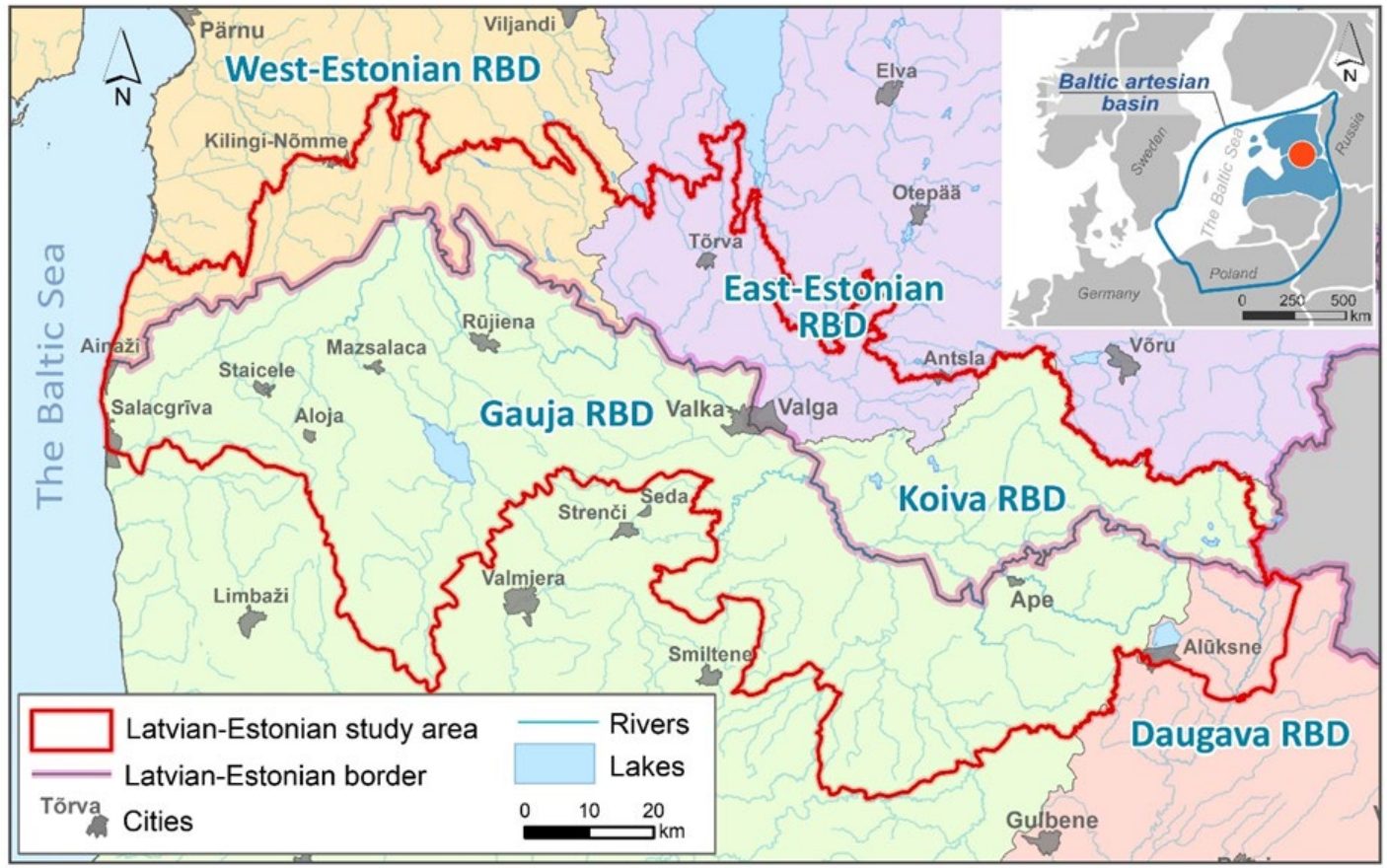
Theis, C., V. The source of water derived from wells: Essential factors controlling the response of an aquifer to development. Civil Engineering, 1940, Vol 10, No. 5, May, 277–280

Transboundary Groundwater management area

5 River Basin District areas:

- 3 in Estonia
- 2 in Latvia





Transboundary Groundwater management area

UN Water Convention

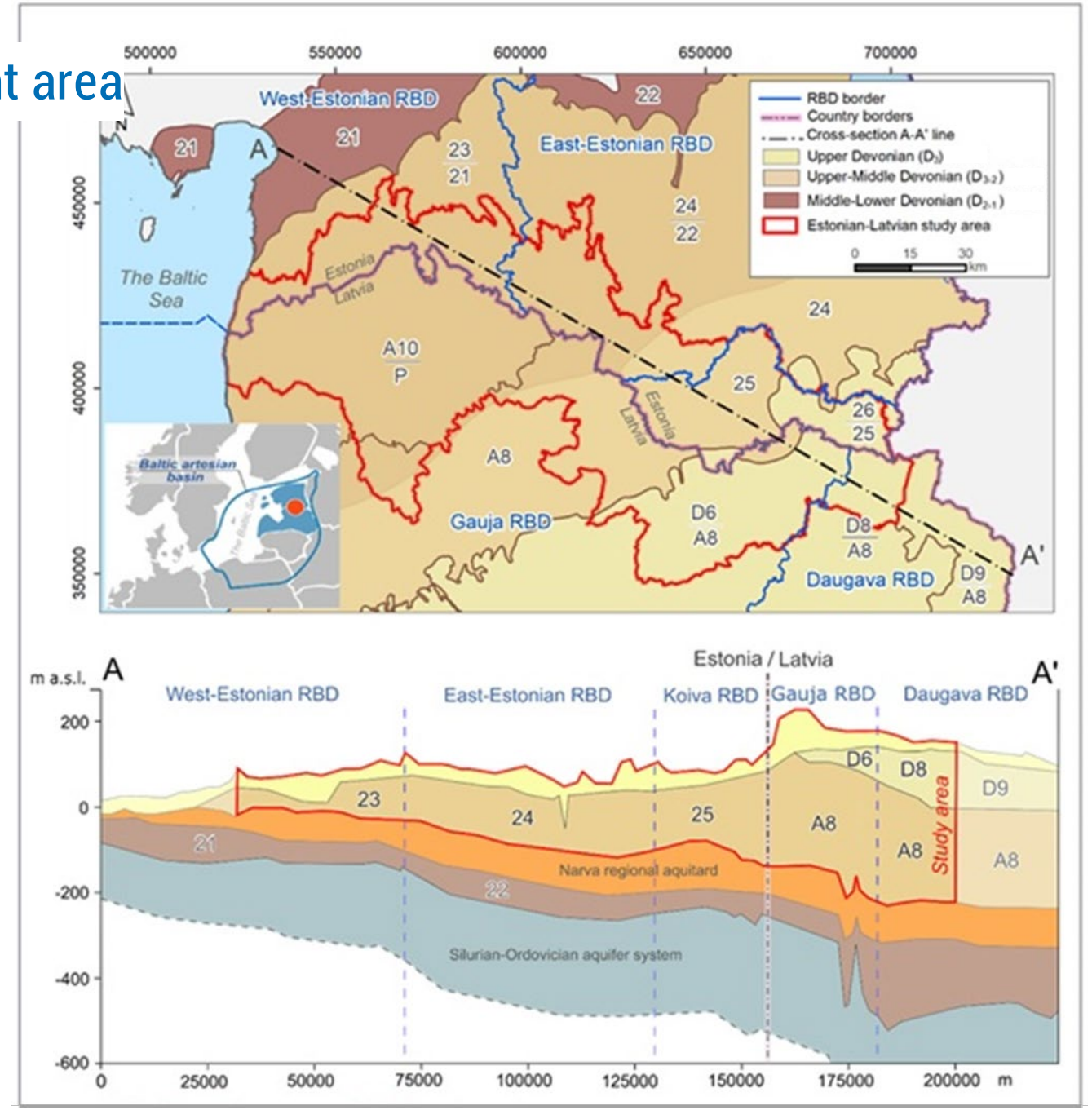
3 TB Aquifer systems:

- D_3
- D_{3-2}
- D_{2-1}

EU Water Framework Directive

11 TB Groundwater Bodies:

- 6 in Estonia (21, 22, 23, 24, 25, and 26)
- 5 in Latvia (A8, A10, D6, D8, and P)



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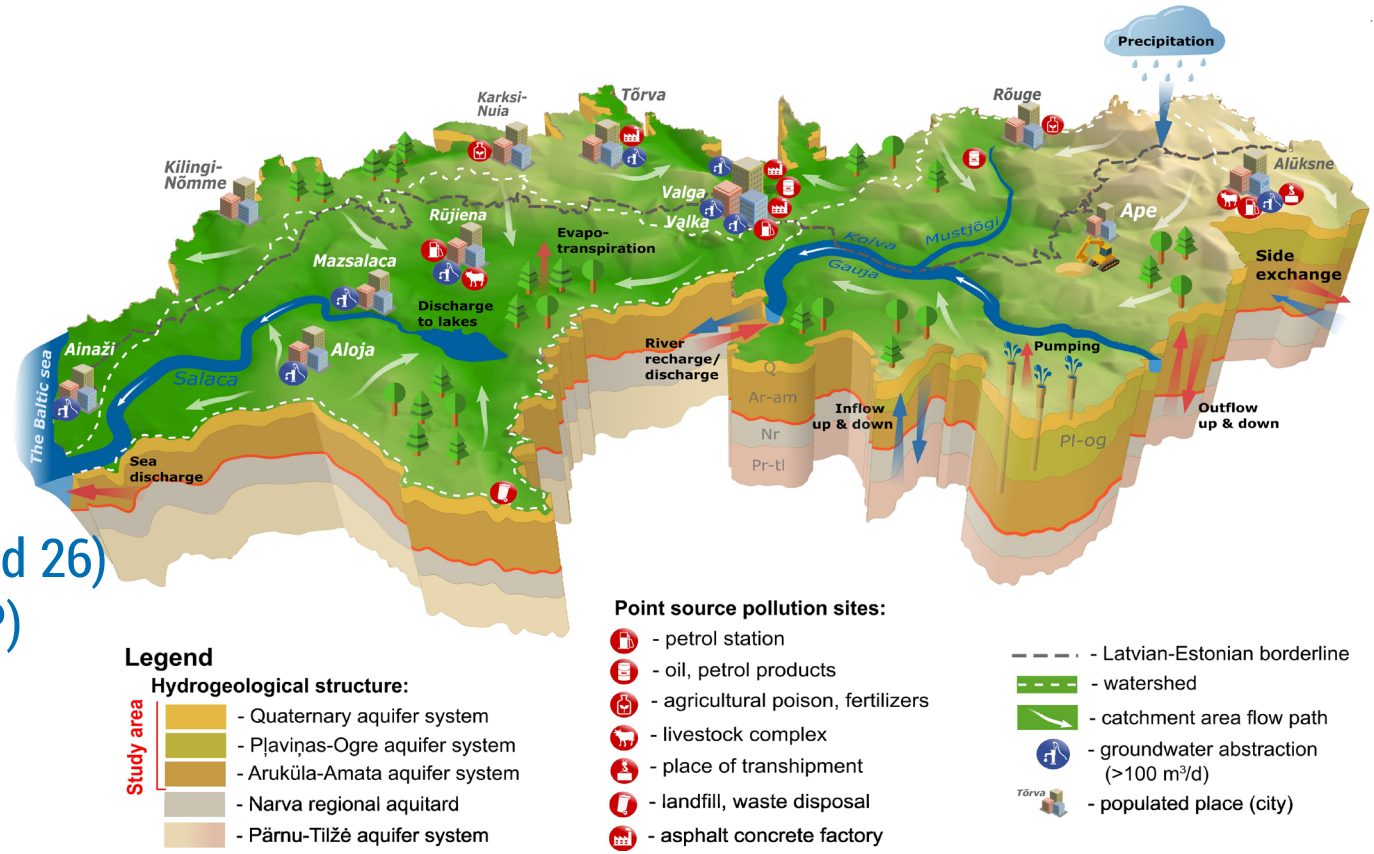
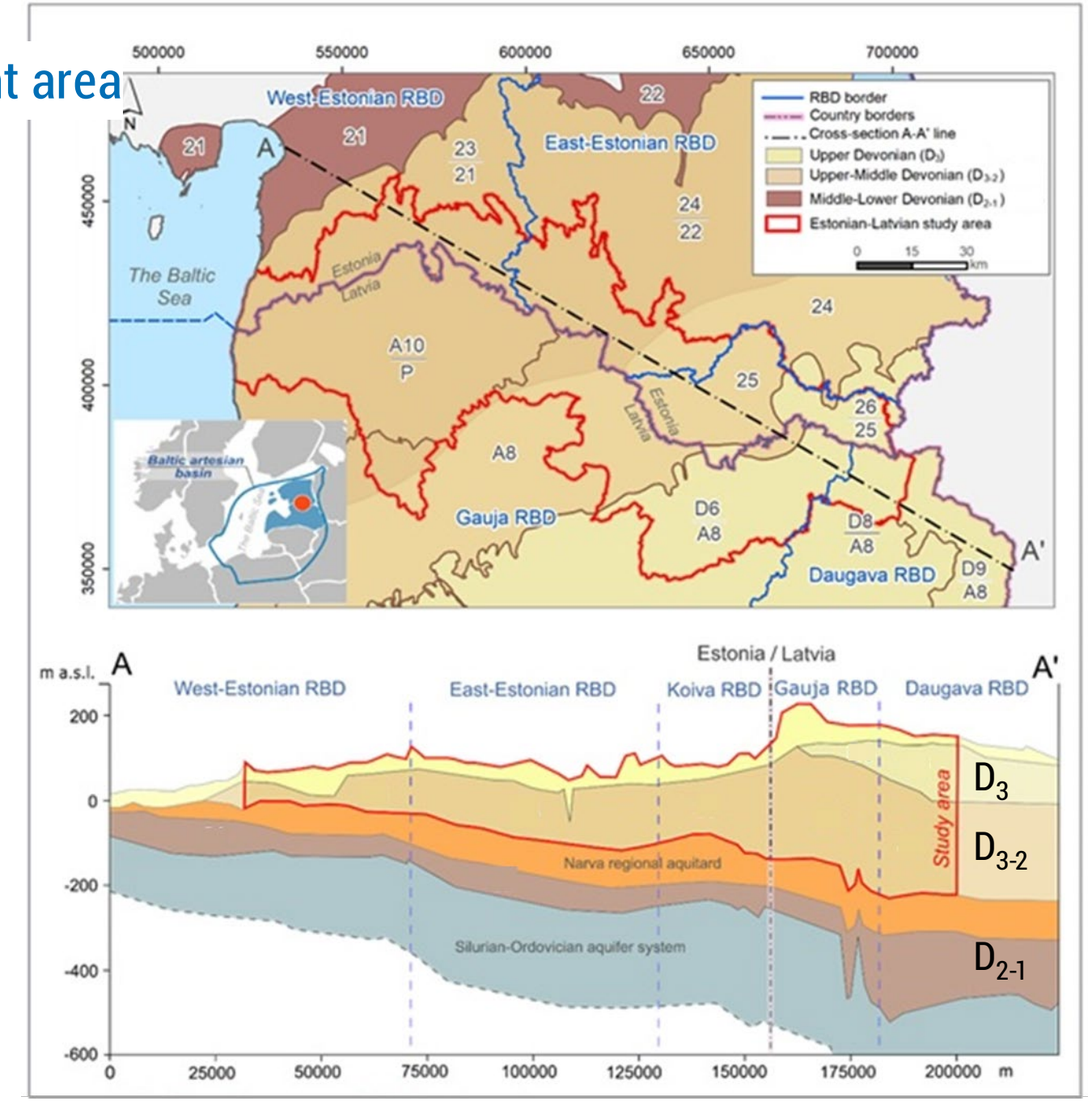


Transboundary Groundwater management area

Water budget of TB aquifer systems (m^3/d)

3 Aquifer systems:

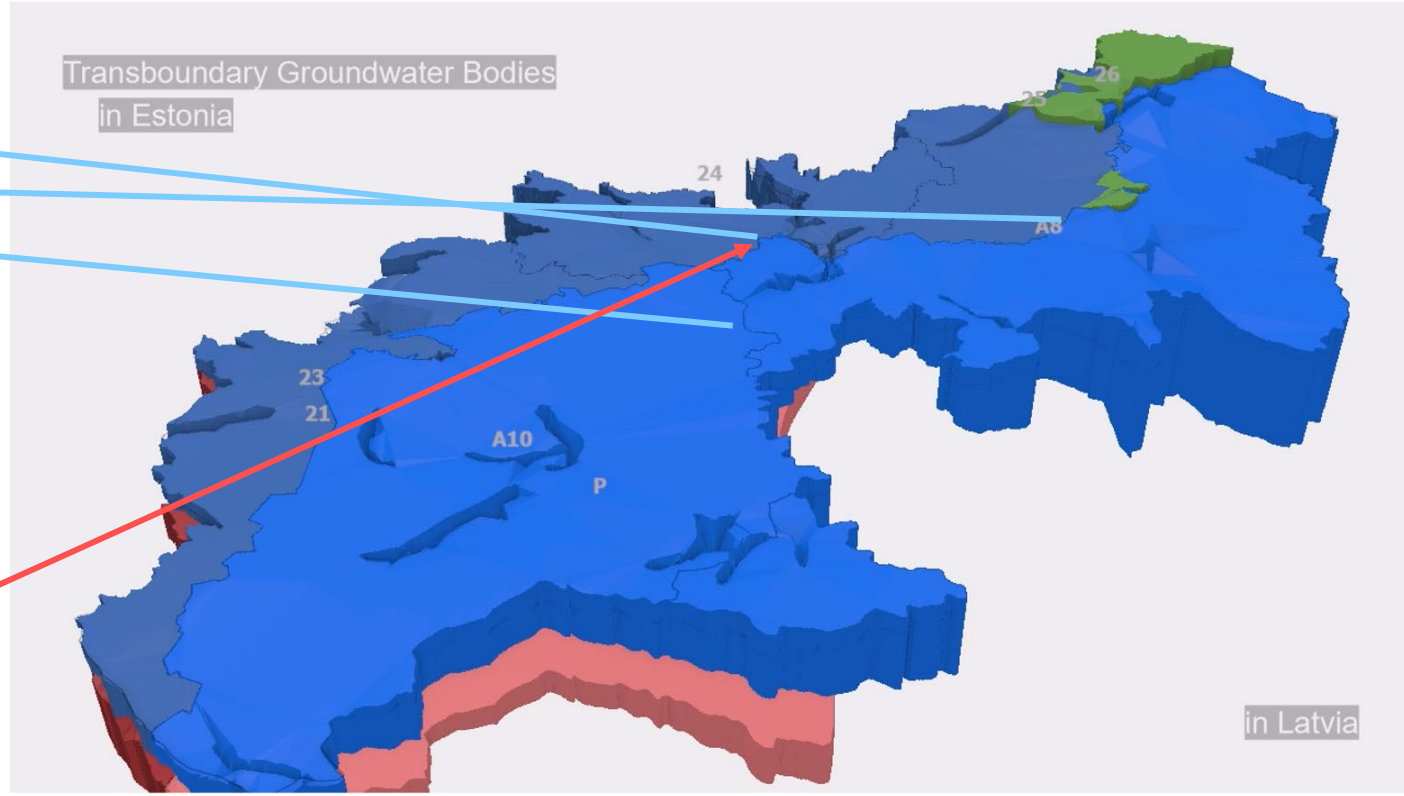
- D_3 700 000 m^3/d
- D_{3-2} 3 300 000 m^3/d
- D_{2-1} 2 100 000 m^3/d



Transboundary Groundwater management area

Water Balance of GWB A8 (*10^5 m^3/d)

Inflow		
	Side exchange	
	Outside study area	0.79
	GWB nr 24	0.05
	GWB nr 25	0.58
	GWB nr A10	0.16
	From above	2.57
	From below	<0.01
Outflow		
	Side exchange	
	Outside study area	0.72
	GWB nr 24	0.30
	GWB nr 25	0.67
	GWB nr A10	0.16
	Down	<0.01
	Up	0.28
	To sea	-
	Pumping	0.000
	River	2.50



Groundwater Dependent Groundwater Bodies

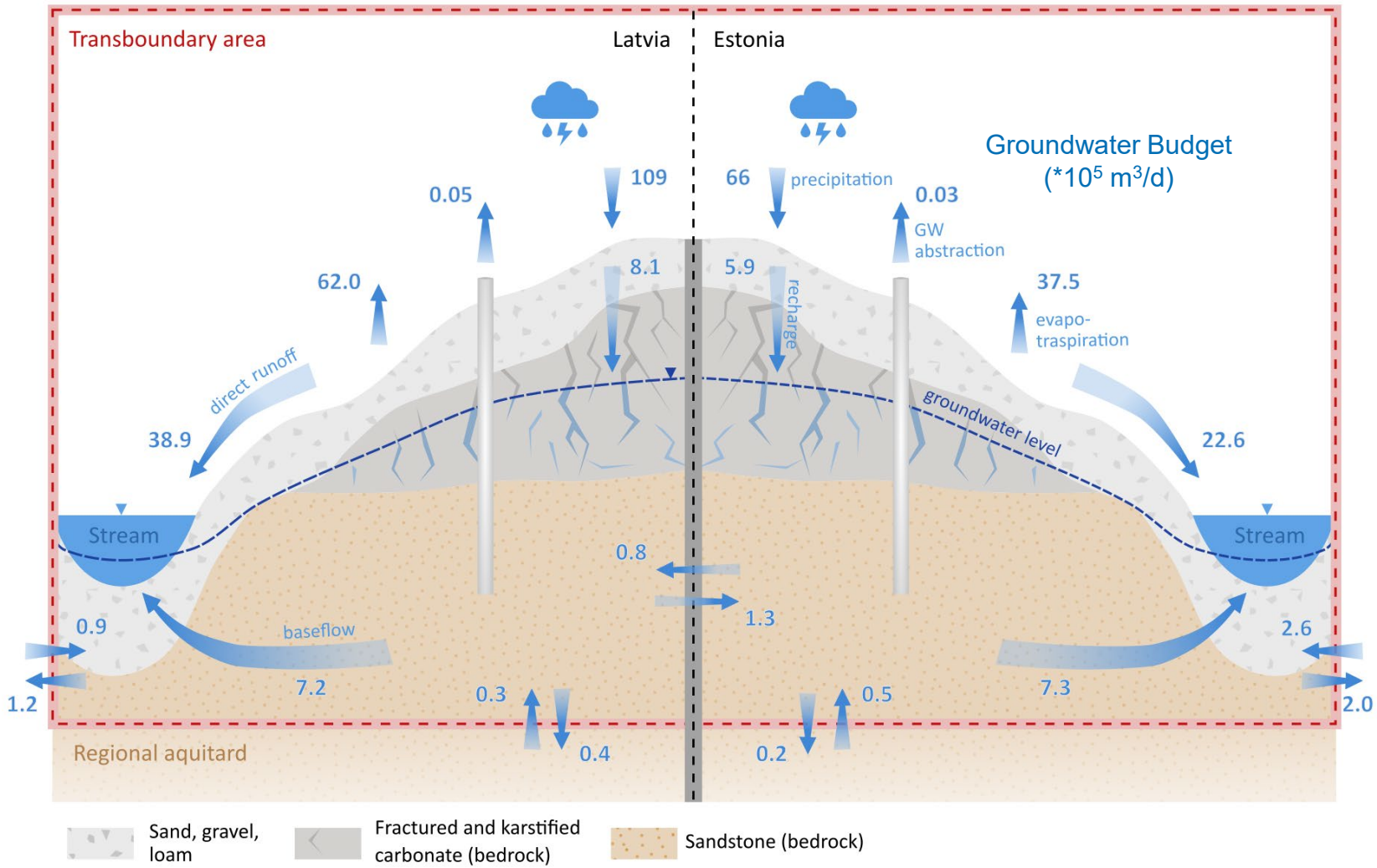
Groundwater and surface water form a joint system in upper 200 m of cross-section

From the precipitation
(17,5 M m^3/d):

- 34-36 % direct surface water discharge;
- Only 7-9 % infiltrate underground

From the infiltration
(1,4 M m^3/d):

- ~90 % discharges back to rivers as baseflow (19 – 32 % of river flow)
- Only 3-5 % feeds deeper aquifers



Hunt, M., Marandi, A., Retike, I. 2023 Calculation of conceptual water balance of transboundary aquifer system between Estonia and Latvia. Water, 15(19), 3327; https://doi.org/10.3390/w15193327

Lessons learned

Benefits:

- Modelling forces conceptual connections between groundwater-surface water
- Modelling gives a quantitative perspective of possible impacts

Danger:

- Modelling gives too many numbers which are hard to track
- Modelling outcomes might be too confusing for general public

Less is better – modelling results must be translated to be understandable to all stakeholders!

Aims must be clear at all times!

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Water is neither created nor destroyed along its course, it simply flows from areas of high pressure to those of low pessure.

If a portion is captured from the flow system, it will result in a reduction in groundwater discharge.

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