Interreg
Danube Region

Co-funded by
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GeoNetSee

Development and validation of data models and AI algorithms for real-time facility monitoring and early risk forecasting

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MoDrone

January, 2026 **Podgorica, MonteNegro**

Application of AIoT in systems for predicting and managing natural and man-made disasters

NAJNOVIJE VIJESTI Forbes BLISKI ISTOK SPORT Fantasy SVIJET MAGAZIN ZDRAVLJE ••• N1 TV

CURINE NJIVE

34 pronađeni rezultati

Vlada zadužila Nikšića da Vladi RS uputi pismo s oznakom "vrlo hitno"

VIJESTI | 04. apr 2025 | 0

Zubić o Curinim njivama: Kriv je čovjek, ne kiša

VIJESTI | 01. apr 2025 | 0

Na dijelu lokaliteta 'Curine njive' konstantan priliv vode stvara plavnu livadu

VIJESTI | 29. mar 2025 | 0

Alarmantno na Trebeviću, Škaljić tvrdi: Treba mnogo novca za sanaciju

VIJESTI | 28. mar 2025 | 0

Na Curinim njivama haos: "Svaku noć ide dova – amin da nas profuli..."

VIJESTI | 28. mar 2025 | 0

Gradonačelnik Sarajeva obišao klizište na Curinim njivama: Situacija

VIJESTI | 28. mar 2025 | 0

Pogled iz zraka na Curine njive: Mnogo pukotina i vode, klizište nadomak kuća

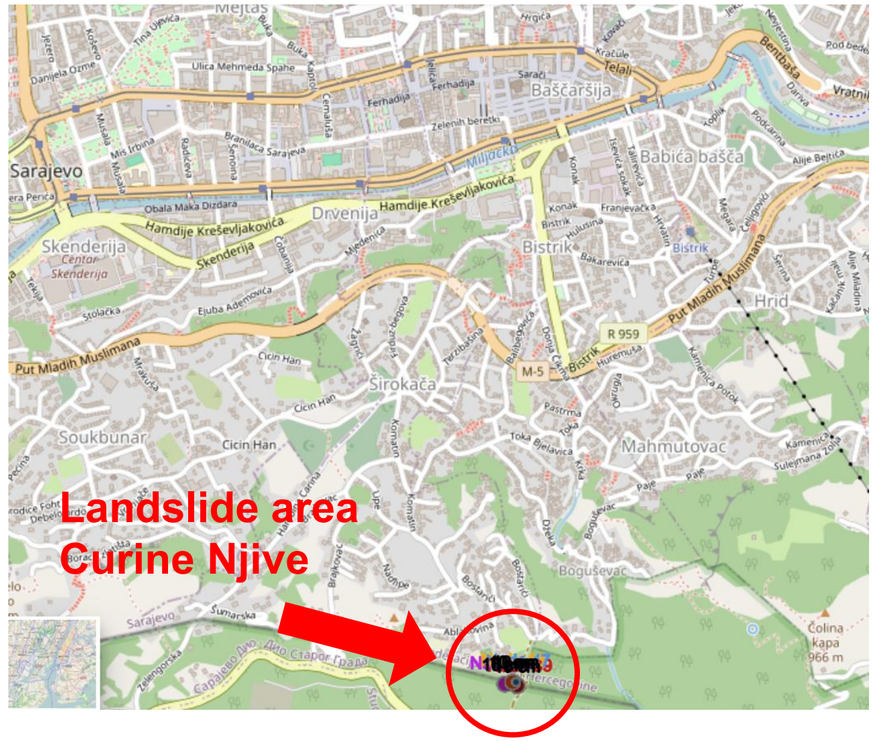
VIJESTI | 27. mar 2025 | 0

Na Širokači bolja situacija, a na Curinim njivama zabilježeno novo klizanje tla

VIJESTI | 27. mar 2025 | 0

Pilot landslide area – Curine Njive

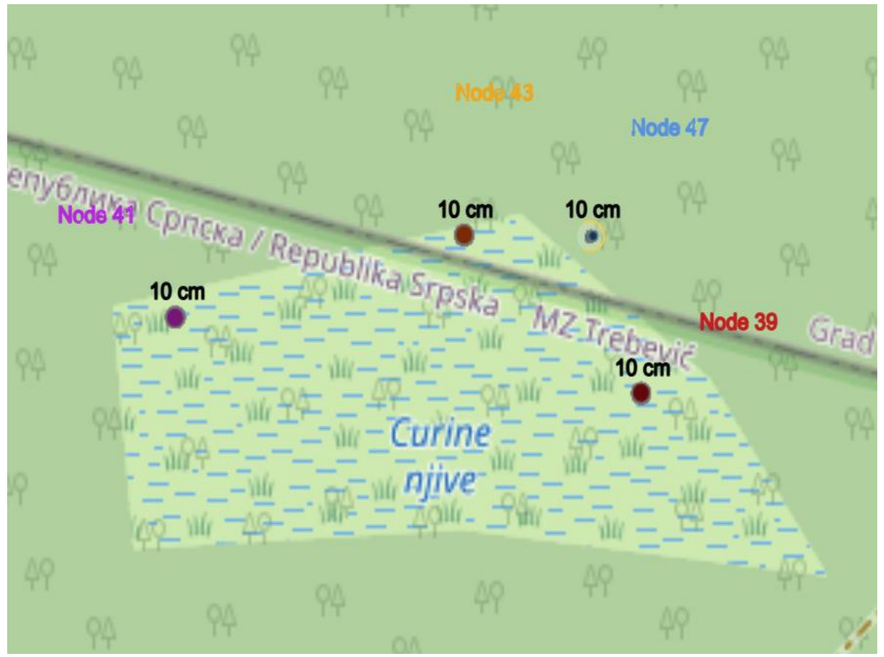
- Due to heavy rainfall at the beginning 2025, there is a risk of landslides on the slopes of Trebević above Sarajevo.
- The worst situation is at the Curine njive site.
- A landslide is currently threatening more than 250 houses in the Sarajevo neighborhood of Bistrik.
- Cantonal Civil Protection Department warned that part of the terrain is gradually moving towards the first houses, and that preparations are underway for the possible relocation of the population to safer facilities.



Dataset - Collecting

High-precision GNSS sensors

- In May 2025, inclinometers were installed and geodetic measurements were carried out for landslide monitoring.
- In place of inclinometers (within the active landslide zone), we installed 4 high-precision GNSS sensors (nodes 39, 41, 43, 47) that enable continuous monitoring of ground movements.
- One reference station was installed outside the landslide zone as a stable base.
- The sensors support the RTK method, multi-frequency reception (L1/L2/L5) with multiple GNSS constellations (GPS, GLONASS, Galileo, BeiDou), which ensures centimeter accuracy in all conditions.
- The sensors have autonomous power supply (solar panels with larger capacity batteries) and protection from atmospheric influences, since they are located in the field for a long time (7 months of continuous operation).



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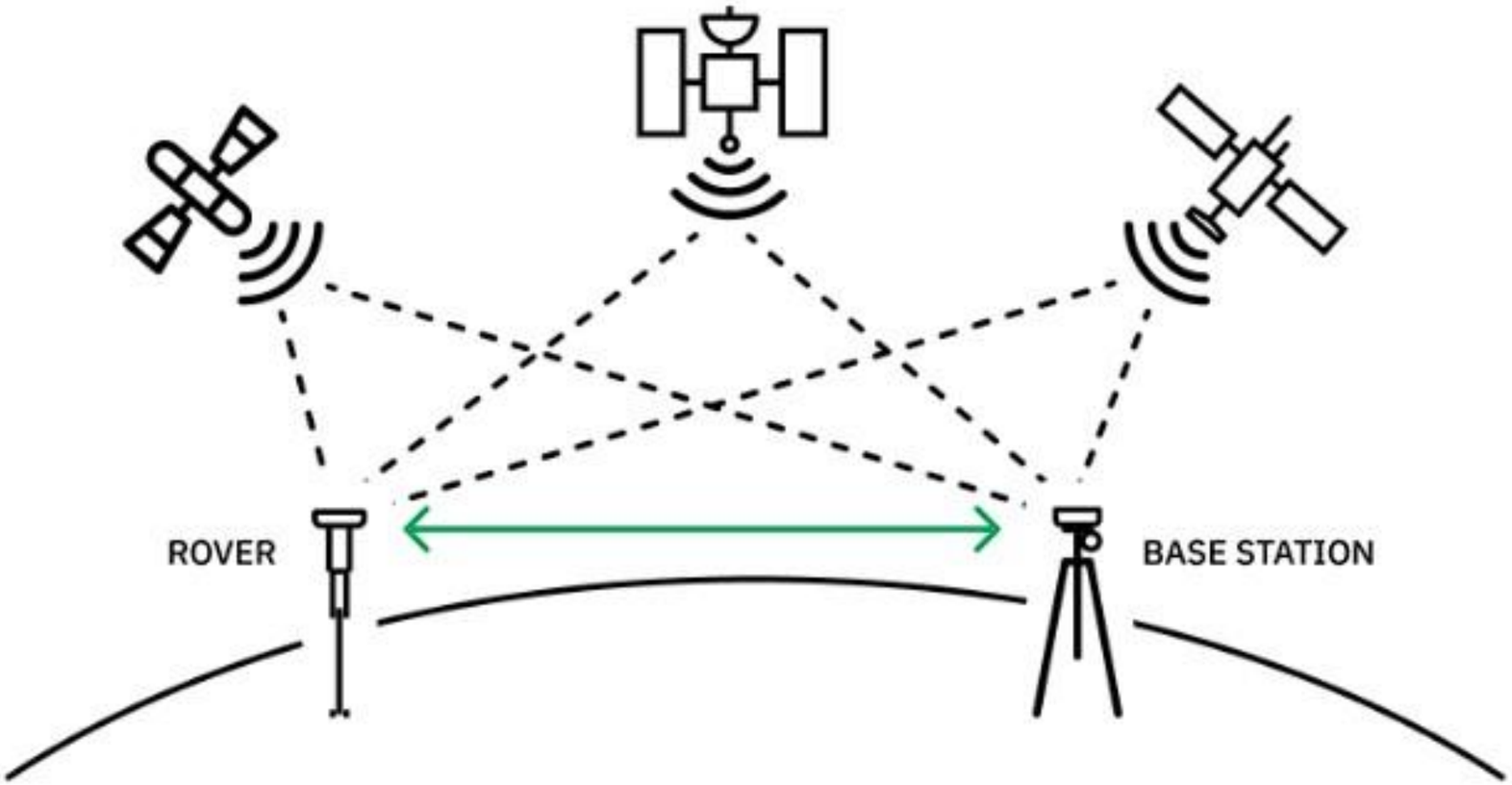
Real-Time Kinematic (RTK) is a technique used to enhance the accuracy of Global Navigation Satellite System (GNSS) positioning, achieving centimeter-level precision. It works by utilizing a base station with known coordinates and a rover receiver that needs precise positioning.



Dataset - Collecting

Real-time data transmission

- Data from sensor nodes is transmitted in real time to a central server.
- Reliable communication is provided, via a mobile network (4G), with an alternative transmission channel via radio modem (LoRa).
- The NTRIP protocol is used to obtain corrections from reference stations and send data for processing.

Referent station

Sensor node

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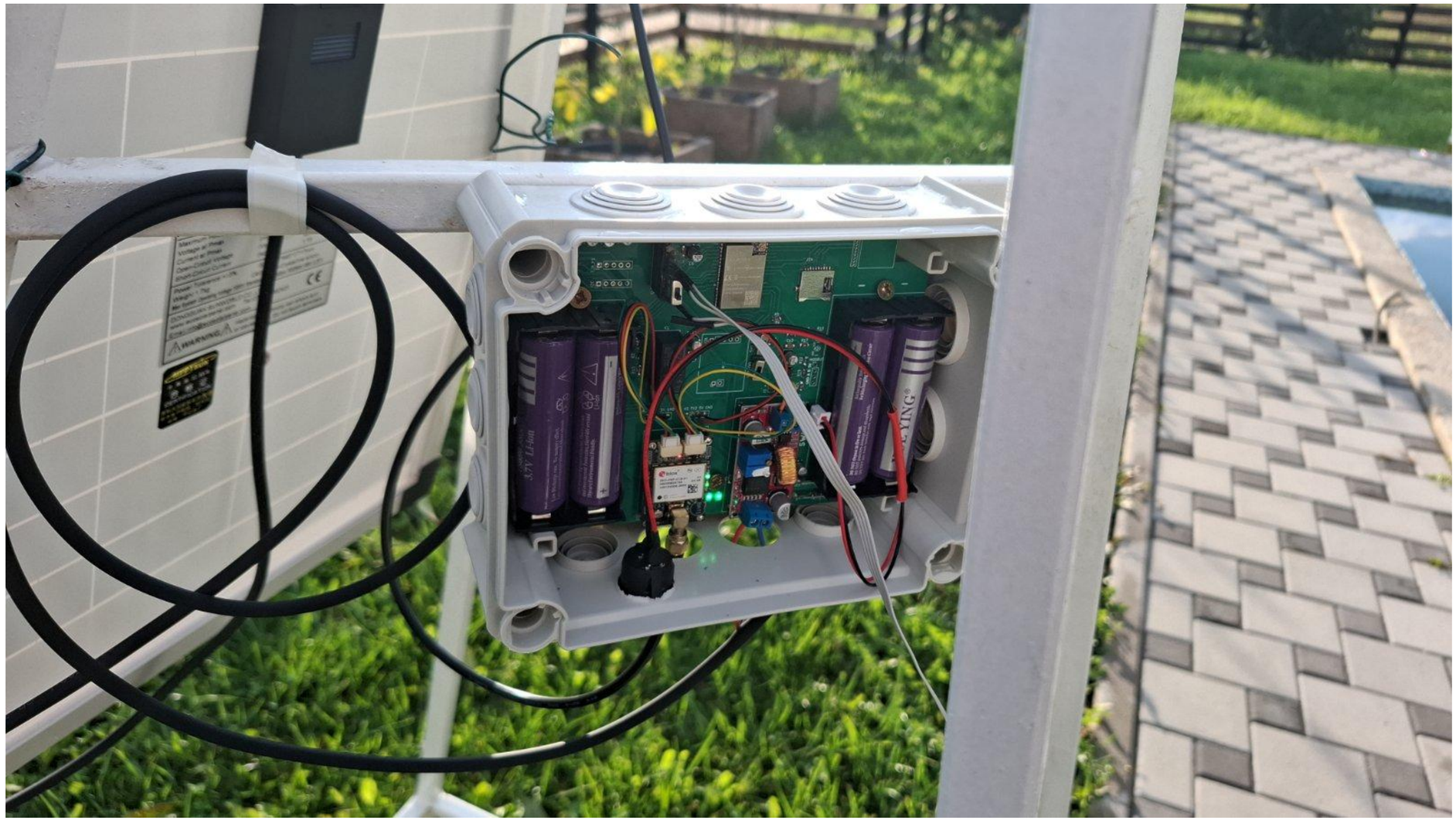
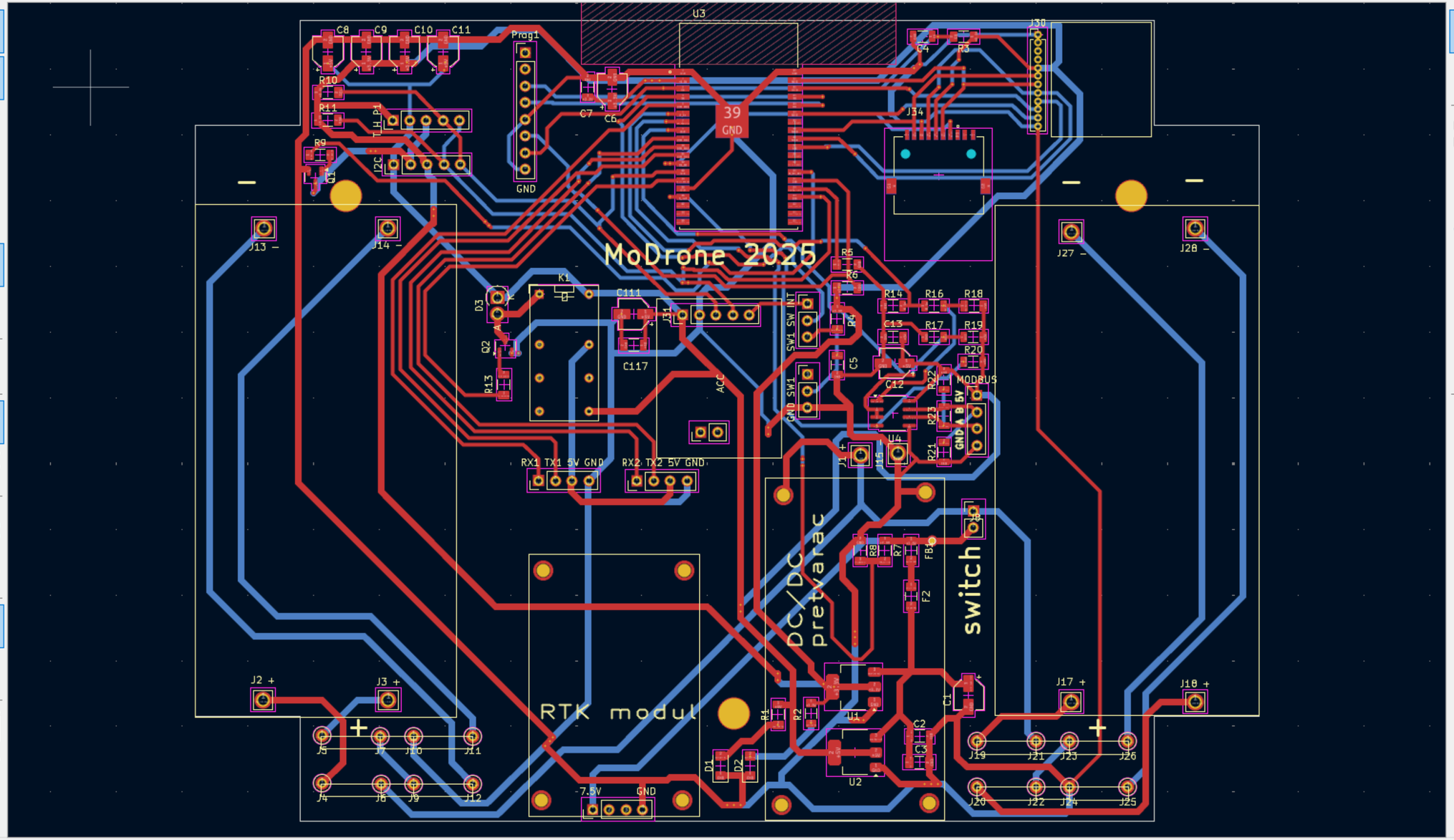


ESP32_DB_T_P_H — PCB Editor

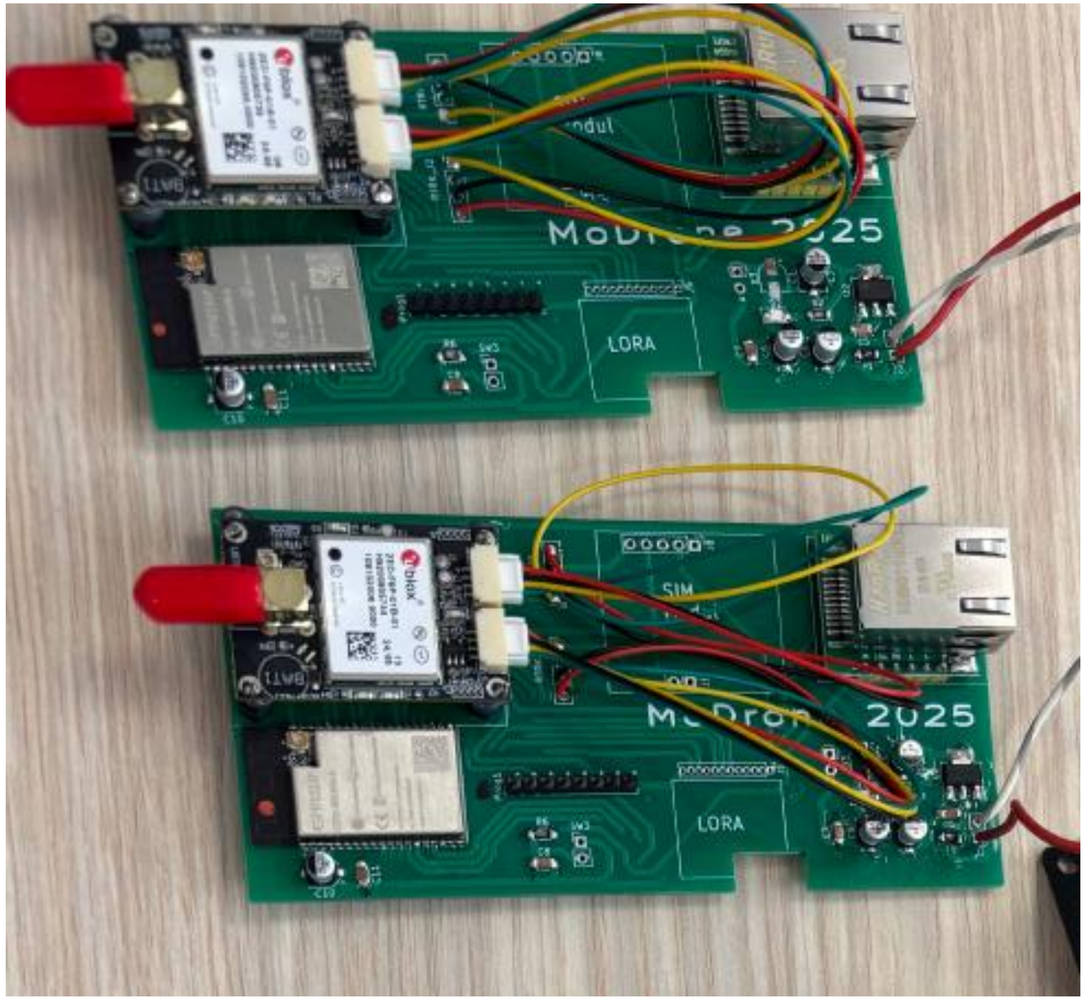
File Edit View Place Route Inspect Tools Preferences Help

Track: use netclass width | Via: use netclass sizes | F.Silkscreen | 0.0100 mm (0.0004 in) | Zoom 2.20



Pads	Vias	Track Segments	Nets	Unrouted
252	123	1000	73	2

Base/Permanent station



Hum na Sutli Croatia

Curine njive

Tuzla

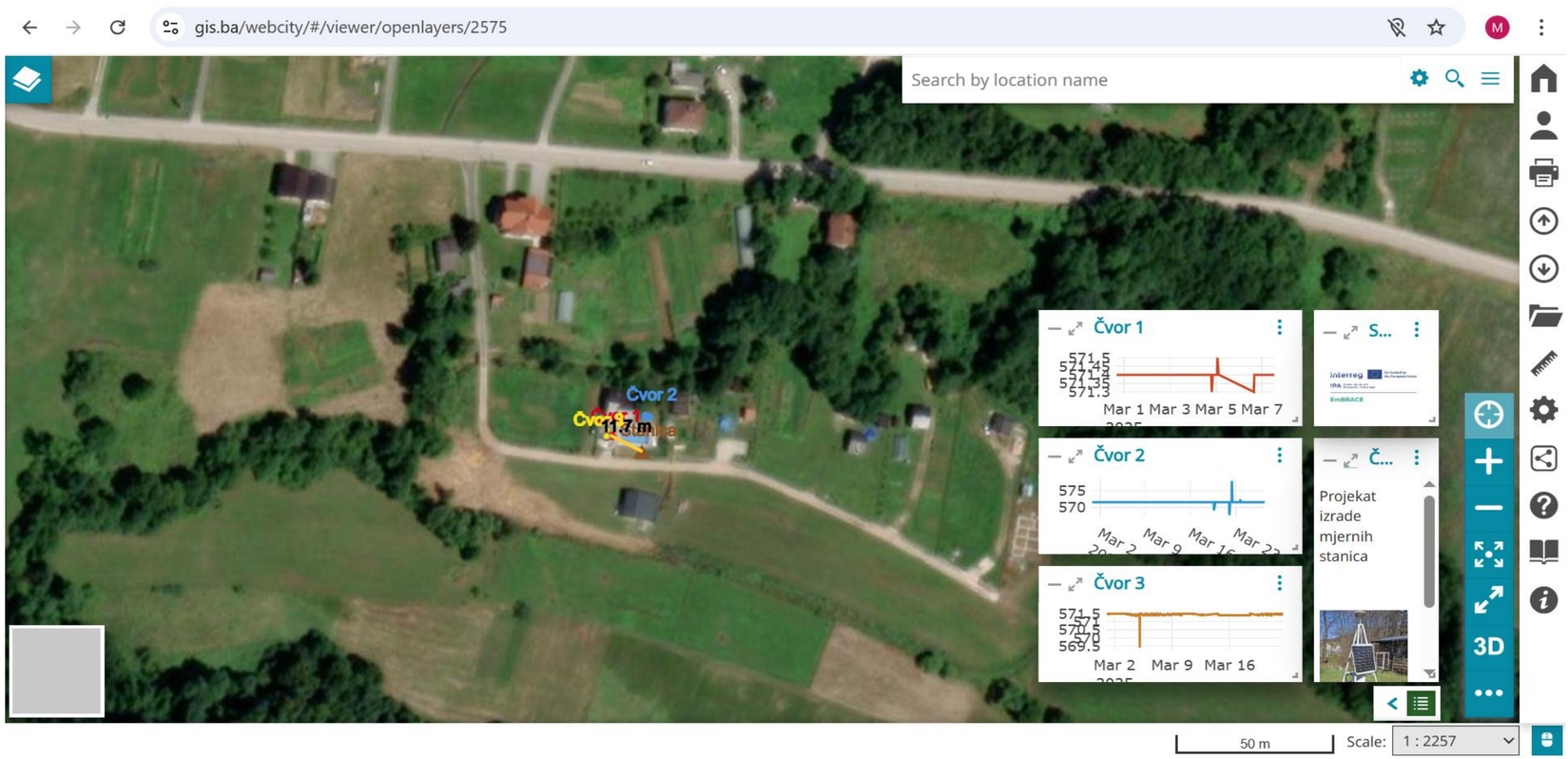

Stanica 3
Stanica 7
Stanica 4 Bazna
Stanica 6
Stanica 1
Stanica 2

Ratac (Montenegro)

Dataset - Collecting

GIS integration for spatial analysis and visualization

- All data – GNSS sensor positions, XYH displacements, meteorological data – are unified in a centralized GIS enabling spatial analysis, visualization and report generation.
- It supports automatic data entry, display of direction and intensity of displacement, as well as alarms that are activated in case of exceeding defined thresholds.
- Web-GIS interface for real-time data access for different user levels.



Dataset - Collecting

Landslide displacement analysis and report generation

- The system enables automatic processing of collected GNSS data.
- It is possible to filter data, compare with historical series, and export results in standard formats (CSV, SHP, PDF).
- Based on the data, daily, weekly and monthly reports can be generated, including visual representations of shifts, warnings and recommendations for further action.

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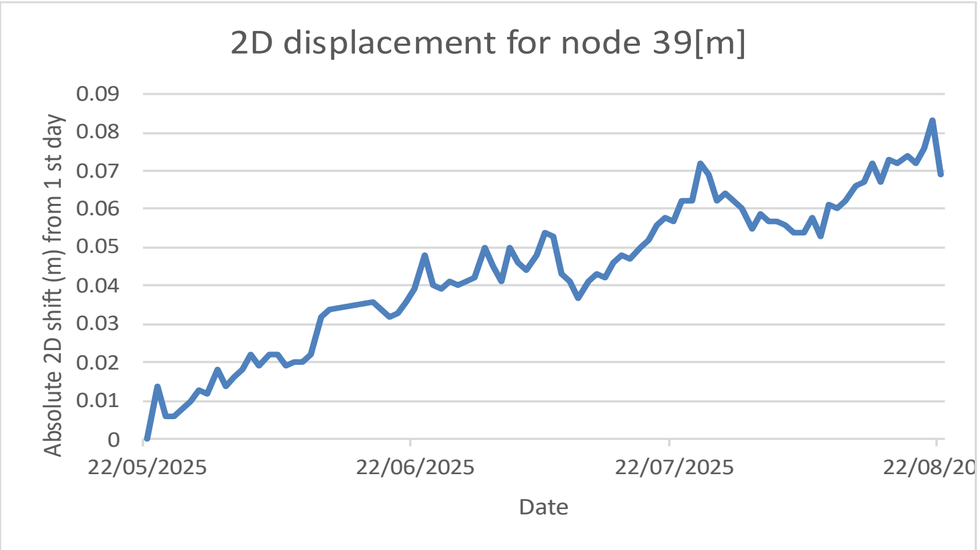
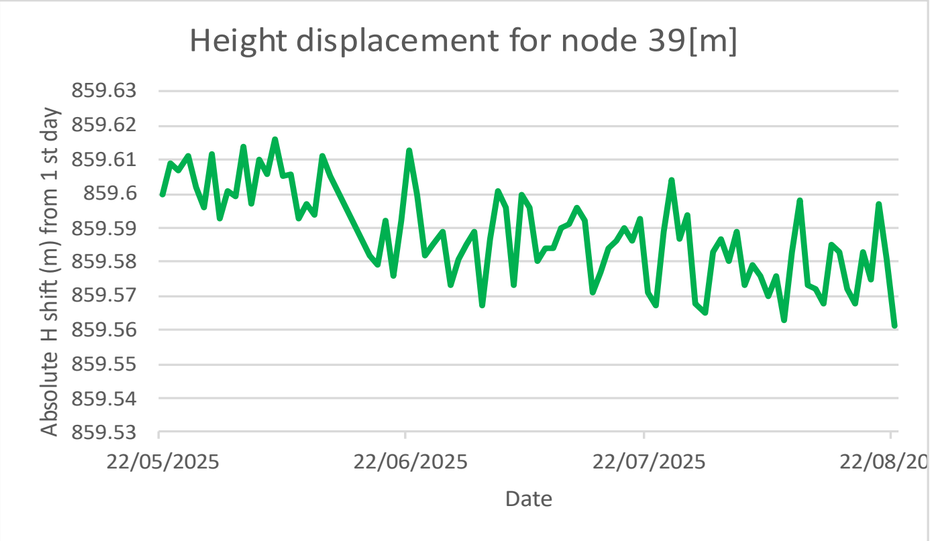
Dataset - Collecting

Presentation of collected and processed data – tables and diagrams

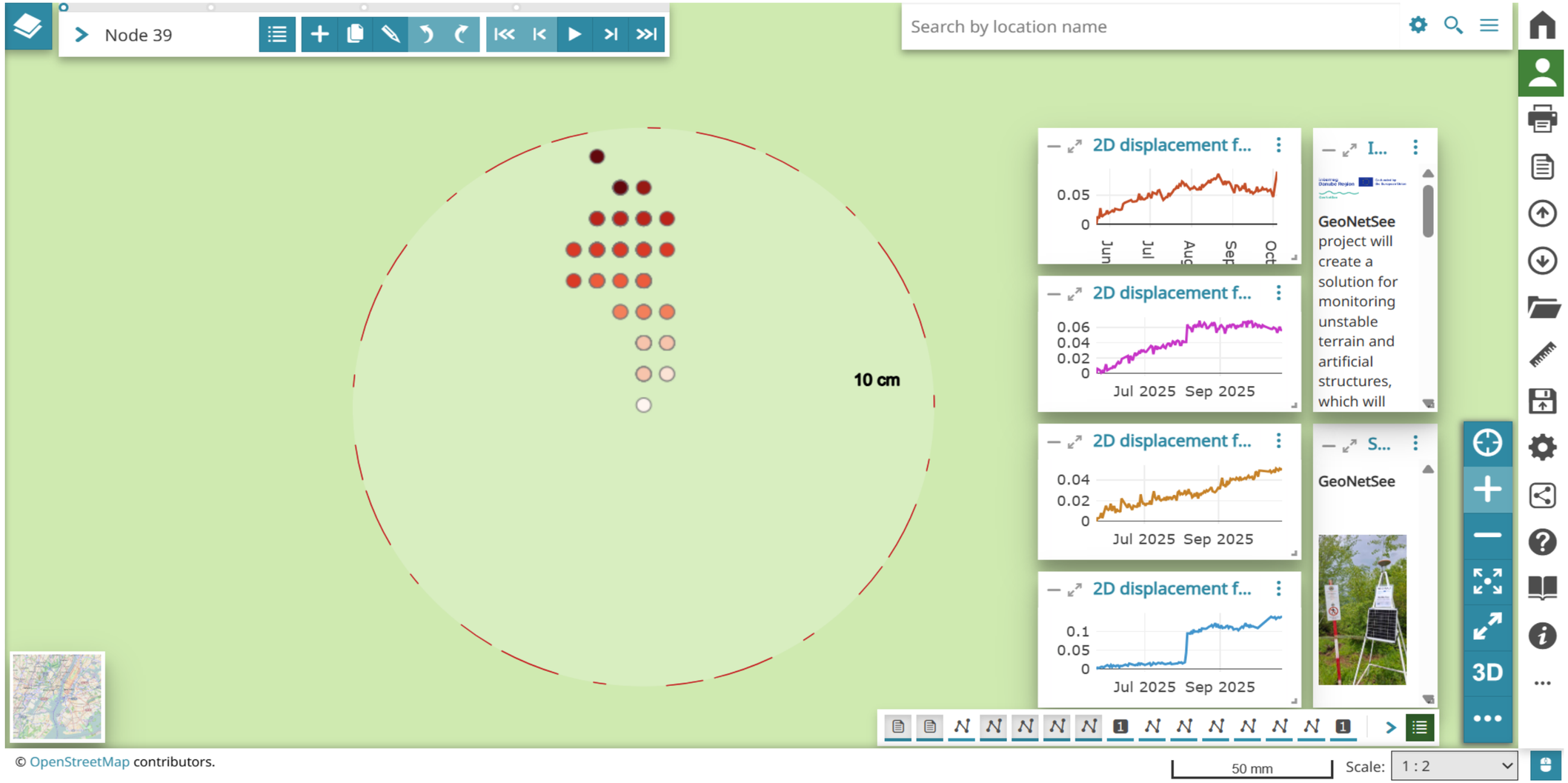
Node	Date	E	N	H	E-shiftDaily	N-shiftDaily	H-shiftDaily	2D-shiftDaily	E-shift	N-shift	H-shift	2D-shift
gps_mjere	22/05/2025	43.84403	18.42906	859.6					0	0	0	0
gps_mjere	23/05/2025	43.84403	18.42906	859.609	0.011	0.008	0.009	0.014	0.011	0.008	0.009	0.014
gps_mjere	24/05/2025	43.84403	18.42906	859.607	-0.013	-0.002	-0.002	0.013	-0.002	0.006	0.007	0.006
gps_mjere	25/05/2025	43.84403	18.42906	859.611	0	0	0.004	0	-0.002	0.006	0.011	0.006
gps_mjere	26/05/2025	43.84403	18.42906	859.602	0.004	0.002	-0.009	0.004	0.002	0.008	0.002	0.008
gps_mjere	27/05/2025	43.84403	18.42906	859.596	0	0.002	-0.006	0.002	0.002	0.01	-0.004	0.01
gps_mjere	28/05/2025	43.84403	18.42906	859.612	0.003	0.002	0.016	0.004	0.005	0.012	0.012	0.013
gps_mjere	29/05/2025	43.84403	18.42906	859.593	-0.008	0	-0.019	0.008	-0.003	0.012	-0.007	0.012
gps_mjere	30/05/2025	43.84403	18.42906	859.601	0.006	0.006	0.008	0.008	0.002	0.018	0.001	0.018





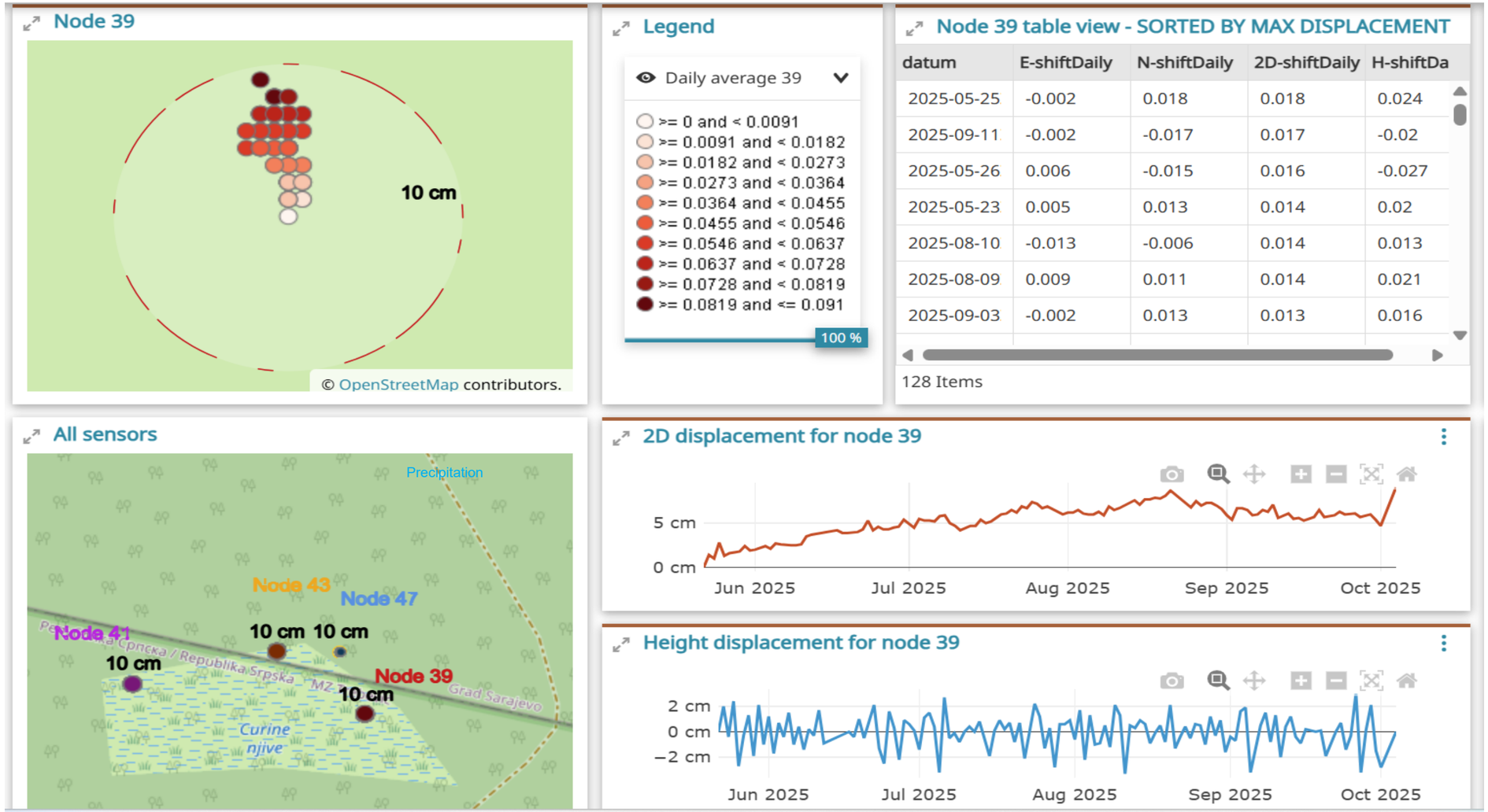
Dataset - Collecting

DCC platform – presentation of landslide displacement

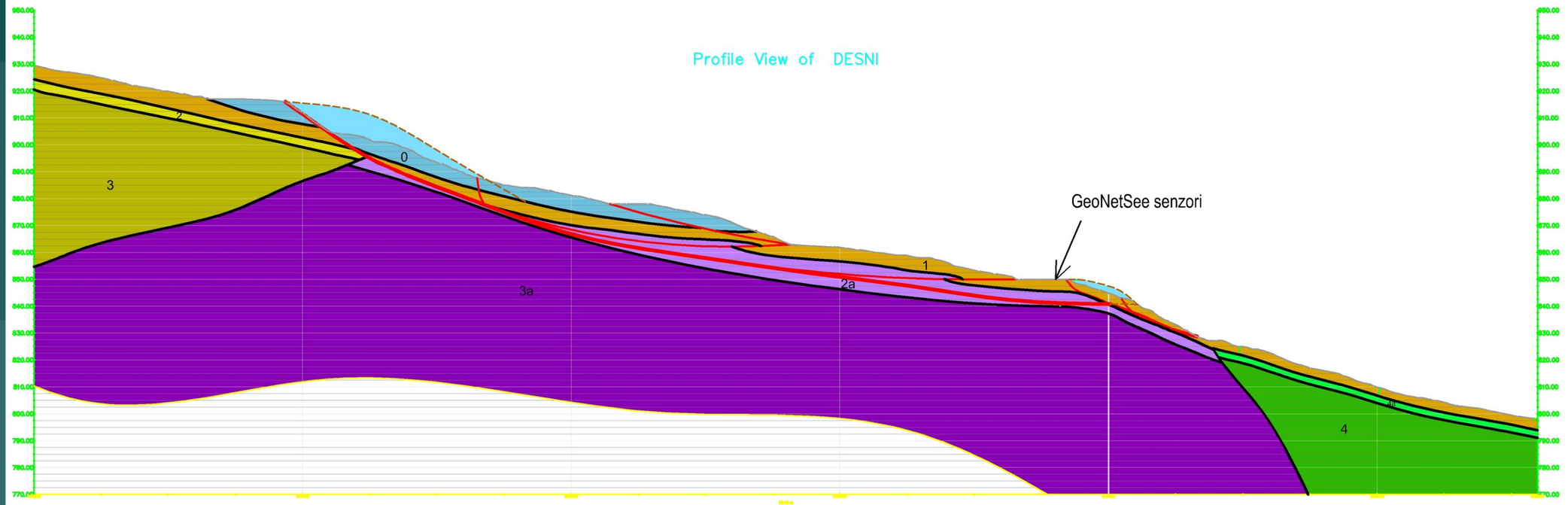


Dataset - Collecting

DCC platform – presentation of landslide displacement



Curine njive



Dataset - Processing

1. Sensor data from 4 nodes obtained from the developed GNSS sensors installed on the Pilot Location Curine Njive, BiH (**22nd May – 4th October**) – **approximately 4 Months period.**

2. Around 50 sensor readings daily per each node (**every 30 min**).

3. Daily Outlier removal is performed separately for each node.

4. Daily 2D displacements for each node are calculated.

5. Daily Height displacements for each node are calculated.

6. Data is averaged for every 24 hours.

Time Series Prediction Model Development

- 127 daily recording (22nd May – 4th Oct) of high accuracy for 2D and height displacement are used as data.

- Three consecutive months are used for training (97 recordings).

- The remaining month (30 points) is used for testing.

- Forecast algorithms also provide estimates for the coming 5th month.

Transformed Training Data

17 input attributes were extracted:

Time_Index
Lag shift (1-7 days)
TimeIndex^2
TimeIndex^3
TimeIndex*Lag_shift (1-7 days)

Regression Algorithms for 2D and Height displacement Forecast

- Linear Regression (LR)

- K Nearest Neighbour (kNN, k = 5)

- Decision Trees (M5P variant)

- Artificial Neural Network Regressor (ANN)

- Support Vector Regressor with Kernel (SVR, Polynomial)

- HoltWinters (HW)

Evaluation metrics

- Root Mean Square Error (RMSE)

- Mean Absolute Error (MAE)

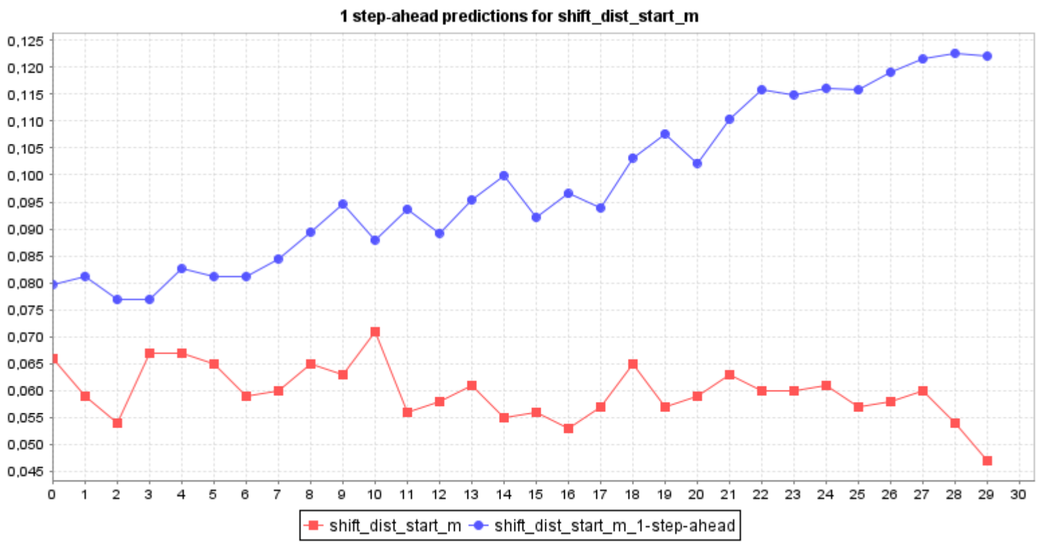
- Mean Absolute Percentage Error (MAPE)

- Correlation Coefficient (R)

- Coefficient of Determination (R^2)

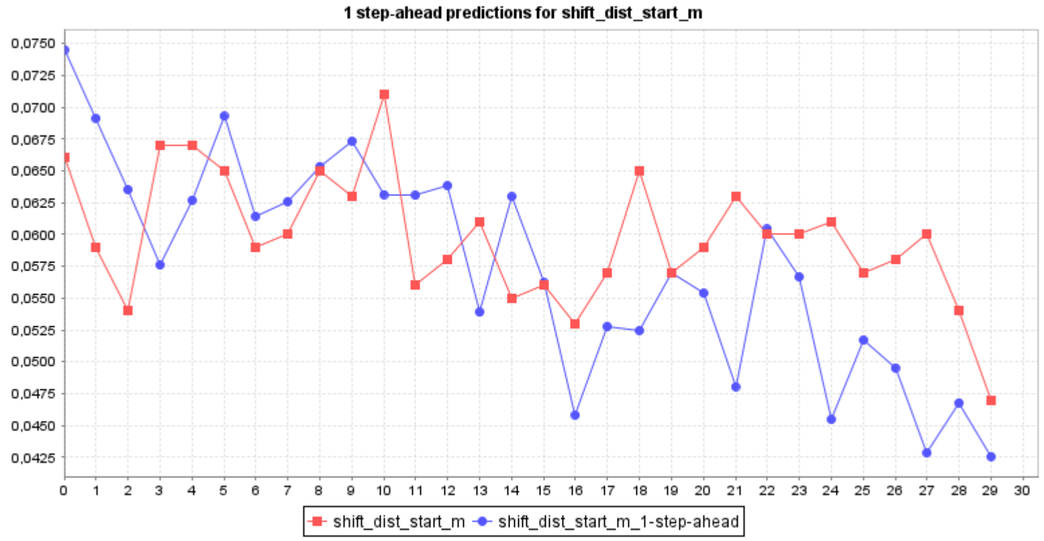
Results for 2D displacement on node 39

LR



Mean absolute error	0.0385
Mean absolute percentage error	66.445
Root mean squared error	0.0423
Mean squared error	0.0018

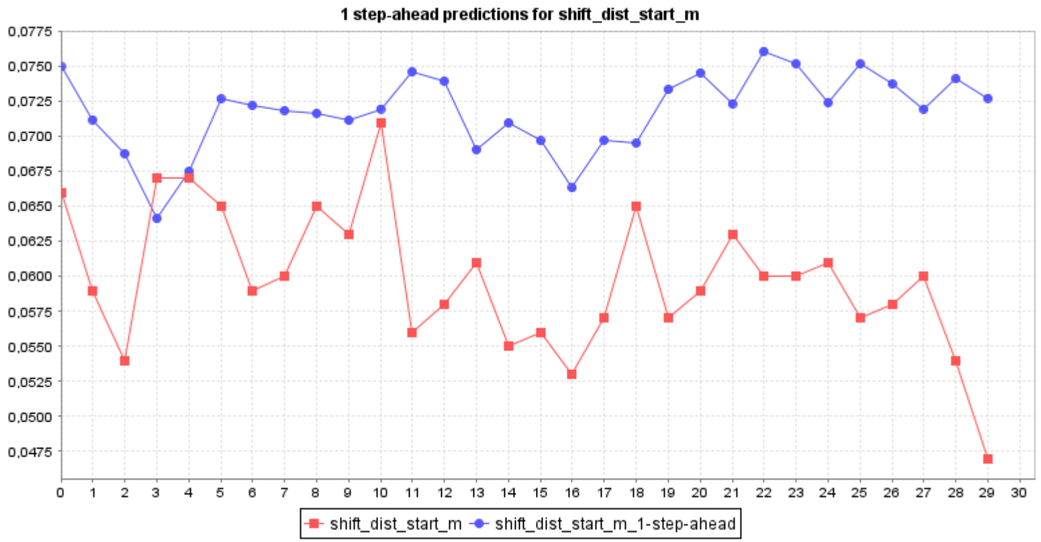
ANN



Mean absolute error	0.0065
Mean absolute percentage error	10.9365
Root mean squared error	0.0079
Mean squared error	0.0001

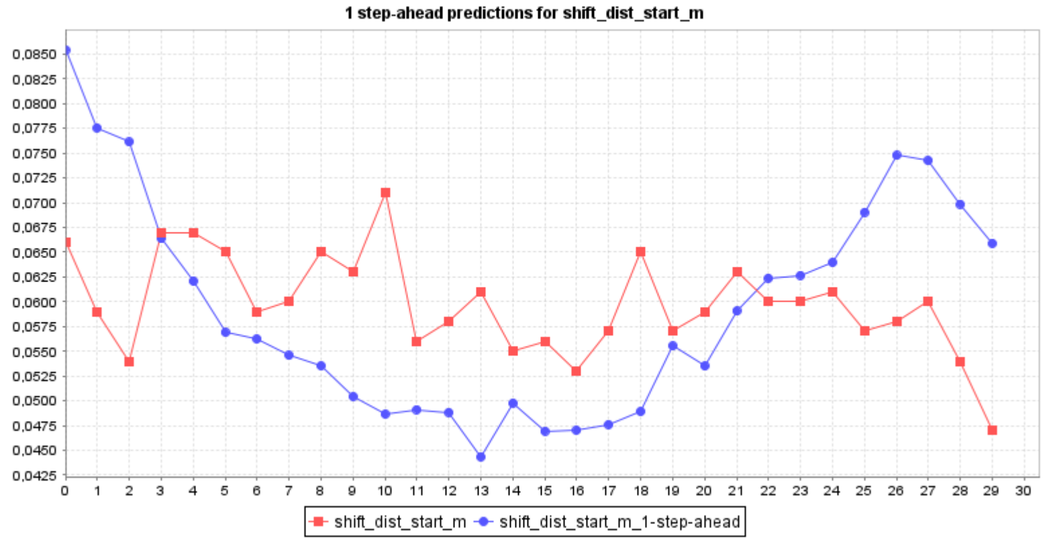
Results for 2D displacement on node 39

M5P



Mean absolute error	0.0122
Mean absolute percentage error	21.2721
Root mean squared error	0.0134
Mean squared error	0.0002

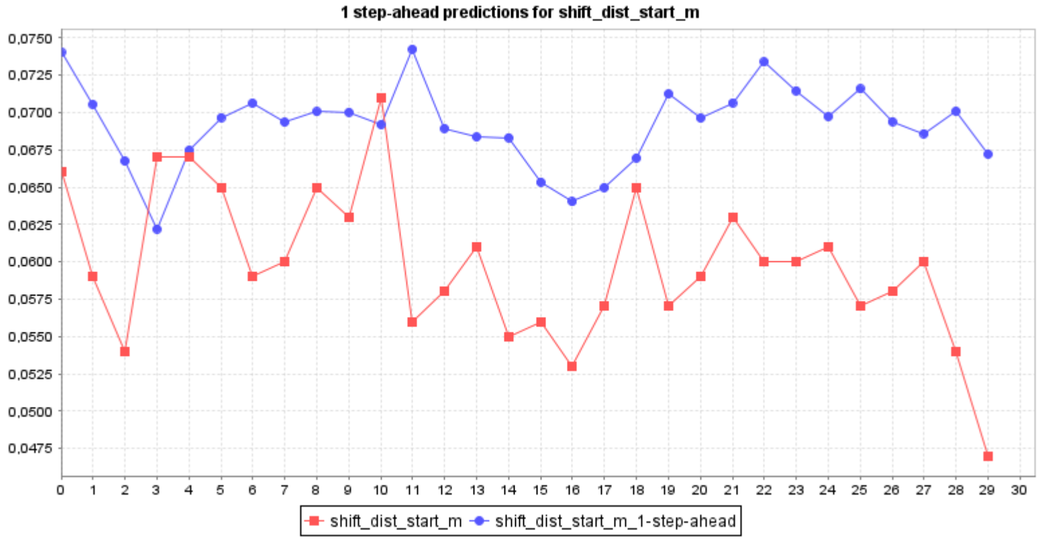
HW (HoltWinters)



Mean absolute error	0.0101
Mean absolute percentage error	17.1164
Root mean squared error	0.012
Mean squared error	0.0001

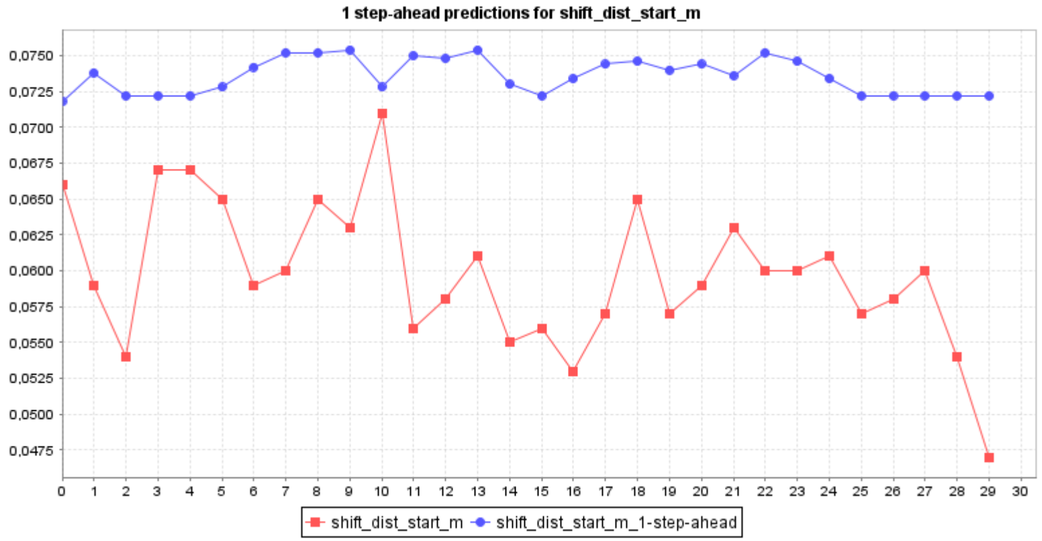
Results for 2D displacement on node 39

SVR (Support Vector Regressor)



Mean absolute error	0.0098
Mean absolute percentage error	17.079
Root mean squared error	0.0108
Mean squared error	0.0001

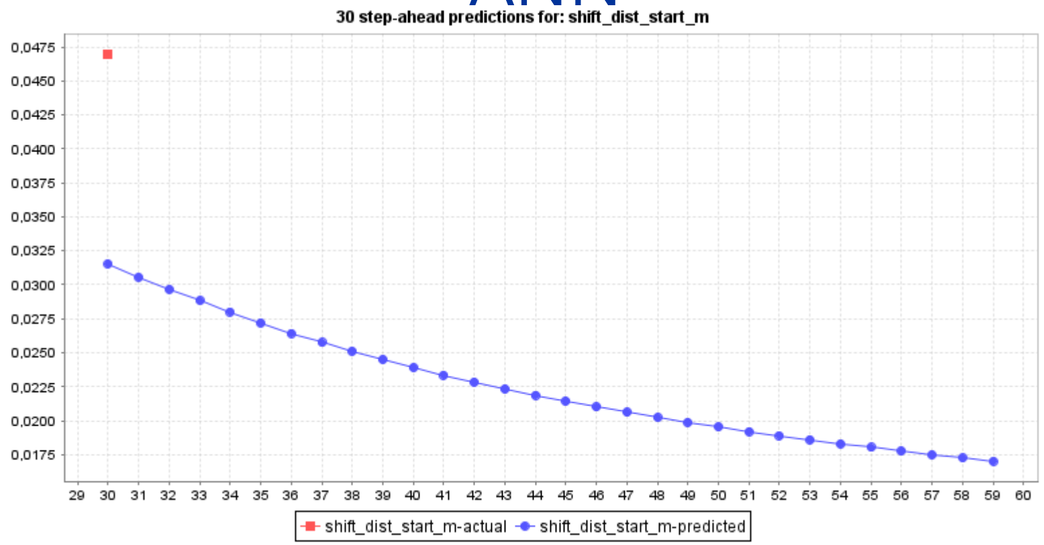
kNN



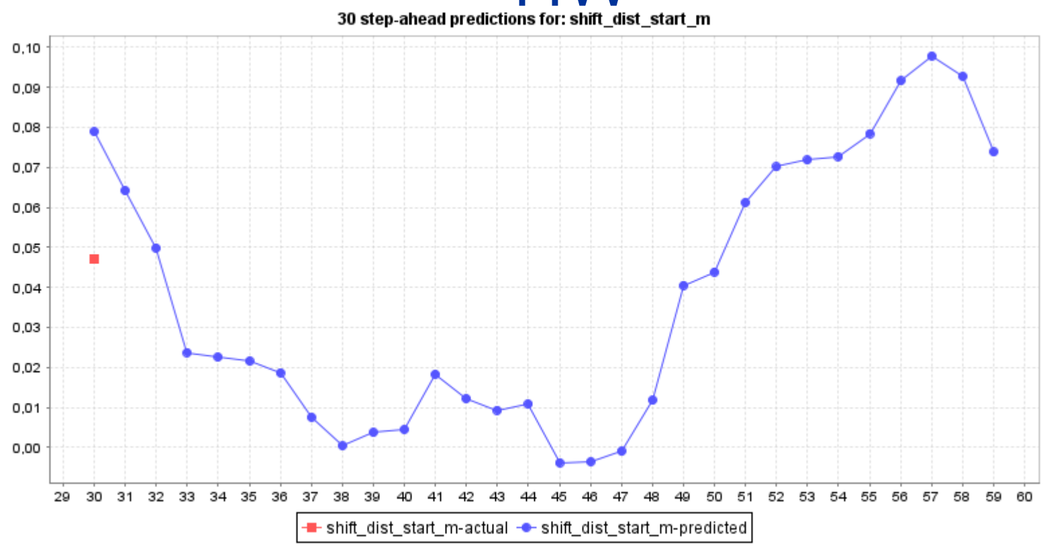
Mean absolute error	0.0138
Mean absolute percentage error	23.9199
Root mean squared error	0.0147
Mean squared error	0.0002

30 days ahead prediction

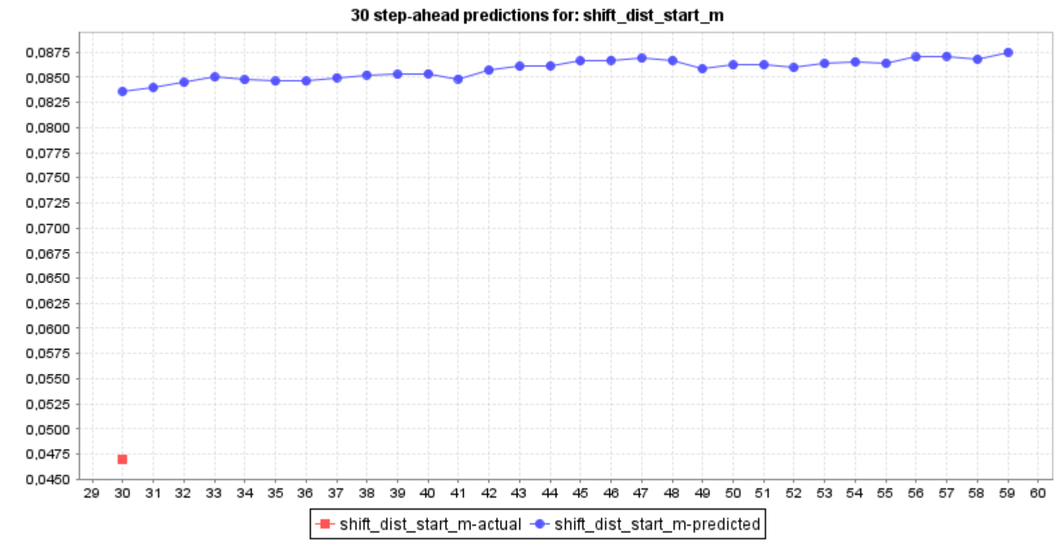
ANN



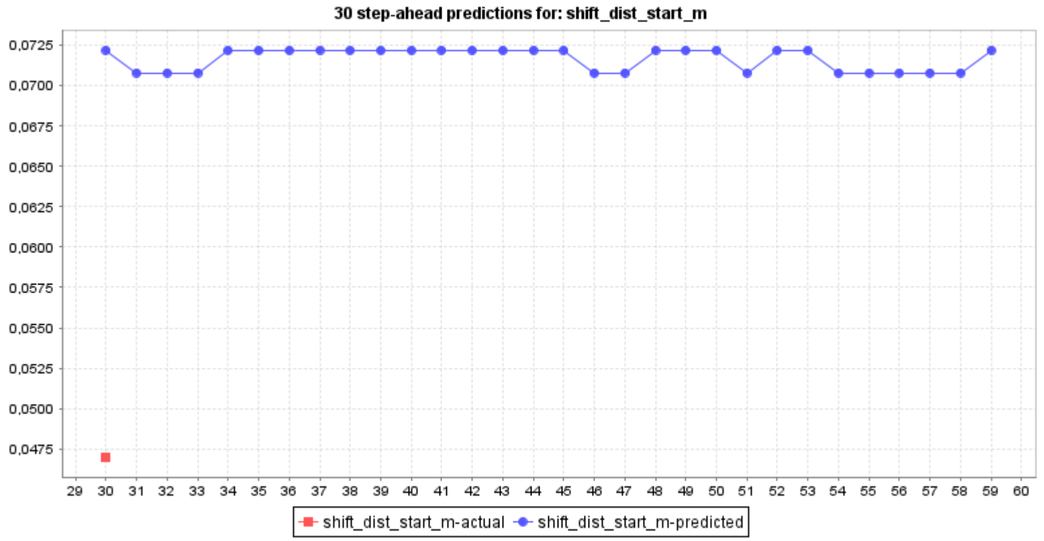
HW



SVR



kNN



Future Work

- Analysis for three remaining nodes (41, 43, 47).

- Usage of Deep learning: LSTM.

- Height Displacement Prediction.

- Testing the quality of prediction for the unseen month / week.

-Testing Different Lag Shifts.

Thank you for your attention!

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January, 2026

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