Luken tiekokeet 2021-2022

Soratietutkimusten työpaja
Väylävirasto
26.4.2022

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SecureLog - Data fusions securing feedstock supply to bioeconomy

- Research project funded by Luke
- 1.4.2021-
- The overall objective of this project is to enhance the resilience of biomass supply to bioeconomy concerning the first legs of transportation
- Tasks
    - T1.1 An optimization model for forwarding will be further developed by incorporating models for energy consumption and loading and unloading. The model will also be tested in collaboration with human operators.
    - T1.2 Methods based on aerial and terrestrial photogrammetry in wheel rut measurements will be compared.
    - **T2.1 A digital twin of forest road will be created enabling dynamic trafficability assessment.**
    - T2.2. The possibilities to assess road trafficability based on data collected by a timber truck will be evaluated.
    - T2.3 A simulation model will be developed to compare novel logistics systems for low-category roads.
    - T2.4 A simulation model will be developed to compare centralized and distributed biogas production systems.

What we want to know?

- Weak condition and spring thaw of forest roads pose challenges to forestry logistics
- Better understanding on the behaviour of forest roads needed for logistics management and road maintenance
- First questions
    - How road moisture and temperature behave as a function of ambient weather conditions?
    - How does the bearing capacity vary?
    - How does the road react on driving?

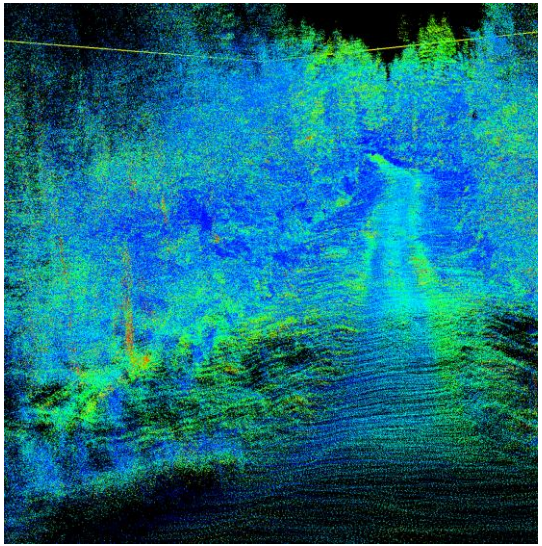
Instrumentation

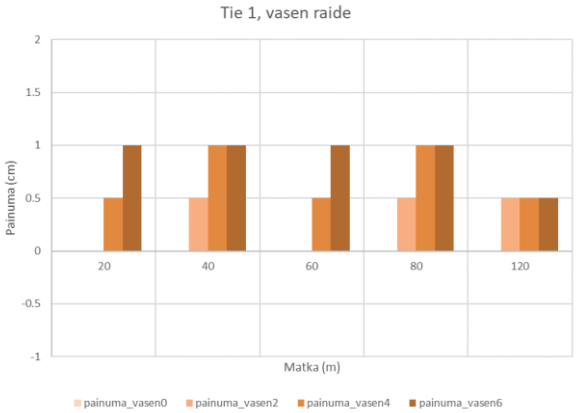
- Two road sections instrumented in Outokumpu
  - Weather station
  - Moisture and temperature sensors
  - Pressure sensors
  - Water table height measurements
- Road profile with lidar scanning
- Road structure with a ground penetrating radar and soil samples

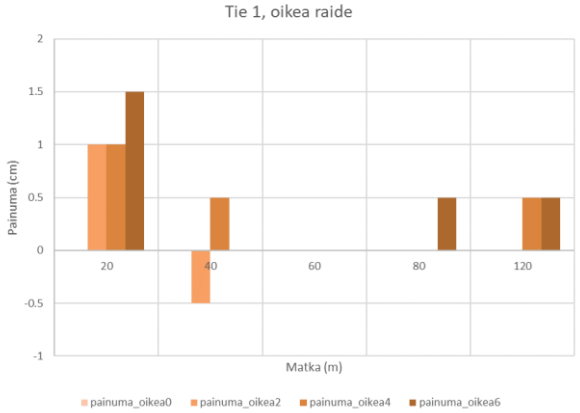
Stress Test

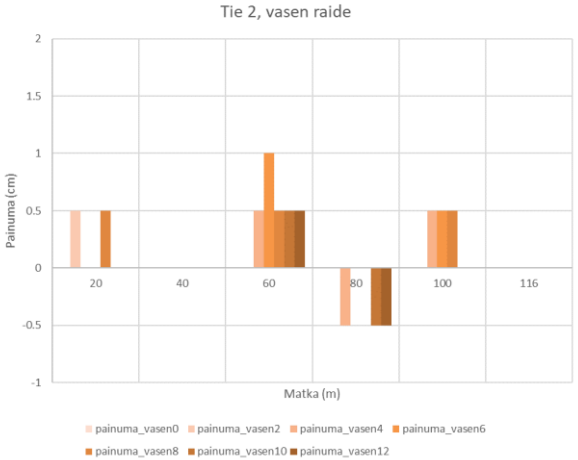
- Before the test road bearing capacity measured with a light falling weight deflectometer
- Effect of load on the road profile tested
- 12 and 6 times with a fully loaded timber truck (76 t)

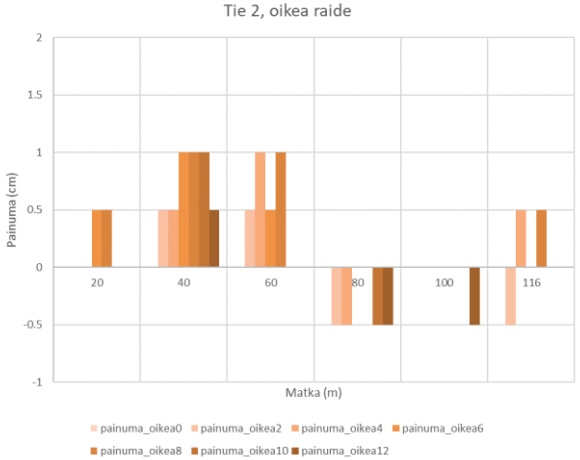
Road profile



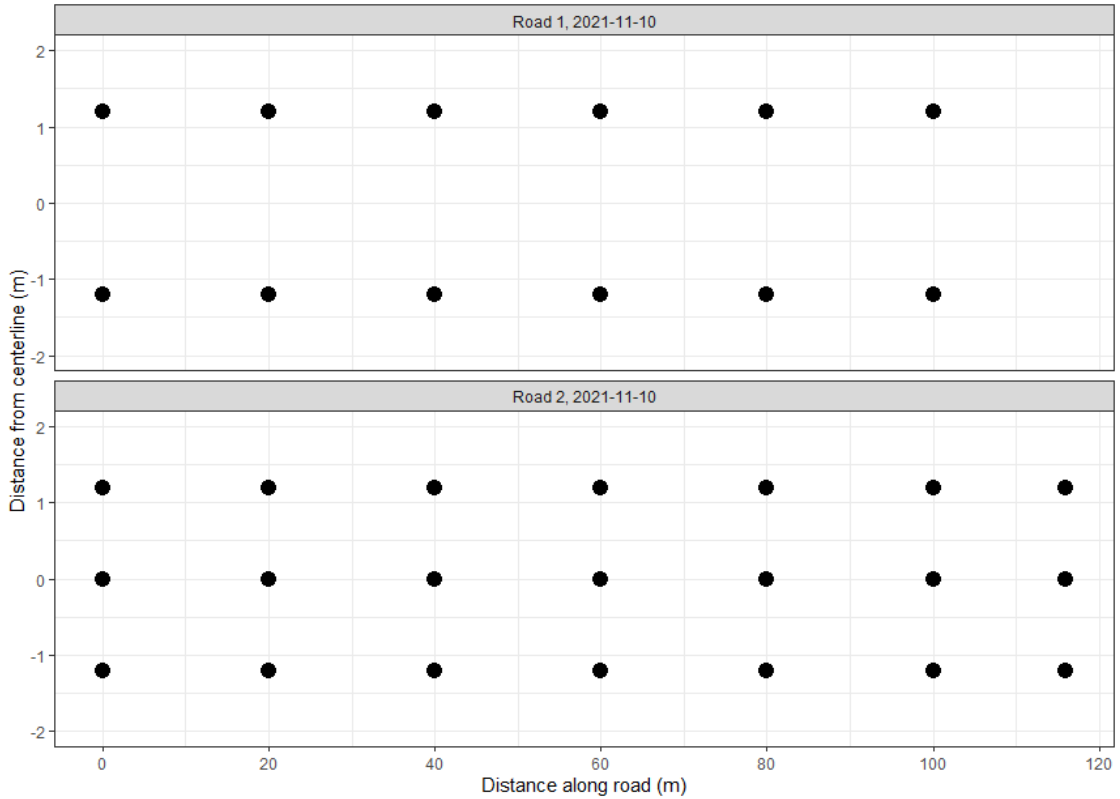


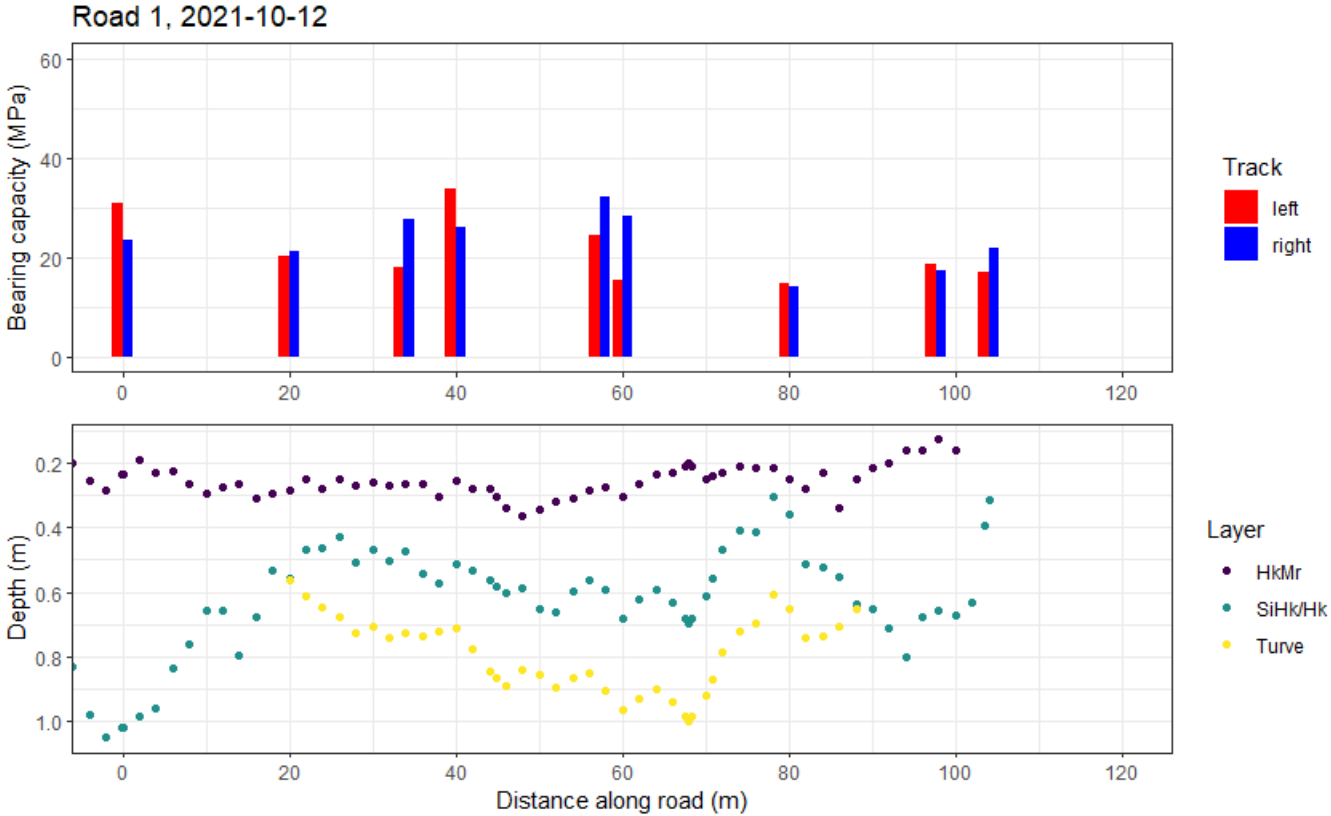


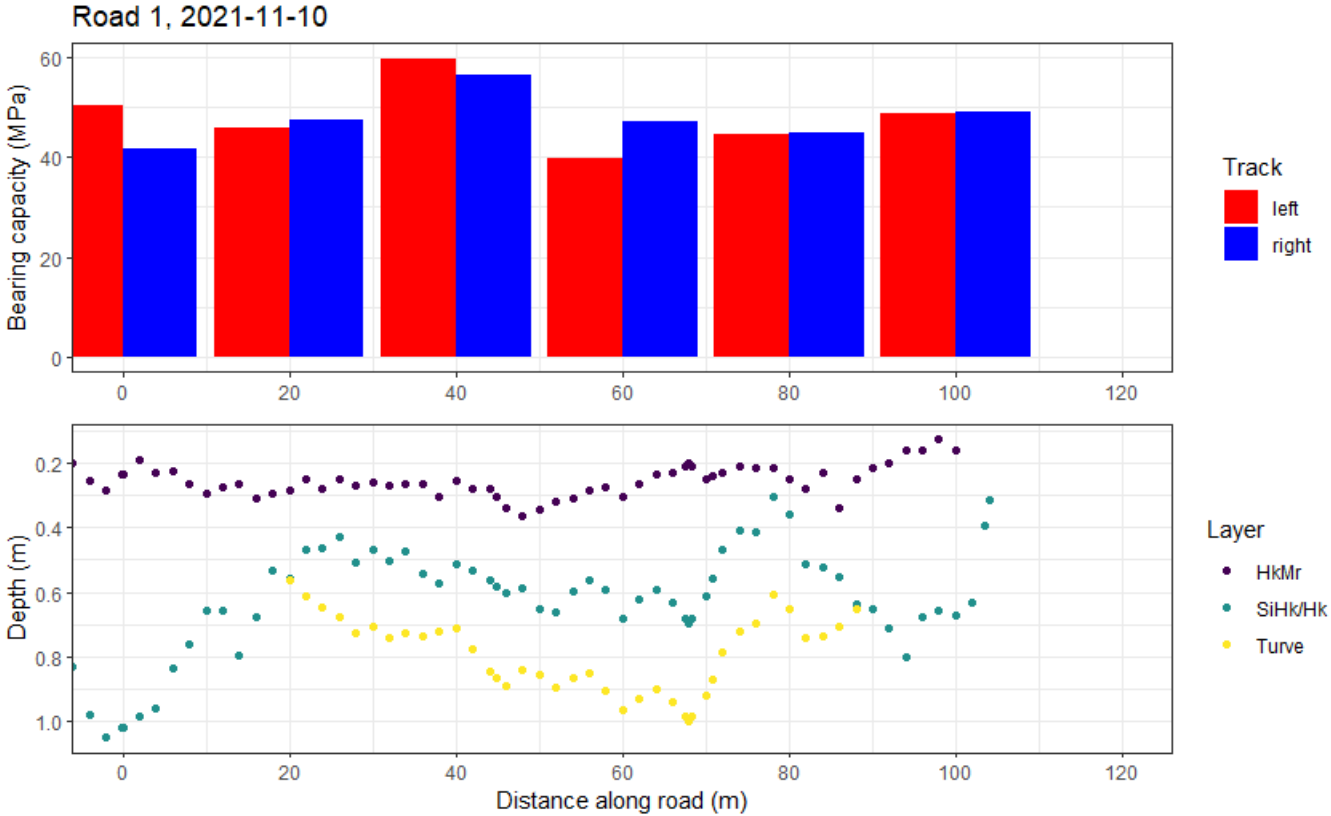


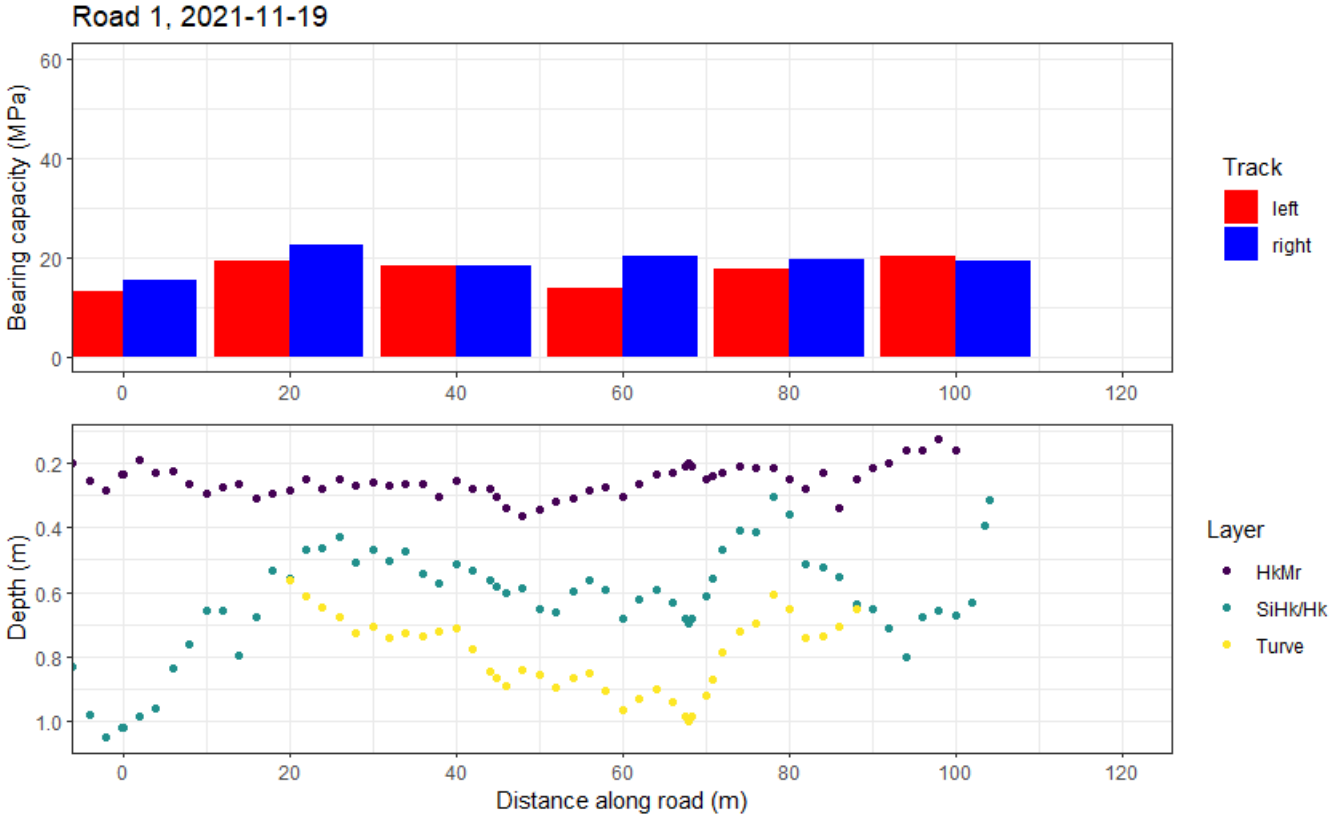


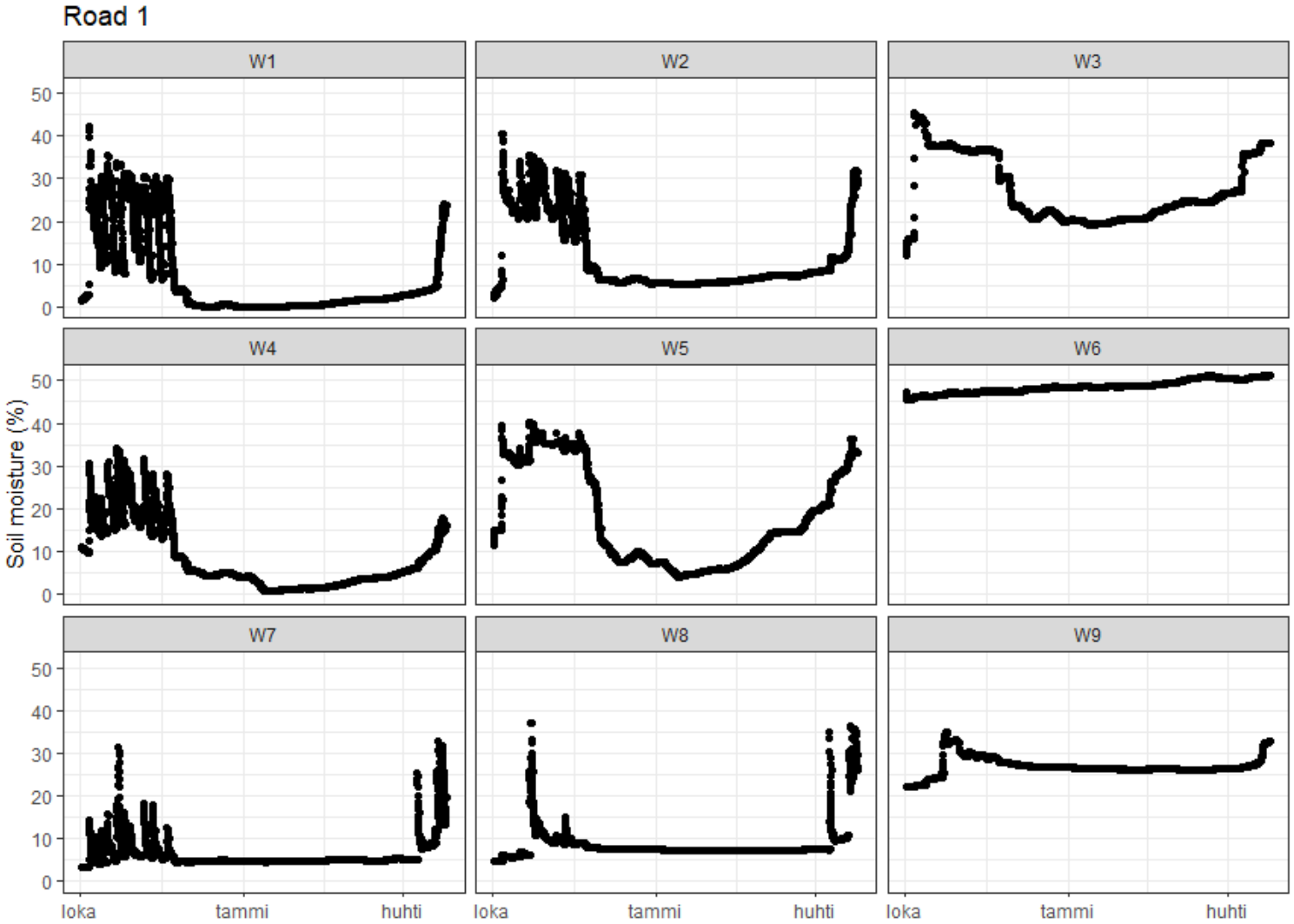
Bearing capacity measurements

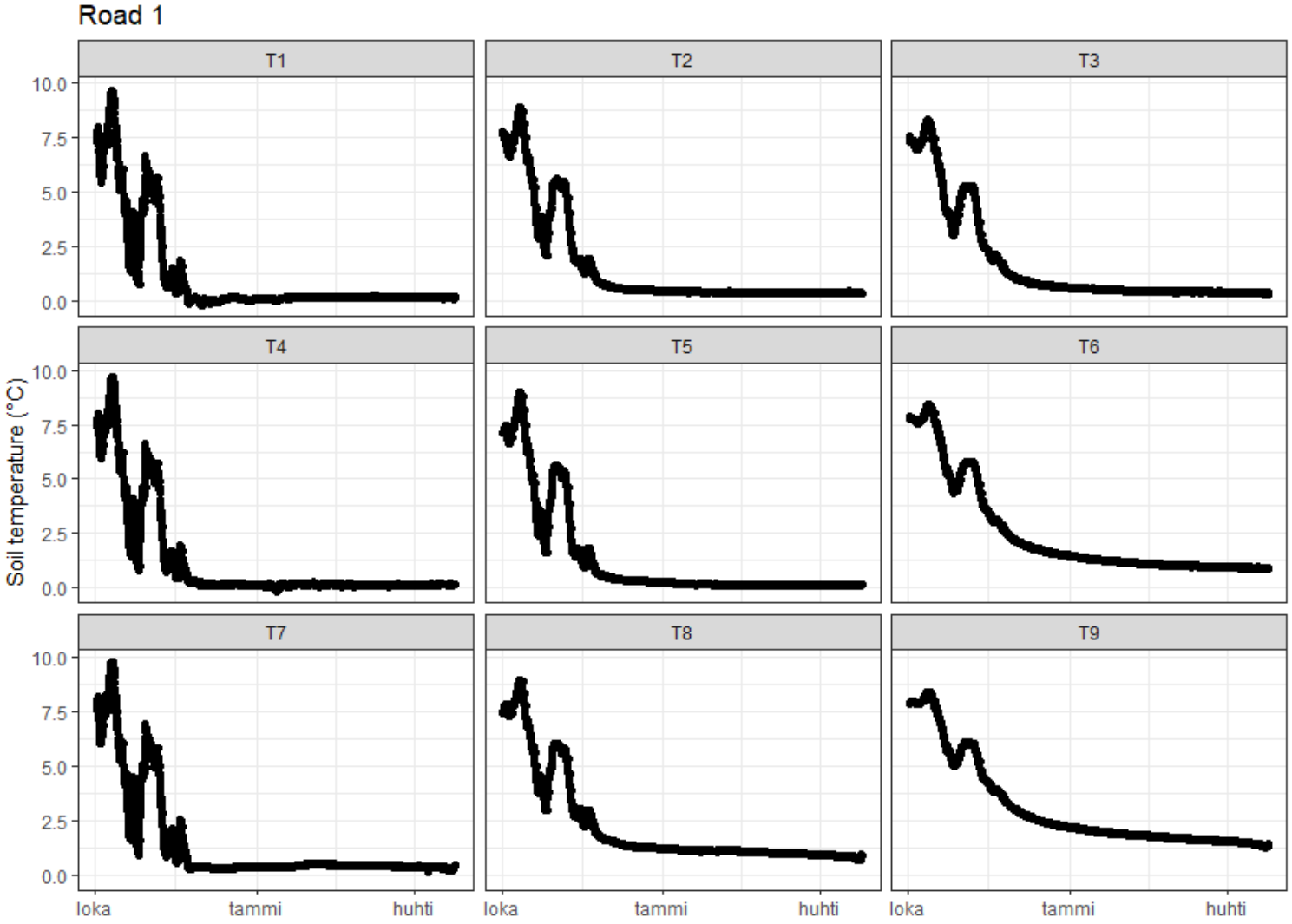


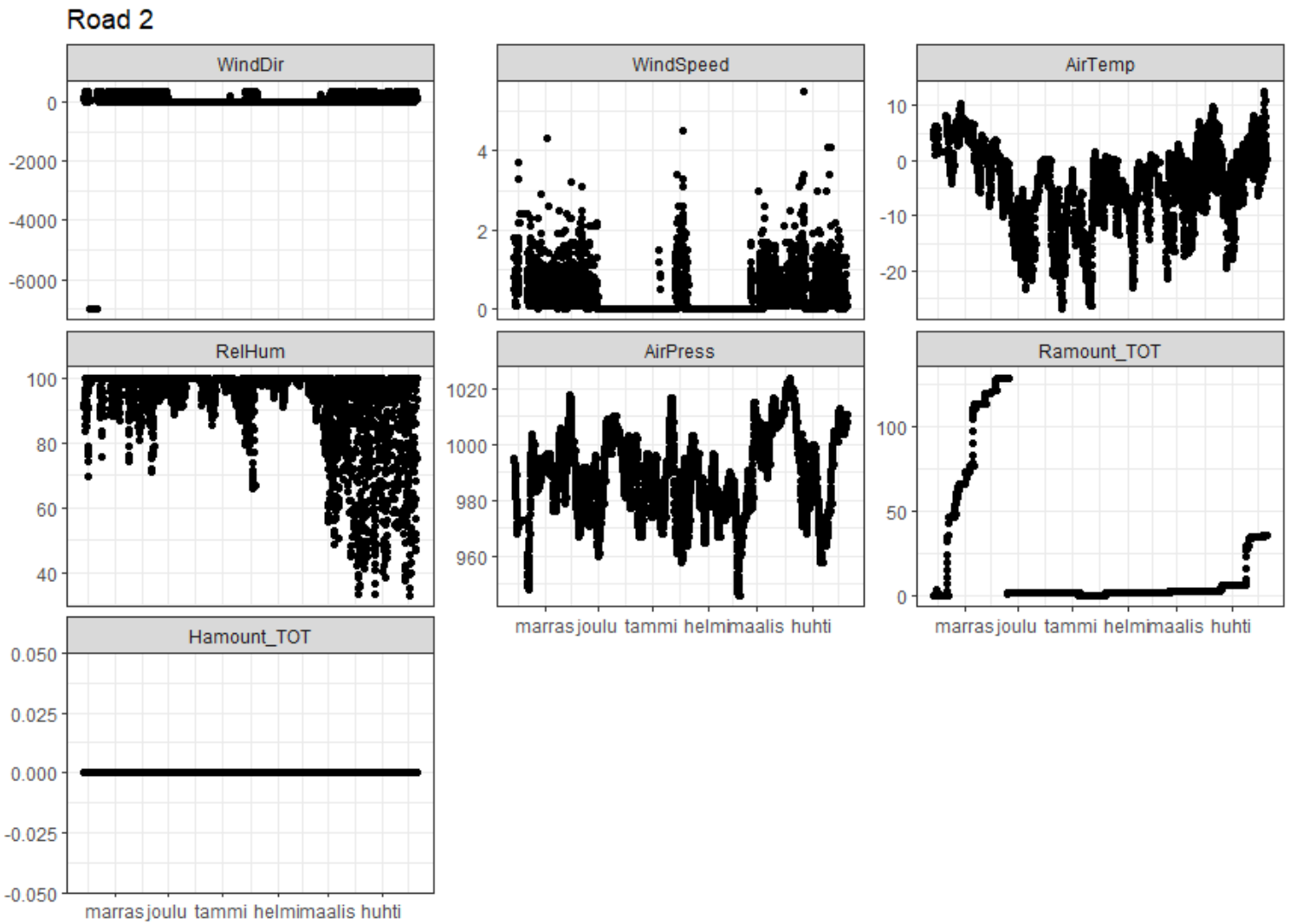

Road 1, 2021-10-12
Bearing capacity (MPa)
60
40
20
0
0
20
40
60
80
100
120
Track
left
right
Depth (m)
0.2
0.4
0.6
0.8
1.0
Distance along road (m)
Layer
HkMr
SiHk/Hk
Turve

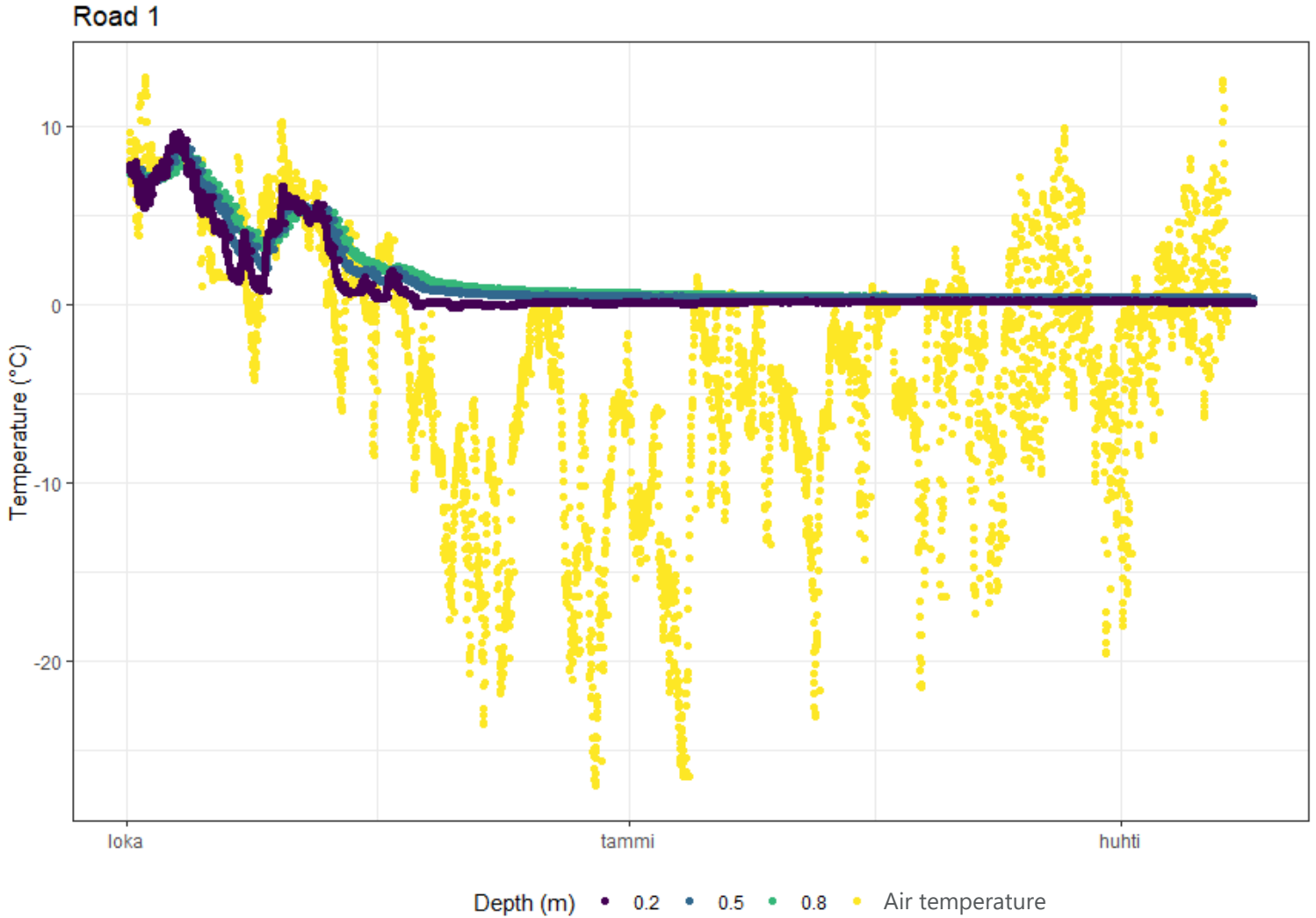

Road 1, 2021-11-10
Bearing capacity (MPa)
0
20
40
60
0
20
40
60
80
100
120
Track
left
right
Depth (m)
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
120
Distance along road (m)
Layer
HkMr
SiHk/Hk
Turve

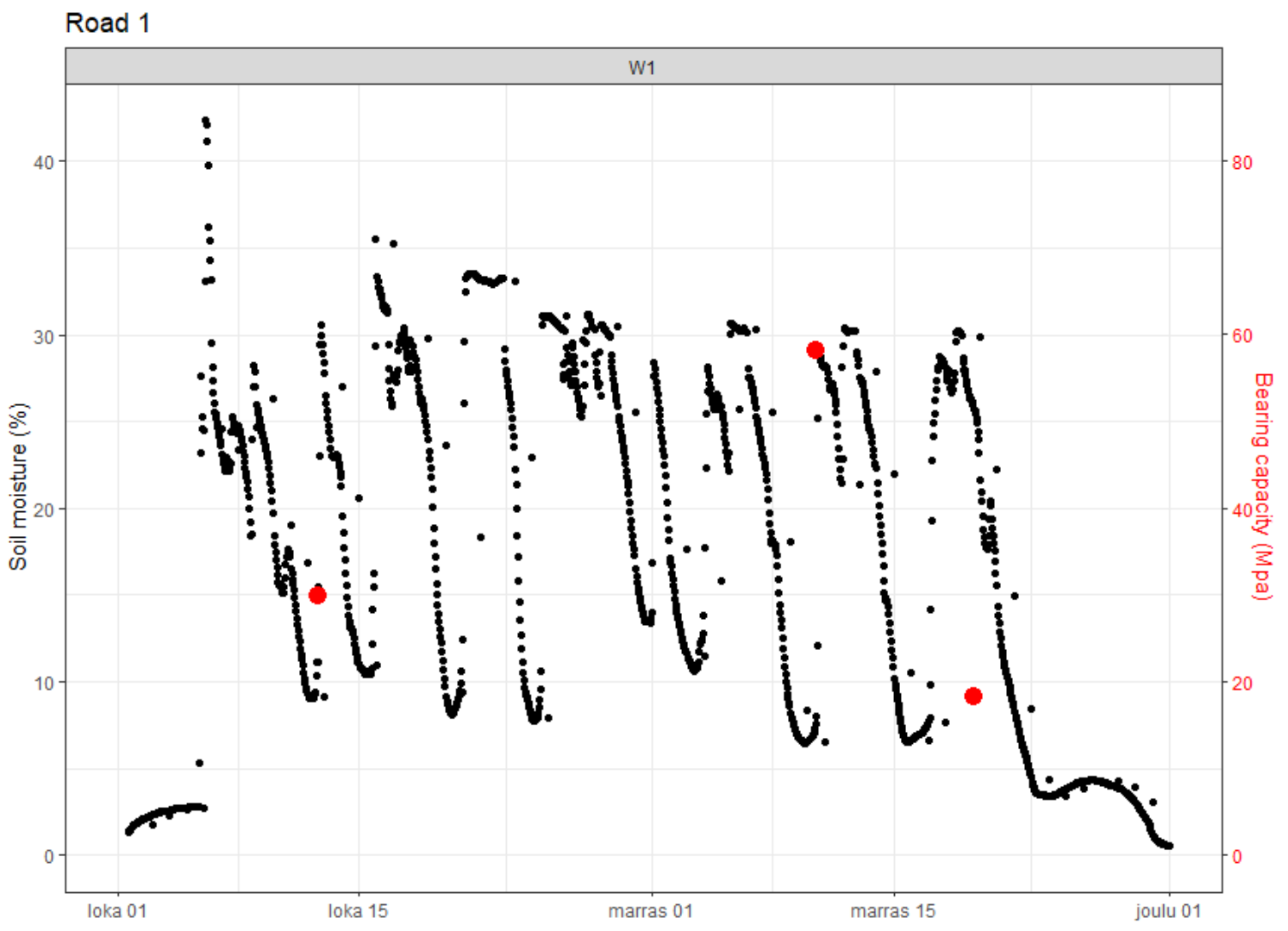

Road 1, 2021-11-19
Bearing capacity (MPa)
60
40
20
0
0
20
40
60
80
100
120
Track
left
right
Depth (m)
0.2
0.4
0.6
0.8
1.0
Layer
HkMr
SiHk/Hk
Turve
Distance along road (m)


Road 1
W1
W2
W3
W4
W5
W6
W7
W8
W9
Soil moisture (%)
0
10
20
30
40
50
loka
tammi
huhti


Road 1
T1
T2
T3
T4
T5
T6
T7
T8
T9
Soil temperature (°C)
10.0
7.5
5.0
2.5
0.0
loka
tammi
huhti


Road 2
WindDir
0
-2000
-4000
-6000
WindSpeed
4
2
0
AirTemp
10
0
-10
-20
RelHum
100
80
60
40
AirPress
1020
1000
980
960
Ramount_TOT
100
50
0
Hamount_TOT
0.050
0.025
0.000
-0.025
-0.050
marras joulu tammi helmi maalis huhti


Road 1
10
0
-10
-20
Temperature (°C)
loka
tammi
huhti
Depth (m)
0.2
0.5
0.8
Air temperature


Road 1
W1
Soil moisture (%)
Bearing capacity (Mpa)
0
10
20
30
40
0
20
40
60
80
loka 01
loka 15
marras 01
marras 15
joulu 01

Future Plans

- More bearing capacity measurements
- Repeat the stress test during spring thaw
- Increase the number of instrumented roads in EAKR-funded project ‘Take me home country road’