Summary

Estonian Land Board's vision is to start three-dimensional capturing and distribution of spatial data in the coming years. As a result, national registers can provide digital services that meet the increasing needs of the society, based on a common 3D model. As a self-initiated side project, the Land Board has created and distributed a 3D model of the whole of Estonia. The upgrade of national spatial data into three-dimensional format is a large-scale transformation concerning numerous parties and processes. This requires a conscious management of change inside the Land Board as well as in cooperation with partner organisations, to formulate common strategic goals. Close collaboration is essential to ensure that all stakeholders consider and allocate the necessary budget and resources to test and implement new technologies.

Production and distribution of the 3D model take place mainly as part of the activities related to the Estonian Topographic Database (ETDB) and this will be the case in the future. Furthermore, creating and updating the 3D model will support the currentness of 2D topographic data. Data of the whole country is acquired by aerial photography (AP) and aerial laser scanning (ALS) from an airplane and used for updating ETDB. At least half of the Estonian territory is flown over annually – ¼ in spring for mapping, ¼ in summer for forestry, and additional low-altitude flights over densely populated areas (in order to achieve better precision of data). The data collected during the flights will be processed, producing ALS point clouds, aerial photos, and orthophotos. The pipeline of ALS and AP production uses more than ten software solutions, some of which are self-developed. Production of data depends on the software offered by the hardware manufacturer. However, the aerial camera and aerial laser scanner used today are reaching the end of their life. Additionally, the network of base stations of ESTPOS (the national satellite data centre of the Global Navigation Satellite System) has reached the end of its life. ESTPOS ensures the monitoring of temporal changes of the geodetic system and provides precise location-based information in real or close to real-time. ESTPOS is essential for airborne data collection.

The regular collection of data ensures that the changes taking place in nature and as a result of human activities are timely reflected on map products. Changes are identified through visual comparison of photos. Topographic database is updated using the stereophotogrammetric method, supported by orthophotos. As ETDB database contains approximately 4.8 million objects, the manual updating is very time-consuming. As a result, topographic data are currently updated (including improving the location of phenomena) for approximately one tenth of the territory of Estonia annually. To meet the expectations of the state and the public, updating of some data layers (e.g. buildings) have higher priority, and others are updated on a need basis (e.g. land surveyor discovers an error in land cover data). Some data layers (e.g. roads, watercourses) are updated in cooperation with other organisations. Automatic solutions, including the use of artificial intelligence, have been tested but do not yet provide sufficient precision to be suitable for ETDB data production.

The national satellite data centre of Copernicus program (EstHUB) operates in the Land Board. At present, satellite imagery is not used for producing the national 3D model but could be prospective in the future. Considering the level of resolution achieved by AP, the use of satellite data for updating ETDB is feasible only when the state starts purchasing satellite images with resolution of 1 m pixel size or less.

ETDB is a 2.5D database, which means that spatial objects have elevation information (e.g. eave height of buildings), but not full 3D geometry (e.g. roof shape is missing). Stereophotogrammetry allows creating more complex geometries, but this would multiply the amount of manual work. Therefore, only 2.5D data are currently produced manually. When combined with other data sets (e.g. terrain model, ALS point cloud) it enables the production of 3D data automatically.

This process for 3D data production (models of buildings, constructions, terrain and vegetation) was created as a prototype in 2021. Modelling is performed automatically, but the detection of changes and subsequent update of the models is not fully automated. For instance, LOD1 (*Level of Detail*) models of buildings are updated continuously based on ETDB data whereas LOD2 models of buildings are updated annually, based on the data collected during the annual flight. Since 2022 the Land Board has been testing a drone and publishing the results in the 3D map application. Producing 3D data is a supplementary task that is done alongside the main responsibilities of the Land Board. Many 3D layers are available as open data but publishing them all would require additional funding.

For example, geological data are not disclosed in 3D format today. Changes in the rapidly evolving construction sector often receive the most attention. Before new infrastructure and houses can be established, adequate knowledge about the subsurface must be collected and analysed. Hence, 3D visualisation with advanced functionality is also in demand for the geological domain.

User needs for 3D data were collected in the form of interviews and focus groups with stakeholders. Interviews highlighted a common wish to get more frequently updated and more precise 3D data in the future. Additional expectations worth noting are the following:

- More comprehensive 3D data sets, e.g. number of storeys and entrances of buildings, restrictions extending to airspace, traffic signs, underground utility networks, etc.
- Better synergy and compatibility between databases
- 3D street view and interior views of buildings
- 3D models of buildings covered with photo textures
- Route calculation
- Additional formats for downloading 3D data
- 3D data accessible through services and APIs
- Historical 3D data

The broad adoption of 3D spatial data requires new distribution channels, more efficient cooperation between public authorities, transformation of workflows, testing and applying new technologies, and additional human and IT resources. The analysis identified the following needs for implementing the 3D transformation:

- The modernisation of AP and ALS equipment, as well as satellite navigation base stations for collecting more detailed and precise data. The upgrade is a prerequisite to begin producing frequently asked map products, such as true orthophotos and photo textures for building façades. Furthermore, the more detailed data and new products are needed to advance the usage of artificial intelligence in data production.
- Establishment of a 3D competence centre in the Land Board. There is a need for stronger cooperation among experts of spatial data across public sector. A cooperation project with common funding should be launched to create the national 3D model with high precision. This will create preconditions for continuously adding new 3D data into the national 3D model by any stakeholder, in order to keep the national 3D model up-to-date and to improve its precision. The competency centre is necessary to coordinate the building and enhancement of the 3D model by various institutions. Development of possibilities for common funding of data updates.
- The piloting of data collection alternatives to increase the resource efficiency of updating the 3D model. The possibilities of updating ETDB data by imagery from satellites or the stratosphere with sufficient precision should be researched and tested.
- Updates to the ETDB data model and improvement of work processes. Creation of standards and guidelines provide the basis for using and updating the 3D model by all interested parties. Implementing amendments in relevant legal acts.
- A state-controlled collection of engineering geological data, digitalisation of older geotechnical survey reports, generation and distribution of a geological 3D model.
- Increased technical capabilities for distributing the 3D model, including the readiness to incorporate 3D information from other institutions.
- Visualisation and delivery of 2D and 3D spatial data to end users together on one platform. The X-GIS map server currently used by Land Board has no 3D support. The new application should either be built from scratch or developed on top of the existing X-GIS interface by adding the 3D capabilities. In either case the new platform must ensure that all spatial data are up-to-date, service-based, available for all target groups, from a single source, and through a common user interface.