Data for Improving Stream Network Accuracy with Deep Learning-Enhanced Detection of Road Culverts in High-Resolution Digital Elevation Models

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Citation

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Creator/Principal investigator(s)

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Principal's reference number

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Description

This is the training and testing data used to train a Residual Attention UNet for segmentation and detection of road culverts. The data consists of pairs of images with the size 256x256 pixels where one image is a labeled mask and the other a image with four channels containing the remote sensing data. The remote sensing data is a combination of topographical data extracted from arial laser scanning and ortophotos from arial imagery.

An extensive culvert survey was conducted in 25 watersheds in central Sweden by the Swedish Forest Agency during the snow-free periods of 2014–2017. A total of 24,083 culverts were mapped with a handheld GPS with a horizontal accuracy of 0.3 m. Densely populated urban areas with underground drainage systems were excluded from the survey (0.3% of the combined area). The coordinates of both ends of each culvert were measured, and metrics such as diameter, length, material, working condition, and sediment accumulation were collected for most of the culverts. Additional metrics, such as the elevation difference between the outlet and stream water level, were manually measured with a ruler. The inventoried watersheds were split up into training and testing data, where 20 watersheds (23,304 culverts) were used for training, and five watersheds (5,208 culverts) were used for testing.

A compact laser-based system (Leica ALS80-HP-8236) was used to collect the ALS data from an aircraft flying at 2888–3000 m. The ALS point clouds had a point density of 1–2 points m-2 and were divided into tiles with a size of 2.5 x 2.5 km each. A DEM with 0.5 m resolution was created from the ALS point clouds using a TIN gridding approach implemented in Whitebox tools 2.2.0. The

topographical index max downslope elevation change was calculated from the DEM using Whitebox Tools . Max downslope elevation change represents the maximum elevation drop between each grid cell and its neighbouring cells within a DEM. This typically resulted in values between 0 and 10.

Orthophotos from aerial imagery captured at the same time as the lidar data is also included. The orthophotos had three bands (red, green and blue) in 8-bit color depth and had a resolution of 0.5 m. The LiDAR data and orthophotos were downloaded from the Swedish mapping, cadastral and land registration authority.

The topographical data and the ortophotos were merged into 8-bit four band images where the first three band is red, green and blue, and the last band is max downslope elevation change. The merged images where then split into smaller tiles with the size 256x256 pixels.

The trained model was used to predict culverts in Sweden and the file PredictedCulvertsByIsobasins.zip contains the predicted culverts stored as shapefiles split by the watersheds in the file "isobasins.zip".

Data contains personal data

No

Language

<u>English</u>

Time period(s) investigated 2022-01-01 – 2024-12-31

Variables

1

Data format / data structure

Still image

<u>Geospatial</u>

Software

Geographic spread

Geographic location: <u>Sweden</u> Geographic description: Most of Sweden except the mountain chain.

Responsible department/unit

Forest Ecology and Management

Funding 1

- Funding agency: Kempe Foundation
- Project name on the application: Future maps for klimate adapted forestry

Funding 2

• Funding agency: Marcus and Amalia Wallenberg Foundation

- Project name on the application: Challenges and Social Consequences of Artificial Intelligence in Swedish Forests
- Funding information: This work was partially supported by the Wallenberg AI, Autonomous Systems and Software Program Humanities and Society (WASP-HS) funded by the Marianne and Marcus Wallenberg Foundation, the Marcus and Amalia Wallenberg Foundation.

Research area

Earth and related environmental sciences (Standard för svensk indelning av forskningsämnen 2011) Environmental sciences (Standard för svensk indelning av forskningsämnen 2011) Computer and information science (Standard för svensk indelning av forskningsämnen 2011) Infrastructure engineering (Standard för svensk indelning av forskningsämnen 2011) Transport systems and logistics (Standard för svensk indelning av forskningsämnen 2011) Water engineering (Standard för svensk indelning av forskningsämnen 2011) Remote sensing (Standard för svensk indelning av forskningsämnen 2011) Planning / cadastre (INSPIRE topic categories) Geoscientific information (INSPIRE topic categories) Environment (INSPIRE topic categories) Transportation (INSPIRE topic categories)

Keywords

Infrastructure, Rivers/streams, Brook, Infrastructure, Watercourse, Infrastructure, Transport networks, Machine learning, Lidar, Road culvert, Laser scanning

Publications

Lidberg W. 2025. Deep learning-enhanced detection of road culverts in high-resolution digital elevation models: Improving stream network accuracy in Sweden. Journal of Hydrology: Regional Studies. V 57, 102148. <u>https://doi.org/10.1016/j.ejrh.2024.102148</u> **DOI:** <u>https://doi.org/10.1016/j.ejrh.2024.102148</u>

Polygon (Lon/Lat)

20.681763, 57.963689 20.360413, 59.075507 19.34967, 59.989028 18.998108, 60.469065 18.6026, 61.218371 19.042053, 62.073991 21.283264, 63.656926 22.513733, 64.464211 23.788147, 65.541123 23.919983, 66.045633 23.788147, 66.417572 23.656311, 68.147799 22.07428, 68.456489 19.173889, 68.049447 16.976624, 65.812625 16.625061, 65.026655 15.658264, 64.140268 14.208069, 63.967223 12.801819, 63.947929 12.142639, 63.520093 12.156372, 62.816901 12.156372, 62.290281 12.420044, 61.166424 12.244263, 60.696712 11.980591, 59.780596 10.574341, 58.426887 12.332153, 56.000685 13.035278, 55.055562 16.199341, 54.701614 20.681763, 57.963689

Accessibility level

Access to data through SND Data are freely accessible

Use of data

Things to consider when using data shared through SND

License

<u>CC0 1.0</u>

Versions Version 1. 2025-02-25

Contacts for questions about the data

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Download metadata

DataCite DDI 2.5 DDI 3.3 DCAT-AP-SE 2.0 JSON-LD PDF Citation (CSL)

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