Geo3D strategy in the Estonian Land Board: national digital twin from a geological perspective

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According to the Geo3D strategy, the Estonian Land Board (ELB) will implement three-dimensional (3D) data production, maintenance, and delivery by 2026. The main aims for moving towards 3D are (1) improving user experience on web applications, (2) providing more versatile open geospatial data for advancing economic growth, (3) supporting decision-making in the public sector.

A digital twin is a multidimensional model composed for simulation and visualisation purposes. Geo3D business analysis (2023) concedes both the underground and aboveground datasets should be incorporated into the countrywide digital twin to be developed when implementing the Geo3D strategy. In many cases (e.g., spatial planning, construction sector, mining), these two realms are closely interlaced.

ELB published the first 3D web application prototype, 'Estonian Land Board 3D' in 2021, displaying buildings, LiDAR point clouds, trees, and other aboveground data layers. In 2024, a 'Geology 3D' prototype was released, where buildings, geotechnical study sites, boreholes (with probing and groundwater level information), and bedrock systems are visualised, along with various 2D data layers. Three digital elevation models are presented: (1) ground surface, (2) sedimentary bedrock relief, and (3) crystalline basement relief. While the ground surface is generated from the LiDAR point cloud, the other two are interpolated from borehole logging data. In fact, the thickness model of the Quaternary succession is shaped first, during multiple iterations. After subtracting the result from the ground elevation, sedimentary bedrock relief is obtained.

Further developments of the 'Geology 3D' web application depend greatly on user feedback. ELB is preparing the following data: geological successions (systems, formations, beds), objects from the Mineral Registry (deposits, mineral blocks, quarries, mines, survey sites), and abandoned mines. The farther one navigates from the direct measurements (e.g., boreholes), the higher the probability of an interpretational divergence. Hence, besides enriching data layers, uncertainty estimations and analytical tools need more attention. The two previously described prototypes will eventually be integrated into one coherent digital twin.

Future benefits of the subsurface domain within the Geo3D framework:

- upgraded functionality for validating borehole logging data,
- fast national model updates with regularly blended new logs and local models,
- automatic production of geological maps and other derivatives,
- creating synthetic boreholes and cross-sections, volume calculations,
- more sophisticated projecting of geological surveys, buildings, infrastructure,
- coastline changes presented in time sliding mode support marine spatial planning,
- preliminary stability predictions of slopes, abandoned mines,
- real-time monitoring of geological hazards,
- groundwater yield, flow, vulnerability estimations,
- new possibilities for subsurface visualisation enable to clarify the content for non-experts,
- geotourism promotion with augmented reality capabilities.

'Estonian Land Board 3D' web application prototype is available here: https://3d.maaamet.ee/

'Geology 3D' prototype is also accessible from the ELB's geoportal: https://geoportaal.maaamet.ee/eng/spatial-data/geological-data/geology-in-3d-p941.html

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