Hydrogeological studies and groundwater modelling in the project sites in Finland

EU LIFE Project Scientific Group Meeting Programme

26th September 024

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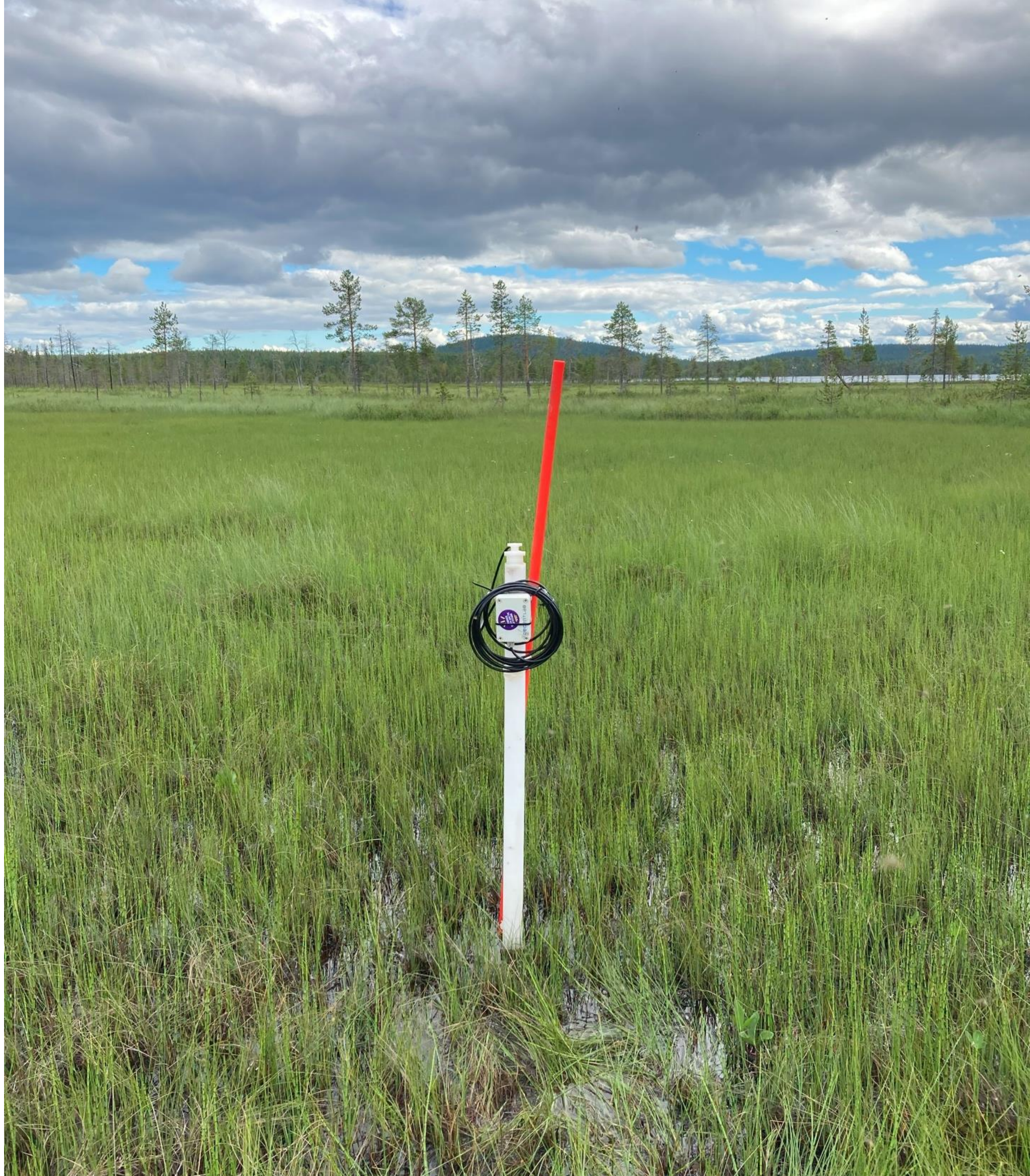
LIFE PeatCarbon

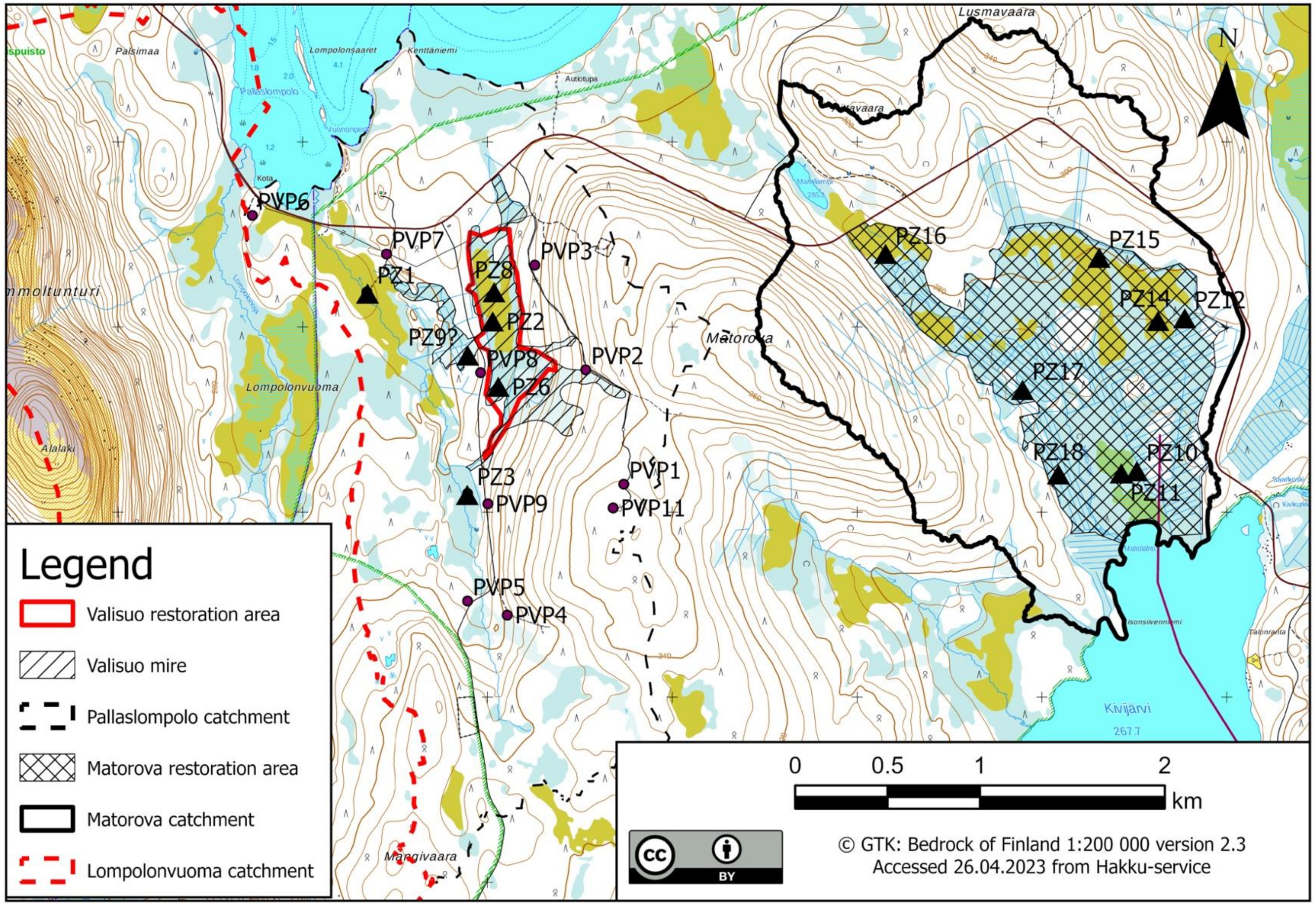
Outline:

- Hydrological monitoring
- Hydrologeloical surveying with geophysical methods
- Other measurements
- Methods: numerical modelling
- Modelling: current progress and first results
  - Välisuo modelling
  - Matorovasuo modelling
- Future plans



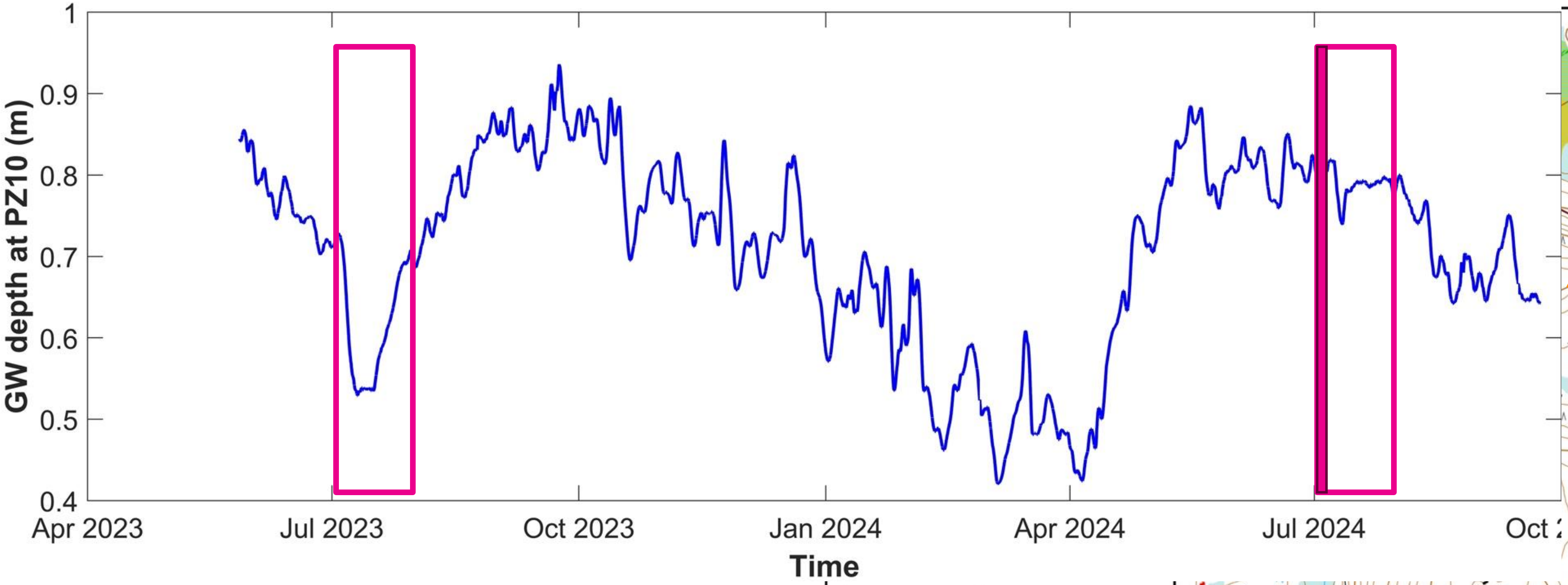
Hydrological monitoring

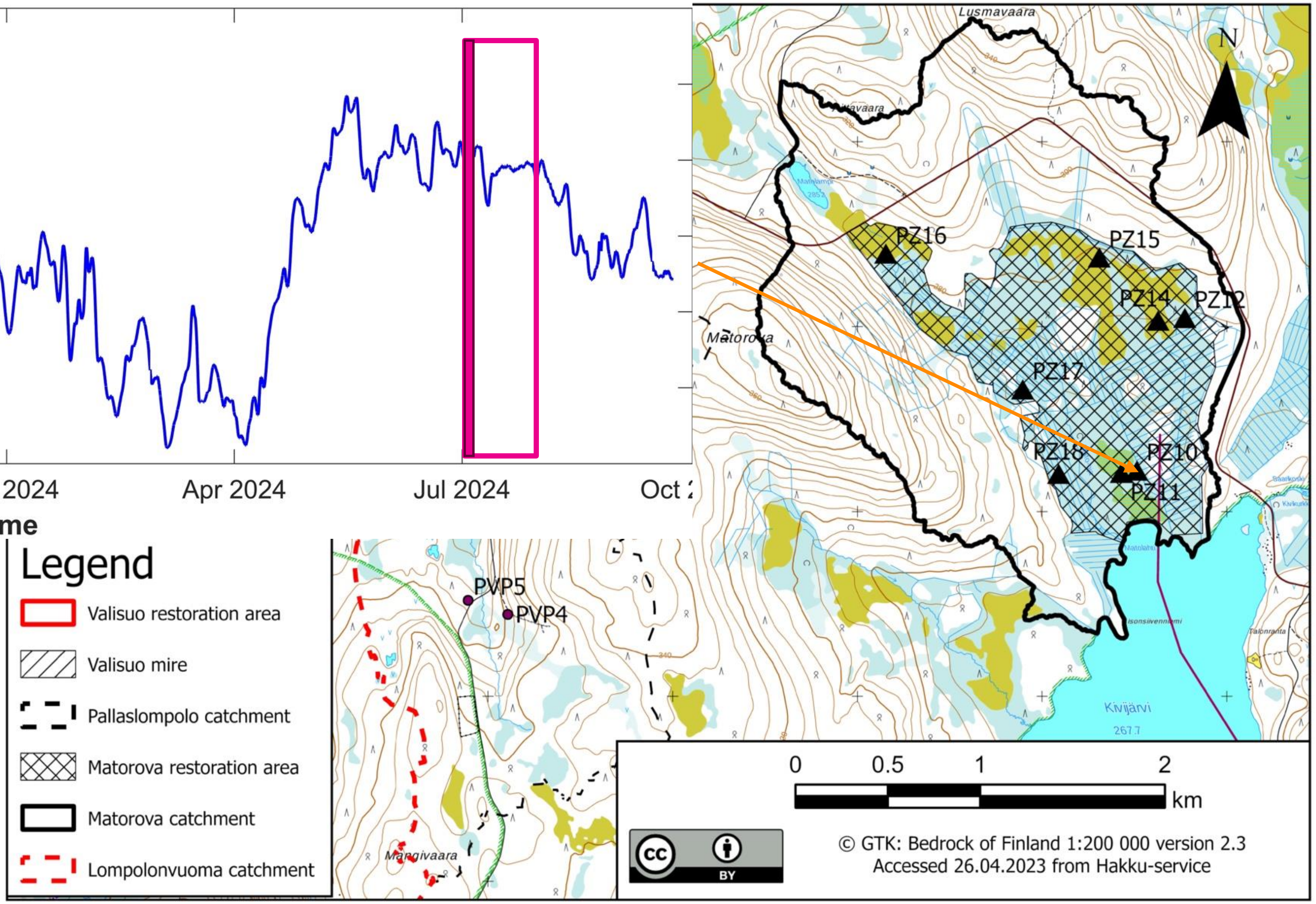
- Monitoring network established in 2022-2024 (drained areas and pristine area)
- Objectives:
  - To monitor the impacts of restoration on GWT in the mires
  - Provide data for model calibration and/or validation
- Currenly 29 monitoring sensors installed in Pallaslompolo in and Matorovasuo catchments (5 in Välisuo, 12 in Matorovasuo, 12 Pallaslompolo)



Hydrological monitoring

Restoration





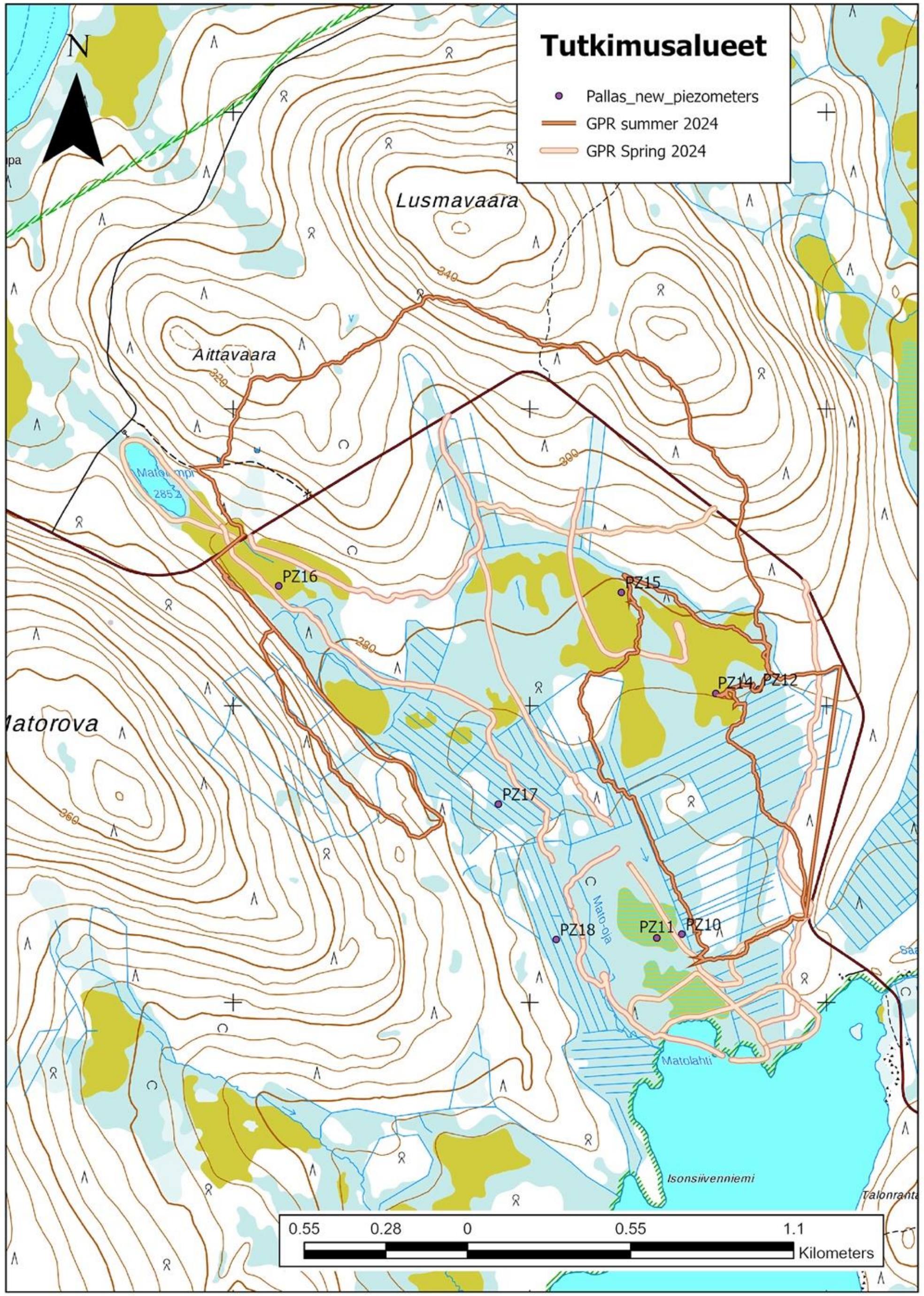
Hydrologeloical surveying with geophysical methods

Ground penetrating radar:

- April and June 2024
- In total ~25 km

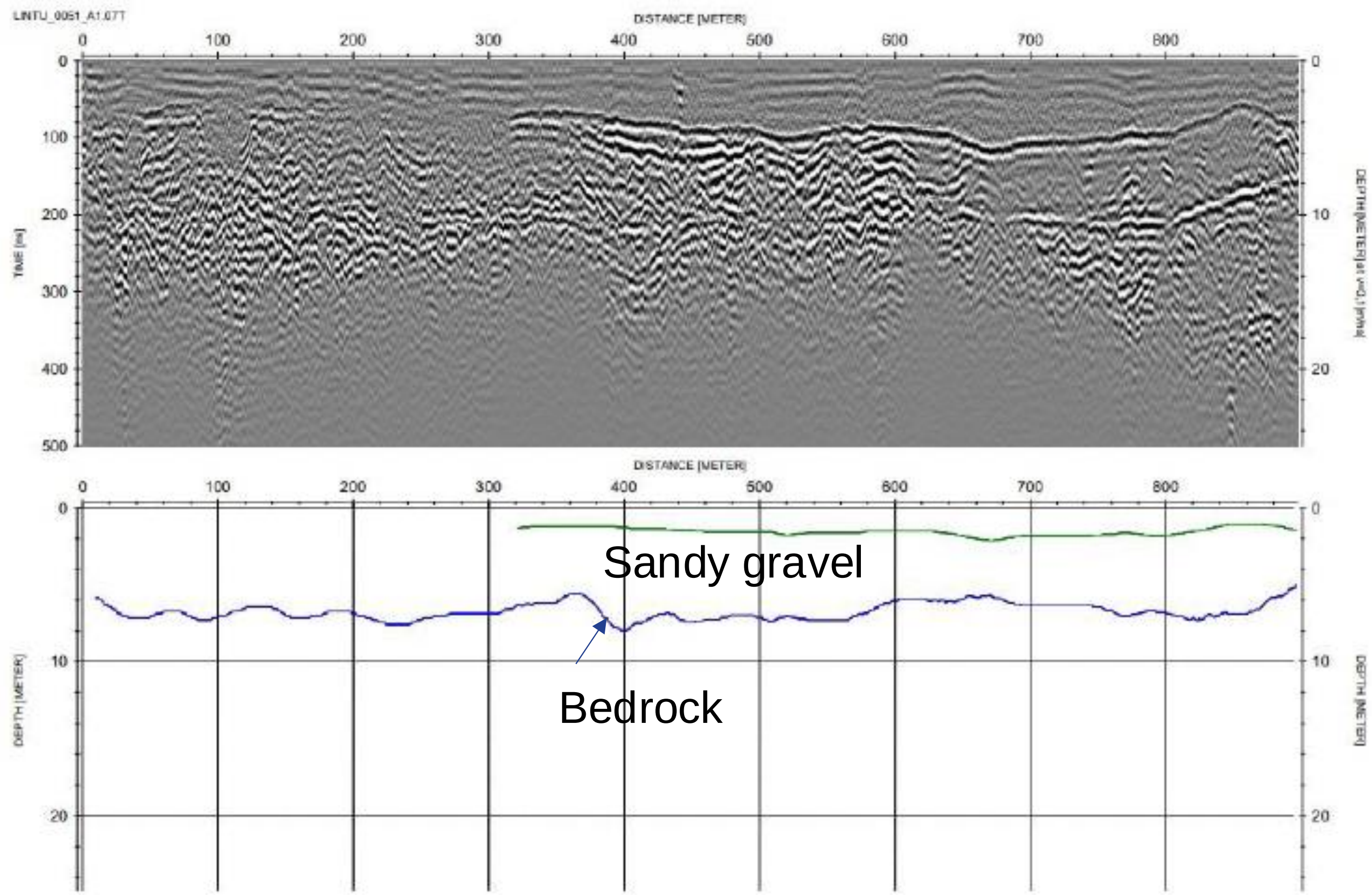
Seismic refraction
-2 lines
-Total length ~220 m

Measurements done for Master’s thesis of Khizer Jadoon (ready in November 2024)

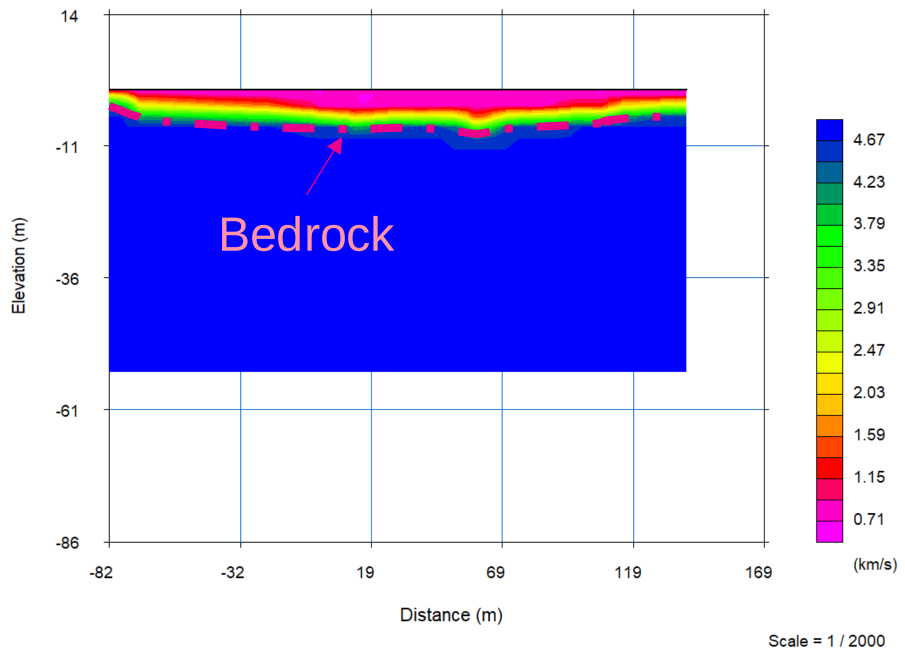


Hydrologeloical surveying with geophysical methods

GPR

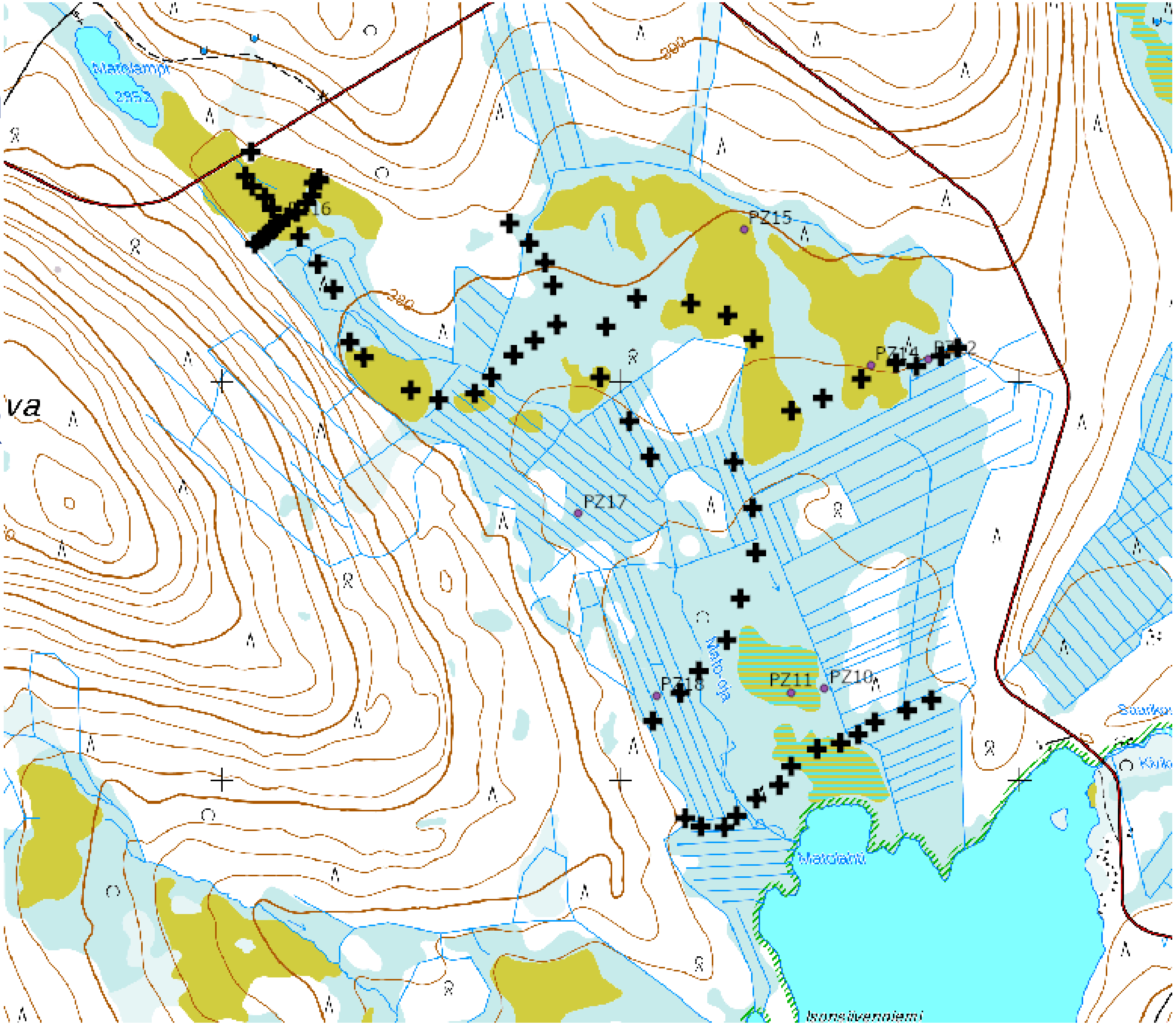


Seismic



Other measurmen

– Manual peat depth measurments
– Validation data for GPR



METHODS: numerical modeling

- Integrated physically based groundwater-surface water modeling
- SPATIALLY DISTRIBUTED model with internal processes for ET, surface flow, groundwater flow
- Each process is described by well-established physical law, based on the hydraulic gradient
- GW and SW solved simultaneously, → Allows autogenesis of surface domain futures (rivers, lakes etc.)
- Software: HydroGoepShere

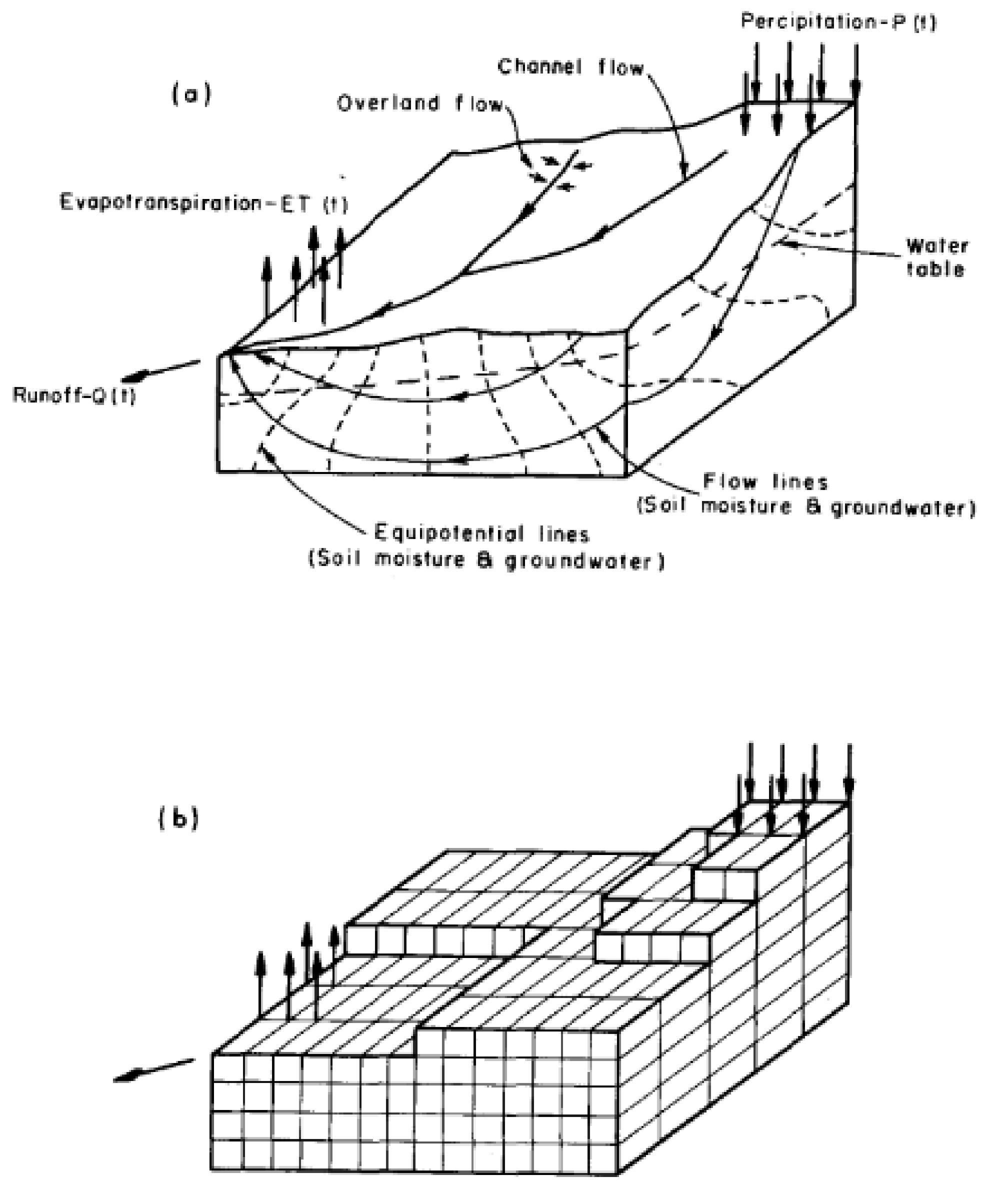


Fig. 3. Schematic diagram of (a) Hydrologic basin and (b) Three dimensional nodal model of hydrologic basin.

Freeze and Harlan 1969

Välisuo modelling

- Objectives
  - Focasting hydrological observations -> validation of hydrological conditions for carbon balance simulation
- Integrated physically based groundwater-surface water (GW-SW) modelling with HydroGeoSpehere
- Modiefied model for whole Pallaslompol catchment
  - Hypothesis: In sucesfully restored fen/aapa mire system GW input to mire should significantly increase
  - Densified mesh to inclue implicitly various resotration structures

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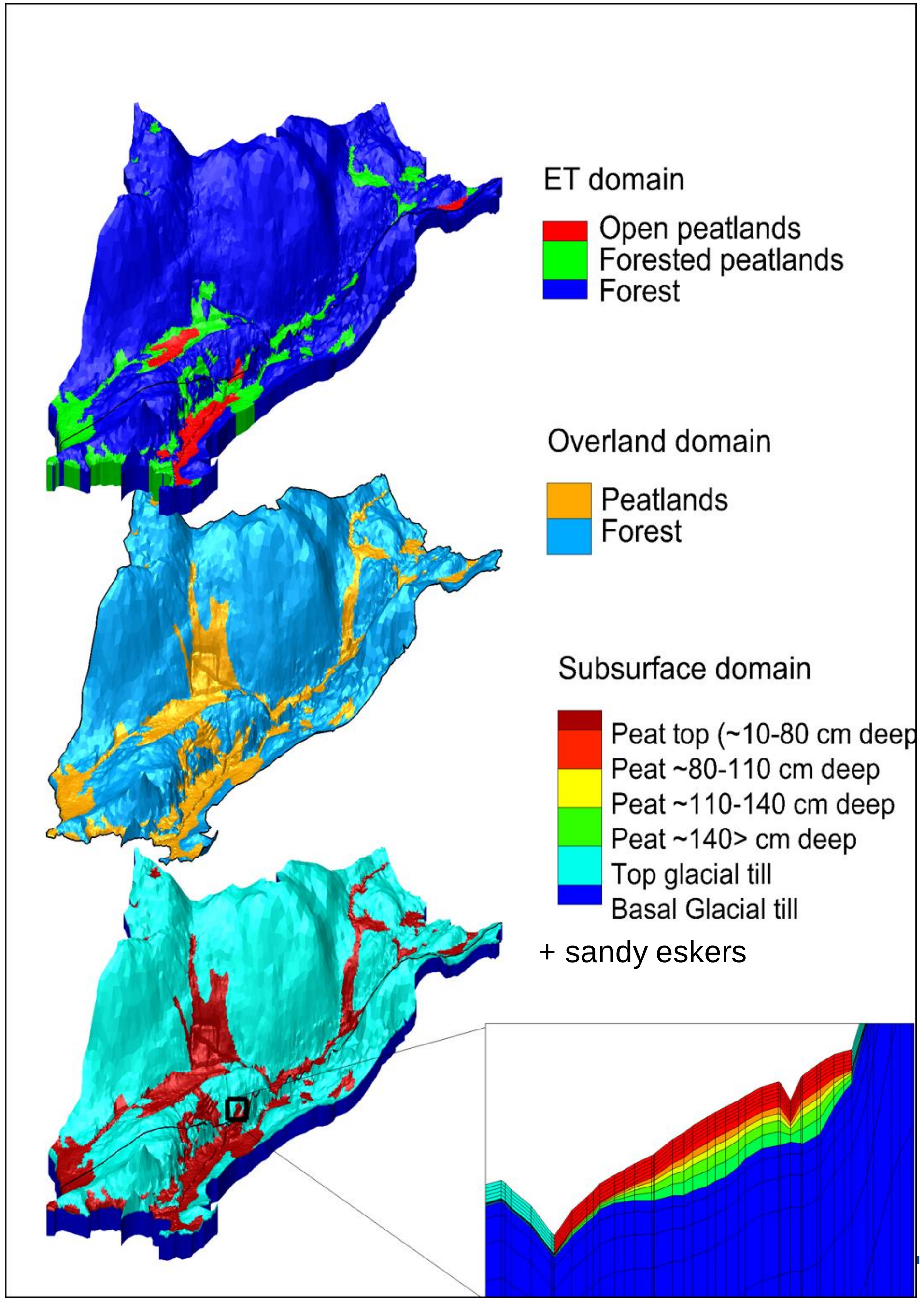
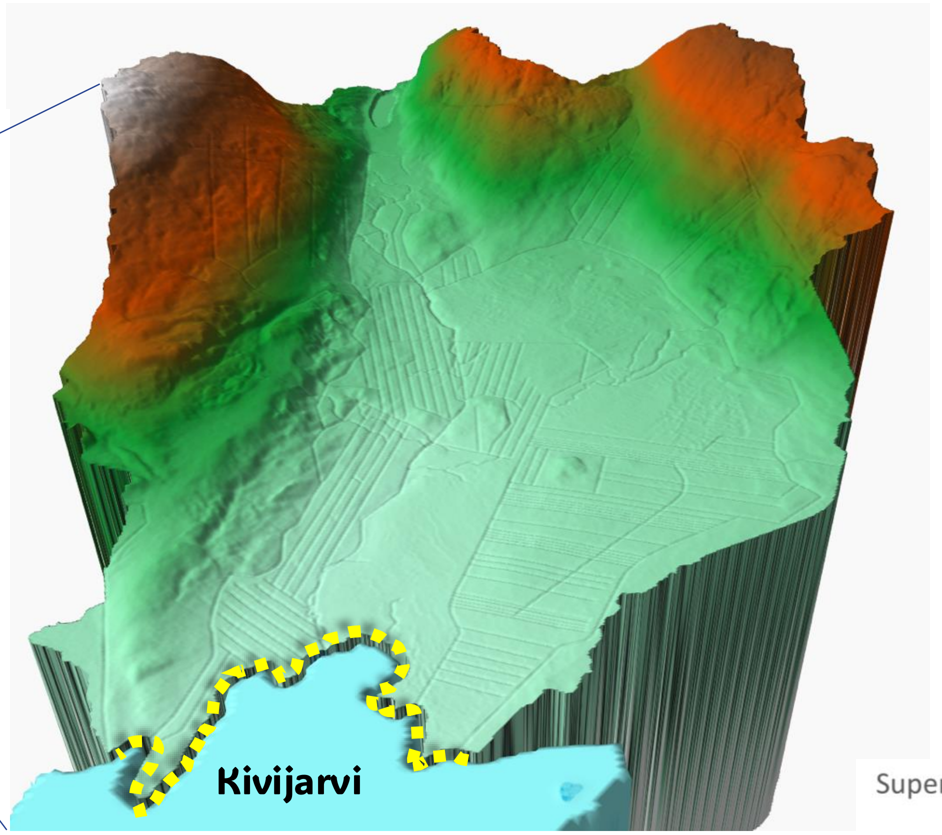
Research papers

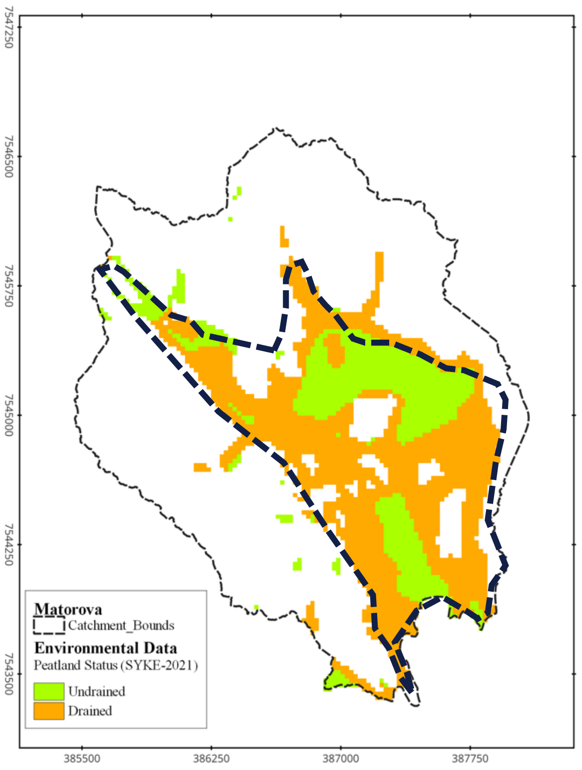
Groundwater exfiltration pattern determination in the sub-arctic catchment using thermal imaging, stable water isotopes and fully-integrated groundwater-surface water modelling

Anna Autio [a,*], Pertti Ala-Aho [a], Pekka M. Rossi [a], Anna-Kaisa Ronkanen [a,b], Mika Aurela [c], Annalea Lohila [c,d], Pasi Korpelainen [e], Timo Kumpula [e], Björn Klöve [a], Hannu Marttila [a]



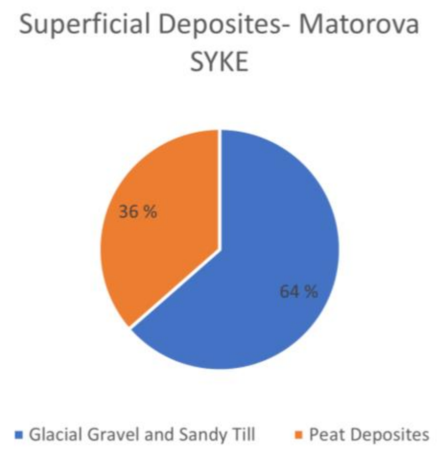
Background

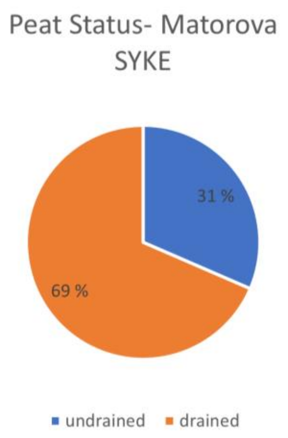




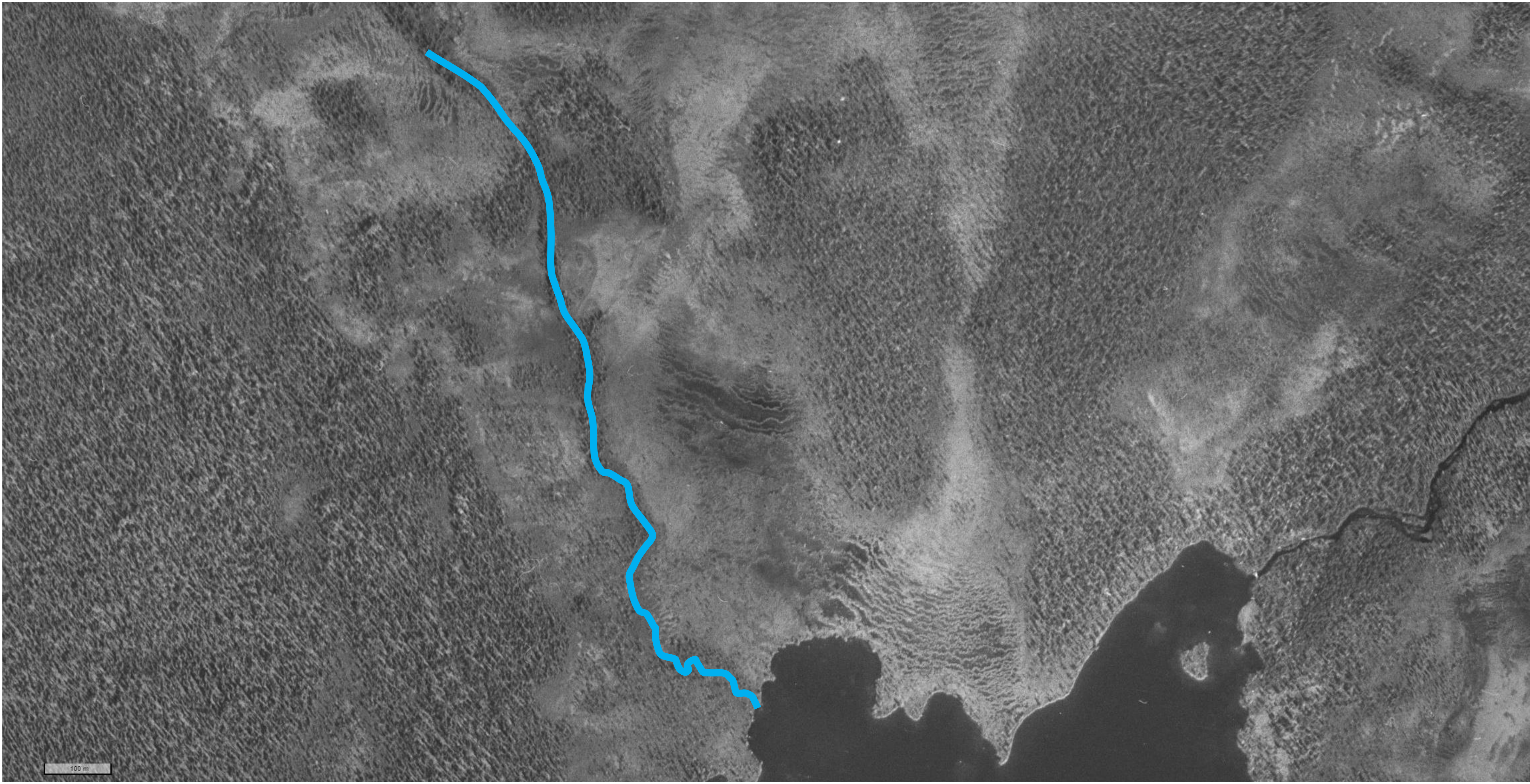
Fan-shaped catchment

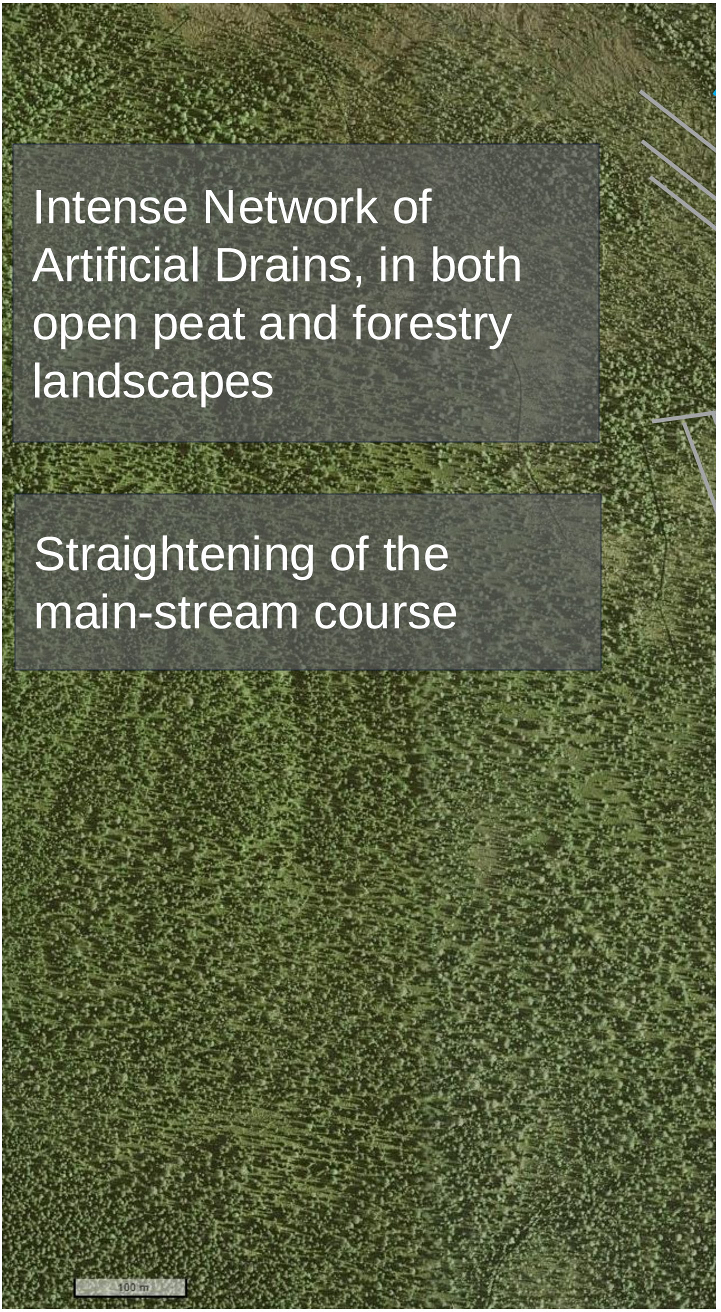
2D Area = 5,46 sq.km
L = 3.2 km; W= 2.3 km





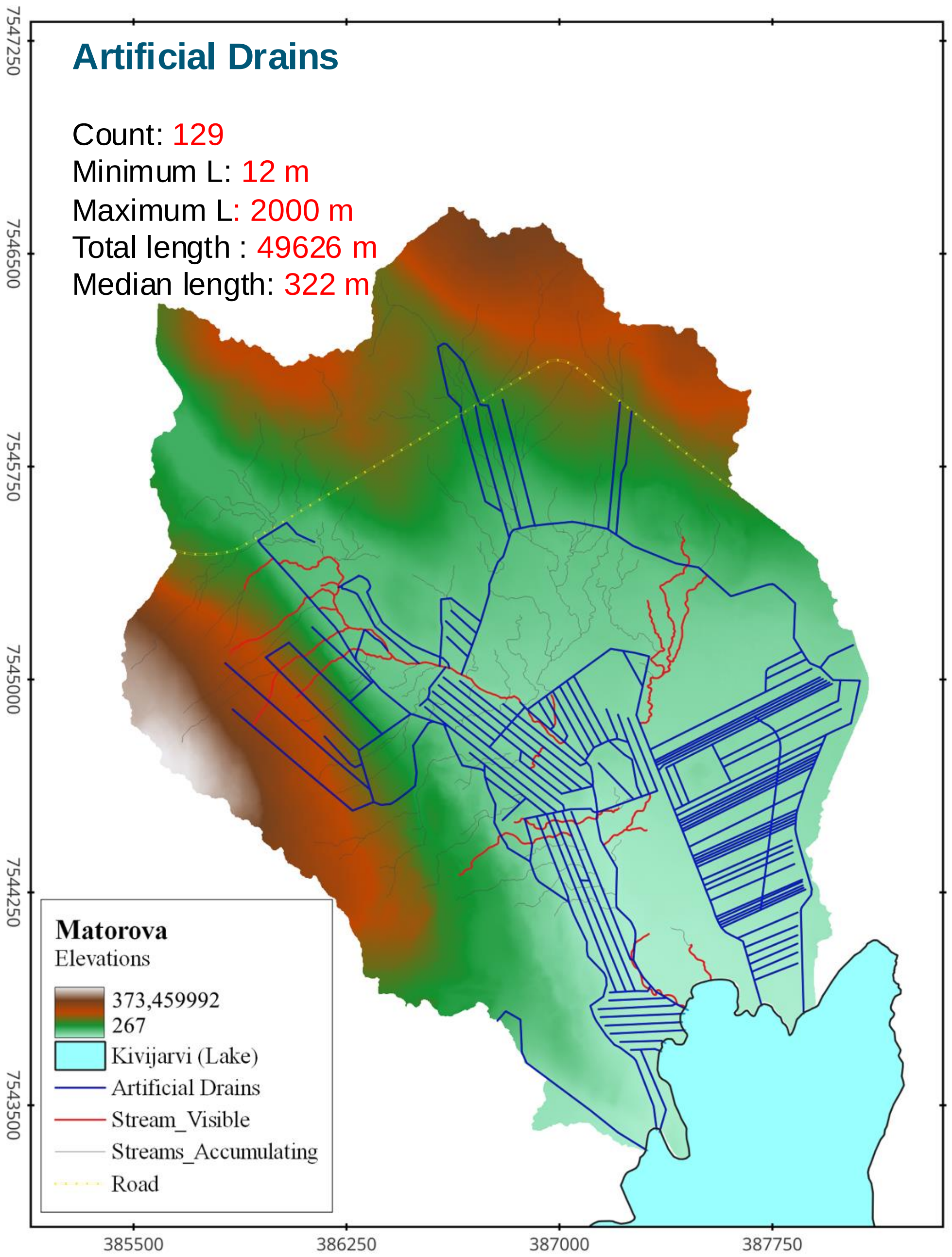
Matorova 1957





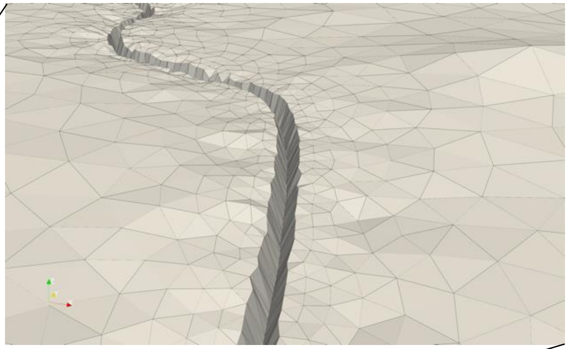
Intense Network of Artificial Drains, in both open peat and forestry landscapes

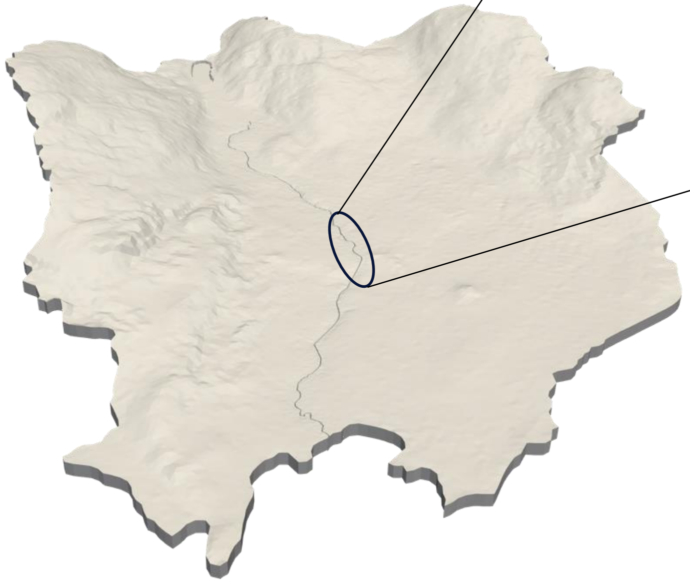
Straightening of the main-stream course



Models Setups

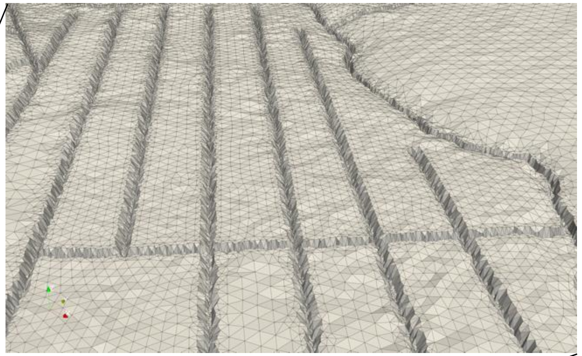
Pre-management model



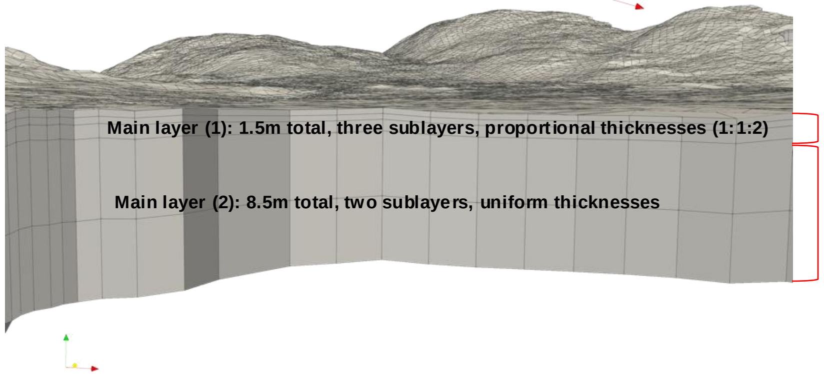


Fine resolution of 1m only at a buffer of the stream, then gradual increase reaches maximum global edge length of the cell = 20m
no. nodes = 31k, no. elements= 61K

Post-management Model

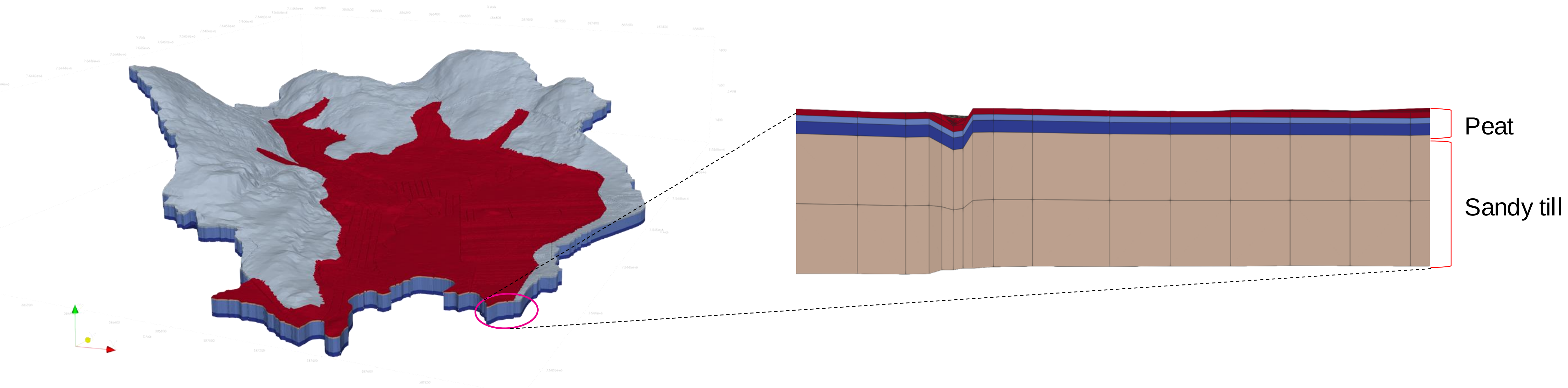


Fine resolution of 1m only at a buffer of the stream, then gradual increase reaches maximum global edge length of the cell = 50m
no. nodes = 316k, no. elements= 632K



HydroGeoSphere (Surface + Subsurface Hydrology)

Zoning/ and Parameterization.



Overland flow domain: (2 zones)
Peatlands (red color)
Forests (light blue)

Porose medium domain : (4 zones)
Three zones for the peat soil (surface layers)
A Zone for sandy glacial till deposits (deep layer)

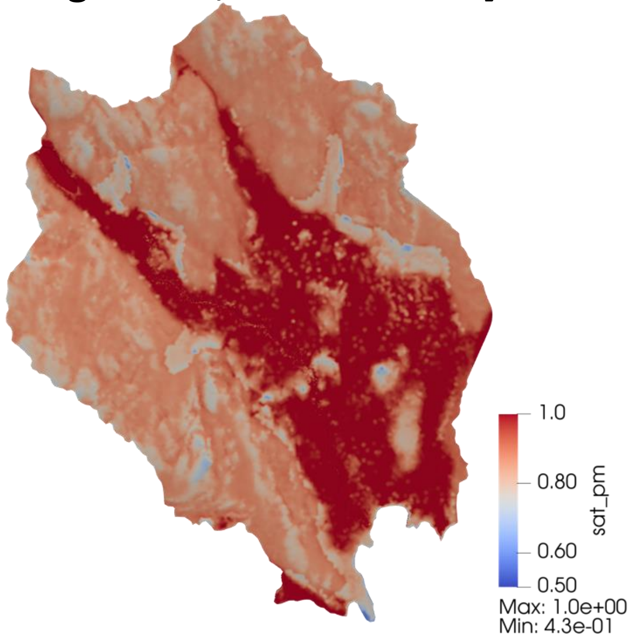
Parameterization is based on soil data and stratigraphy obtained from a neighbouring catchment (Pallaslompolo).

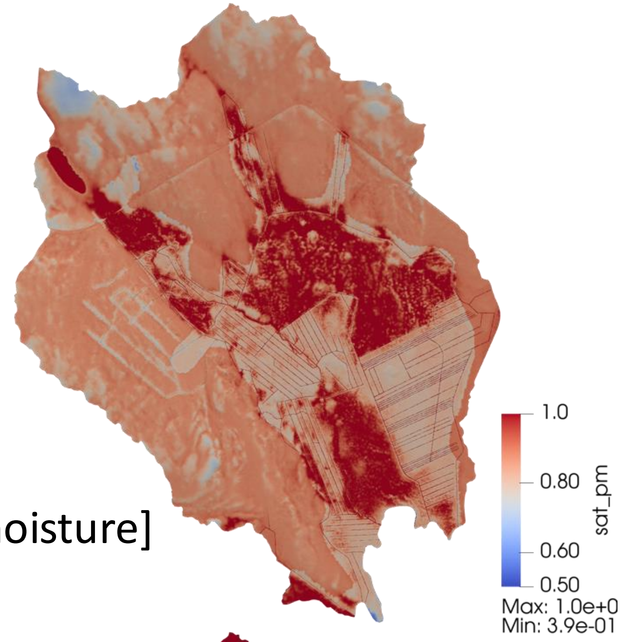
Steady-state results

[pre-management/ undisturbed]

[post-management/ drained]

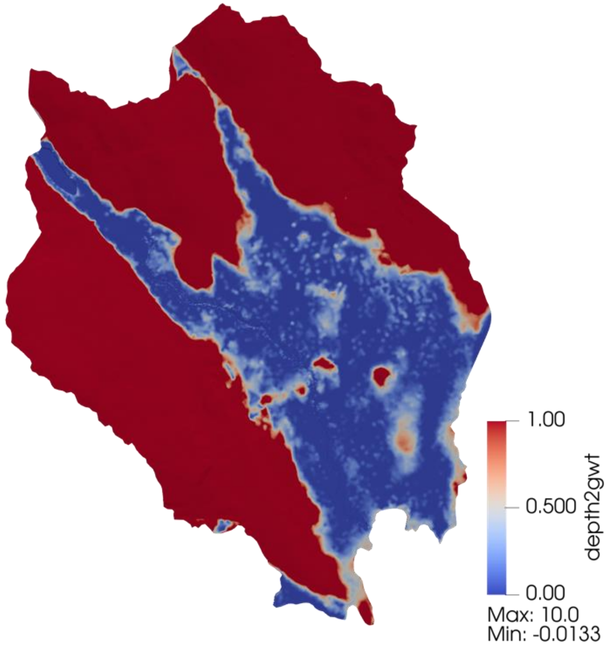
[Saturation]

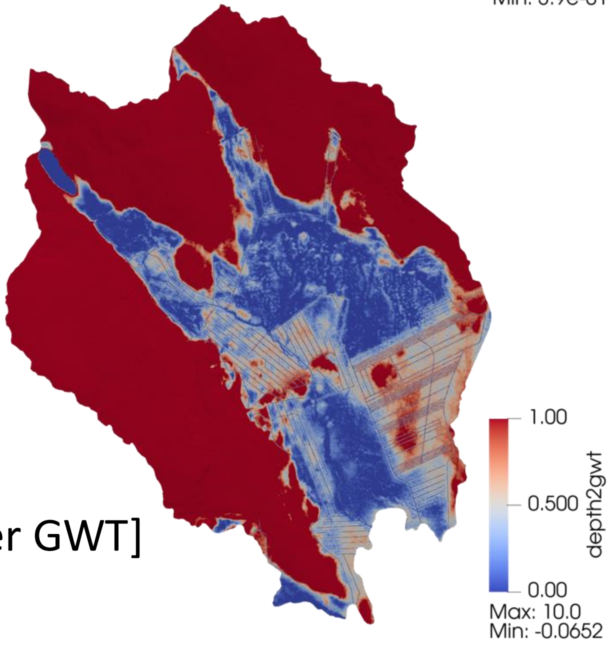




[20% less moisture]

[Depth_to_GWT]





[-60cm lower GWT]

What’s Next?

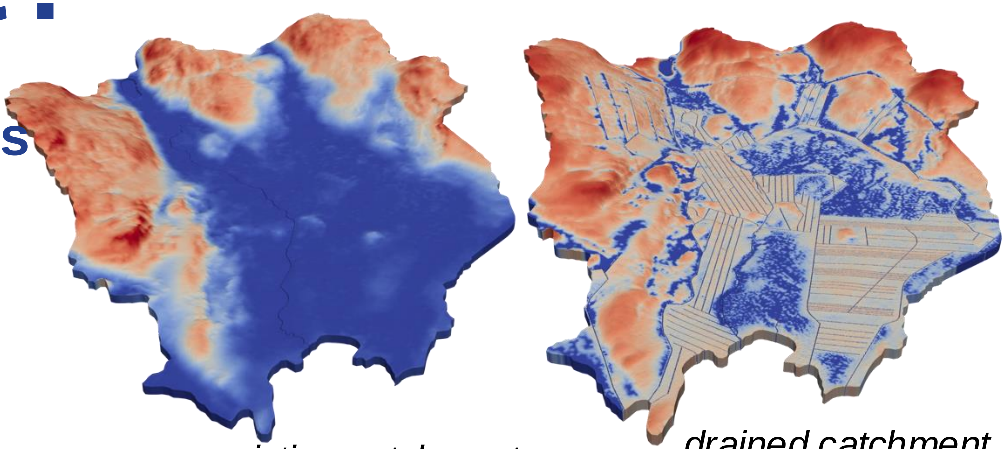
-Measured time-series analysis (pre-restoration and post-restoration, October 2024)

- Calibration/ and validation on long-term transient conditions for both peatlands

- Adding restoration scenario for current and future climate scenarios

- Post-processing approach for in-stream water-origin partitioning (i.e., HMC)

- Assessment – Multivariate analysis on hydrological responses for the different management scenario



pristine catchment

drained catchment

Restored catchment

?

Under development