

## Sensor Description

SwissALTI3D is an extremely precise digital elevation model (DEM) of Switzerland created by Swisstopo, the Federal Office of Topography. A Digital Elevation Model (DEM) is a 3D representation of the Earth's bare surface, stripped of vegetation and buildings, expressed as a regularly spaced grid of elevation values. It represents Switzerland and Liechtenstein's surface without vegetation or development. It provides detailed topographical data used for 3D visualizations, mapping, and planning in fields like telecommunications and natural hazards. The model is updated every six years, incorporating data from aerial images and LiDAR (Light Detection and Ranging).

- **Acquisition:** Mainly airborne LiDAR below 2000 m, stereo photogrammetry at higher altitudes.
- **Resolution:** 0.5 m (urban/lowland areas) to 2 m (mountain areas).
- **Vertical accuracy:**  $\pm 0.5$  m (non-vegetated) and slightly lower under vegetation or photogrammetric zones.
- **Coverage:** Entire Switzerland + Liechtenstein.
- **Update cycle:** Approximately every 6 years.

Its main limitations lie in reduced accuracy in high-alpine areas (due to steep slopes, snow cover, and reduced photogrammetric reliability) and in dense forests (where vegetation canopy can occlude LiDAR ground returns)

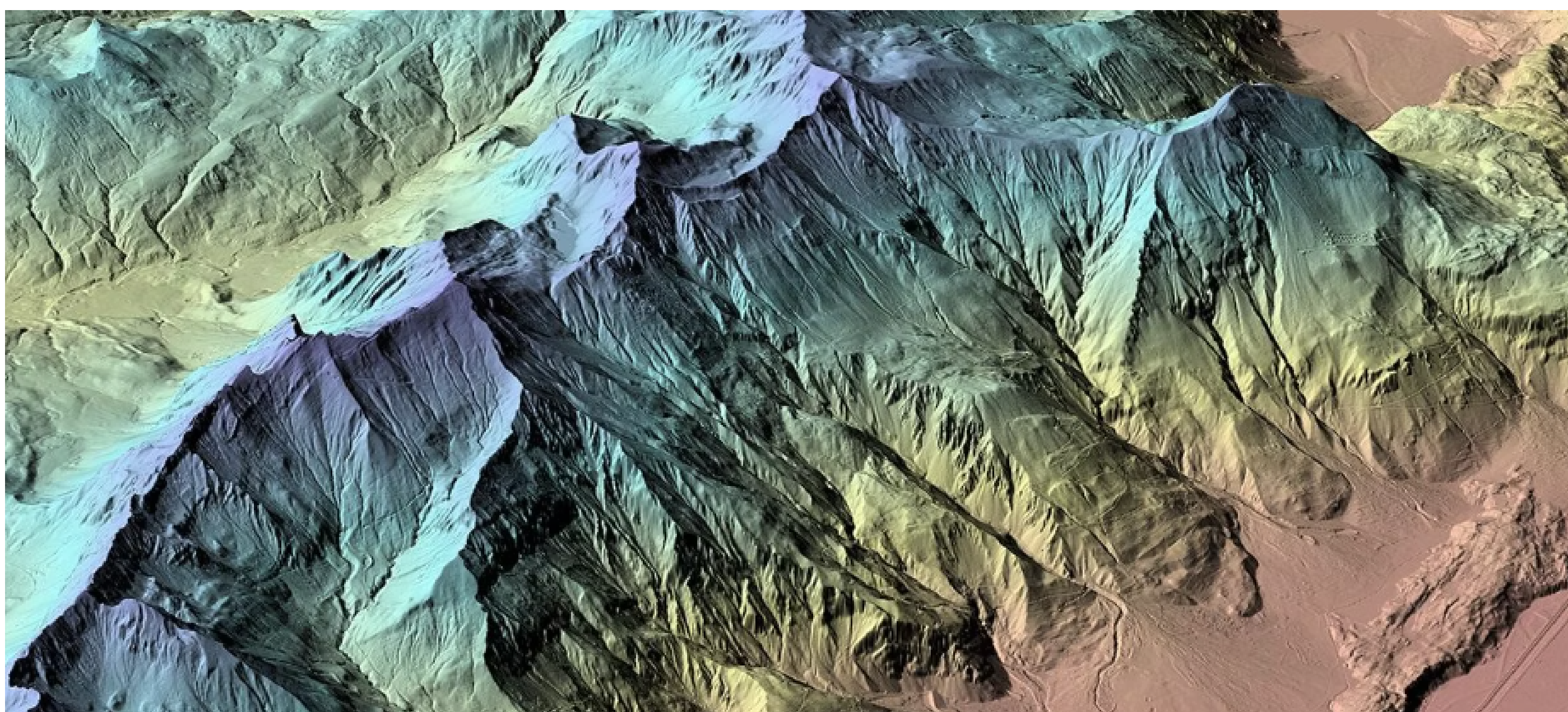


Figure 1. Example of SwissALTI3D hillshade visualization.

## Different Applications

- ⇒ **Change detection:** Monitoring of surface changes, glacier retreat, landslides.
- ⇒ **Hydrological modelling:** Watershed delineation, flood risk, drainage analysis.
- ⇒ **Soil agriculture:** Subsidence detection in the Three Lakes region.
- ⇒ **Forestry archaeology:** Identifying ditches, ancient roads, or buried structures.
- ⇒ **Ortho-Rectification:** Provides an accurate basis to correct image distortion in ariel and satellite photographs.

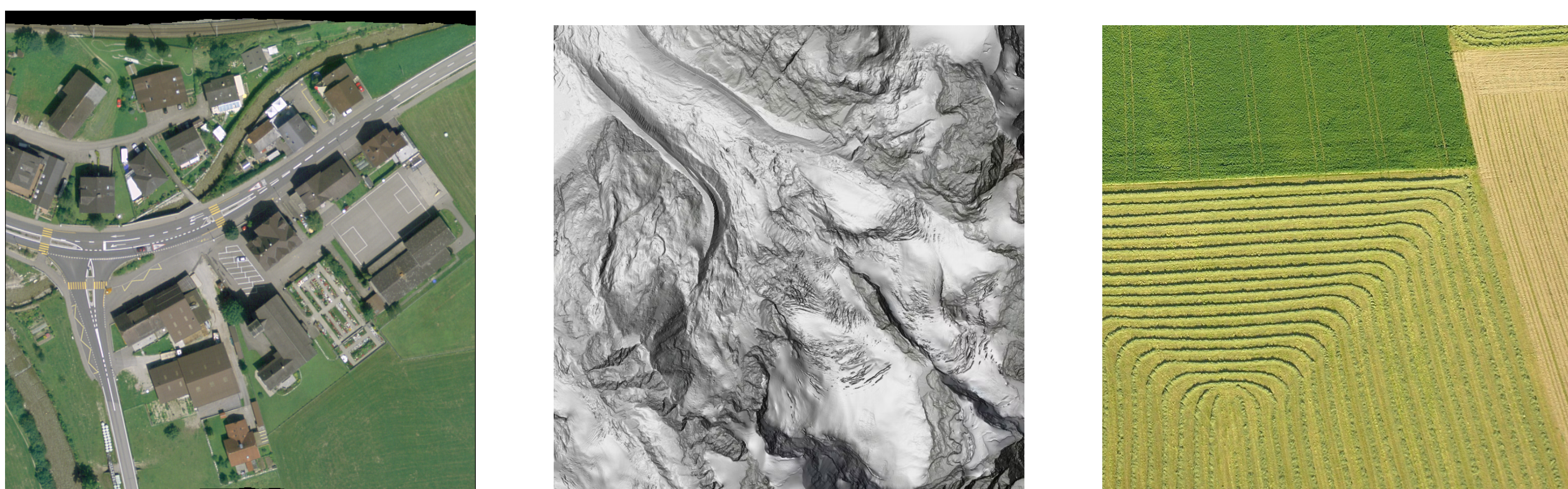


Figure 2. Examples of SwissALTI3D images

## Examples

- National-scale study of decadal surface displacement using SwissALTI3D R13 vs R19.<sup>[2]</sup>
- "Ditch mapping for Switzerland" project using 0.5 m resolution DTM for water management.<sup>[4]</sup>
- Used to discover a Roman camp in the Colm la Runga area through microtopography.<sup>[5]</sup>
- Provided the terrain model used by architects in ETH Zurich to simulate the effects of urban heat islands.<sup>[6]</sup>

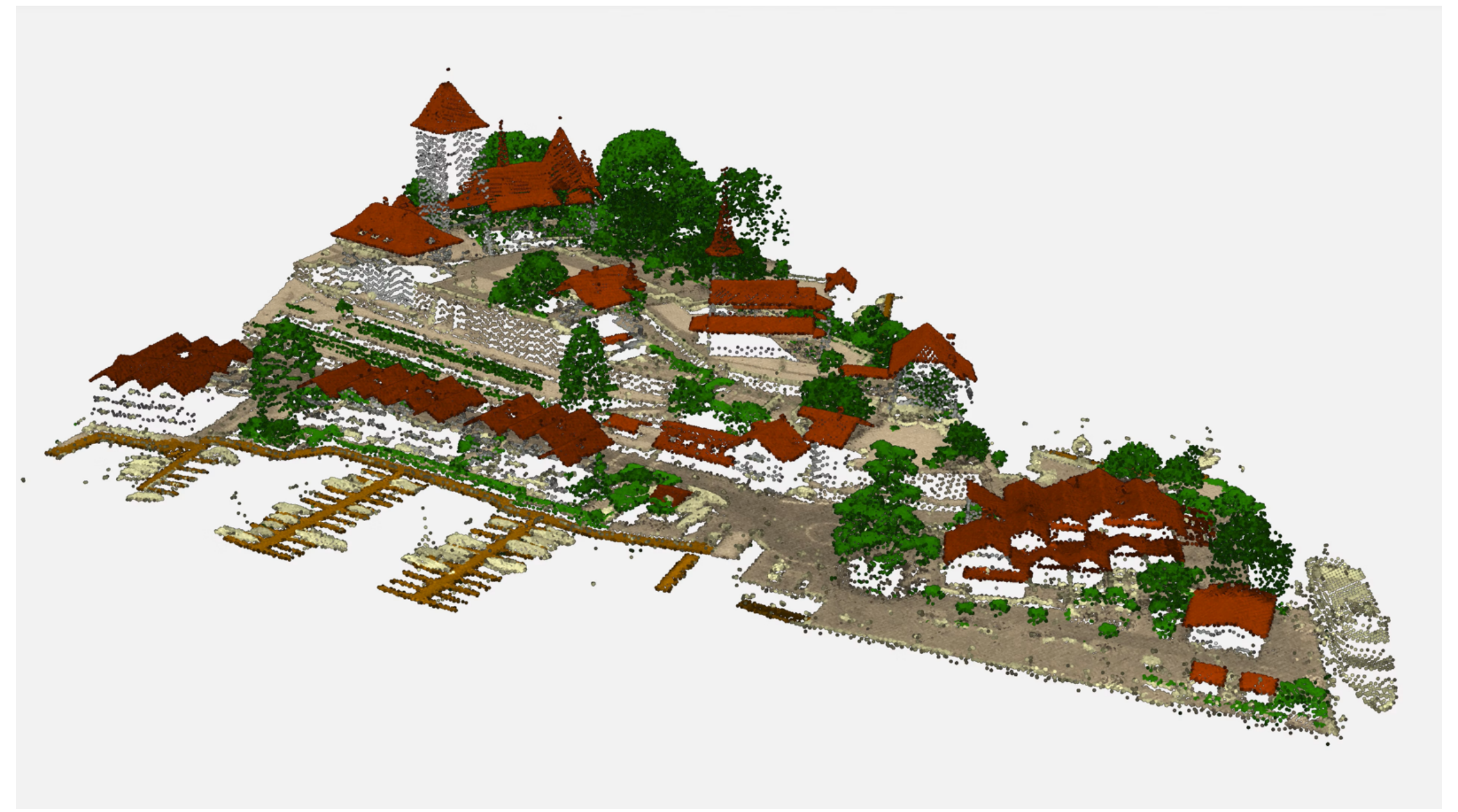


Figure 3. Example of LiDAR mapping at Spiez Castle

## Specificity of the Sensor for DEM application

SwissALTI3D offers unique advantages as a Digital Elevation Model (DEM) for Earth observation and environmental analysis. Its key strengths include:

- **High spatial resolution** allowing small geomorphological features to be detected.
- **Nationwide coverage:** Homogeneous, high-quality data across all of Switzerland and Liechtenstein.
- **High-resolution input:** Airborne LiDAR with point densities of several pts/m<sup>2</sup> enables detailed bare-earth DEMs.
- **Vegetation building filtering:** Produces a true Digital Terrain Model (DTM) ideal for hydrology and geomorphology.
- **High spatial resolution:** 0.5-2 m grid suitable for local studies, microtopography, and infrastructure planning.
- **Vertical accuracy:** Approximately  $\pm 0.5$  m in open areas — crucial for precise volume change and flood modelling.
- **Regular updates:**  $\approx$  every 6 years, allowing multi-temporal change detection.
- **Open access:** Freely available via opendata.swiss, easy to integrate in research and industry workflows.
- **Excellent performance in mountains:** Captures steep slopes and narrow valleys better than global satellite DEMs.

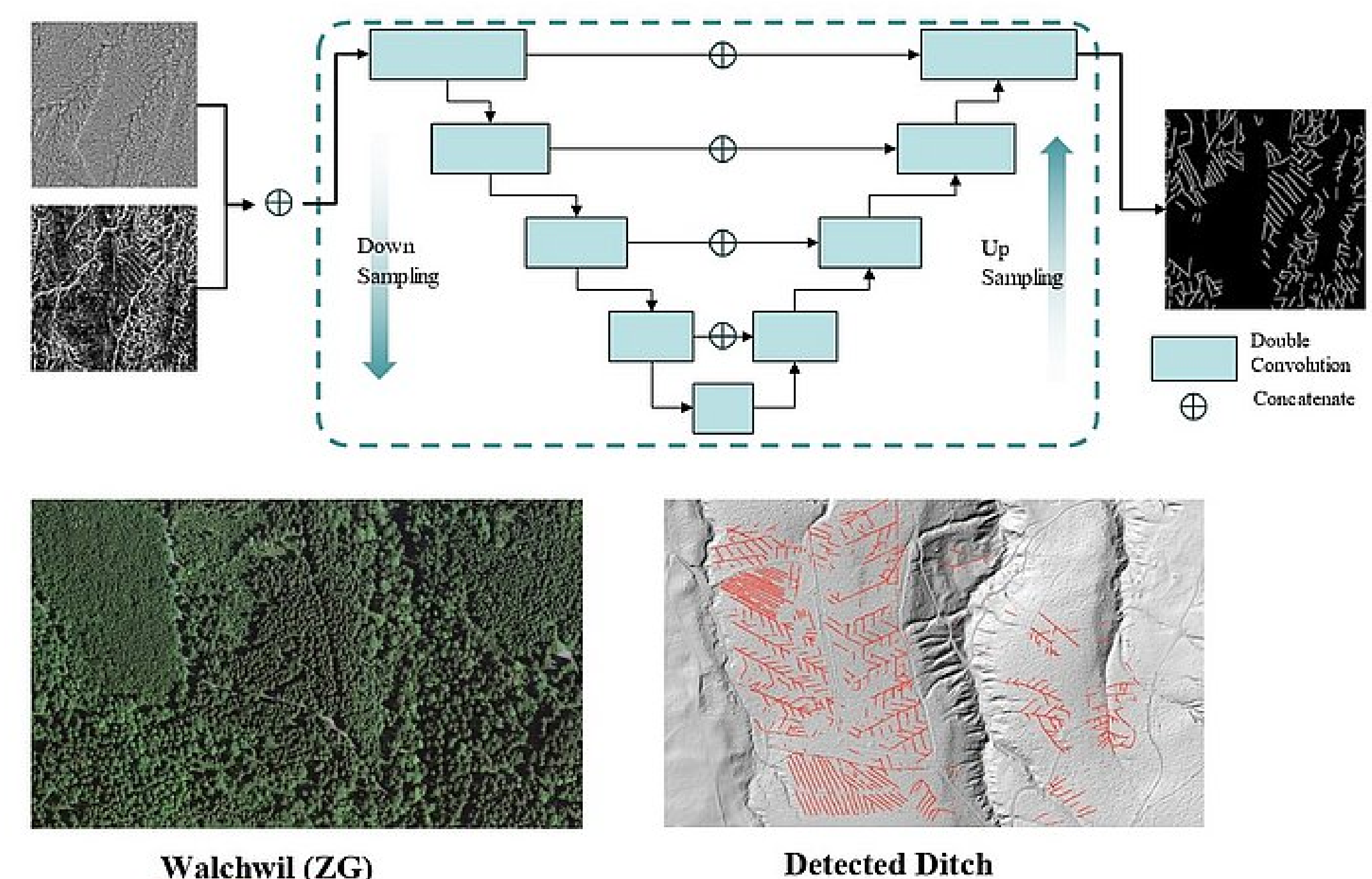


Figure 4. Ditch detection using SwissALTI3D DEM data

## Conclusion

SwissALTI3D provides one of the most detailed and accurate national-scale DEMs worldwide. Its combination of sub-meter resolution, high vertical accuracy, and consistent nationwide coverage makes it an indispensable dataset for terrain analysis, natural hazard modelling, infrastructure planning, and scientific research. Regular updates and open access ensure it remains relevant for monitoring long-term environmental change, from glacier retreat to urban development. SwissALTI3D sets a benchmark for DEM quality at the national level.

## References

1. Swisstopo: SwissALTI3D product page (2023)
2. Bühler et al. (2022), "Decadal Surface Changes and Displacements Based on SwissALTI3D". *Journal of Geomatics*.
3. Opendata.swiss: SwissALTI3D dataset metadata.
4. Forest archaeology with LiDAR: Opitz Cowley (2013) *Interpreting Archaeological Topography: Airborne Laser Scanning, 3D Data and Ground Observation*.
5. Hafner, A., Suter, P. (2020). Discovering Roman camps in the Swiss Alps using high-resolution LiDAR data. *Archaeological Prospection*, 27(3), 235-248.
6. Urban heat island studies: Schmid et al. (2021) SwissALTI3D for urban climate modelling.