



# Case studies showcasing the value of comprehensive measurements used for pavement condition evaluation

European Road Profile Users Group 2023  
Athens, October 25-27, 2023



# iPAVe - intelligent Pavement Assessment Vehicle



+ Roughness  
Left & Right wheel paths

+ 3D Roughness  
Full Lane

+ Texture  
Centre & Both wheel paths

+ 3D Rutting  
Full Lane

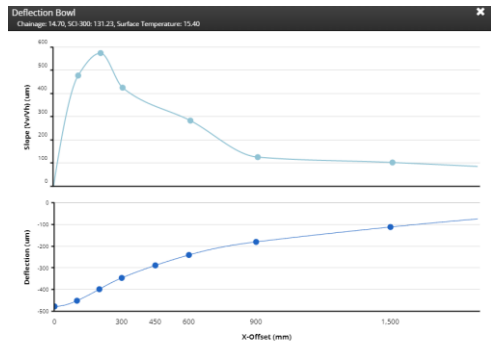
+ GNSS DGPS  
geospatial location

+ 3D Cracking  
Full Lane

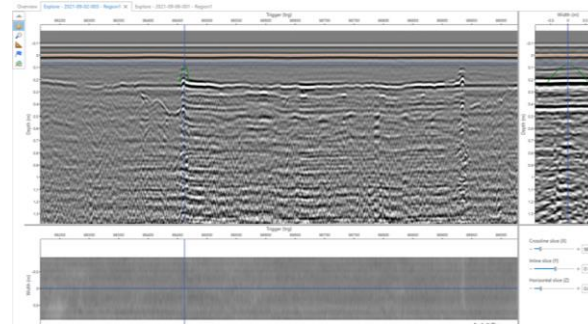
+ Geometry  
Crossfall, Grade, Horizontal & Vertical curvature

+ 3D Surface Defects  
Full Lane

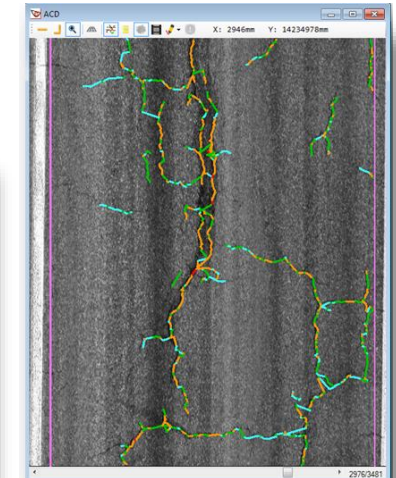
Continuous Deflection Measurement



+ 3D Ground Penetrating Radar



+ Digital Imaging System



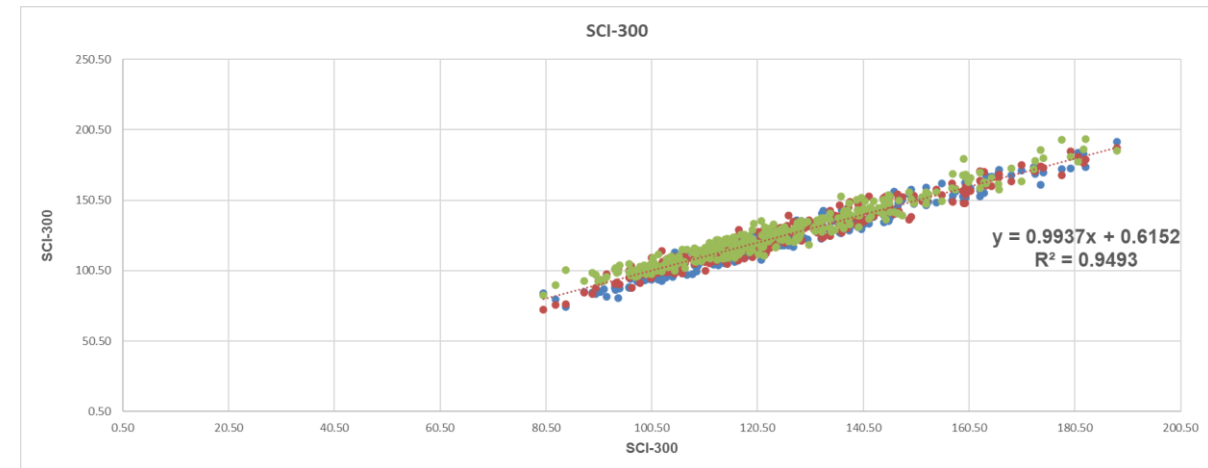
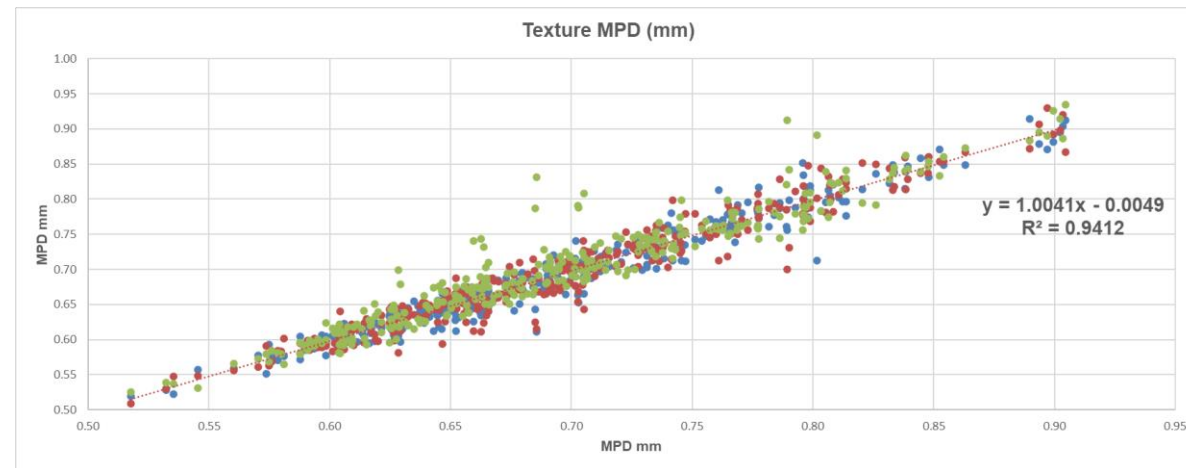
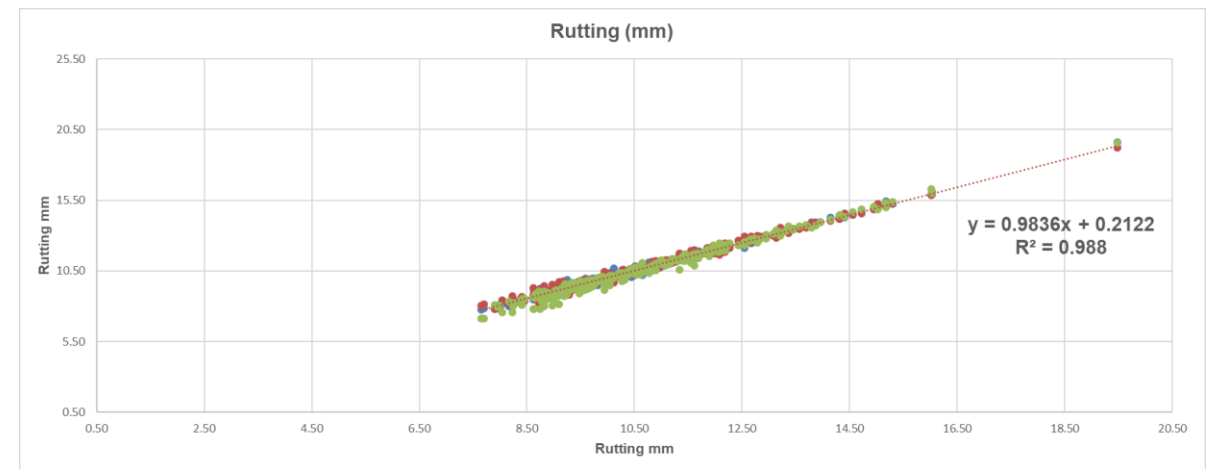
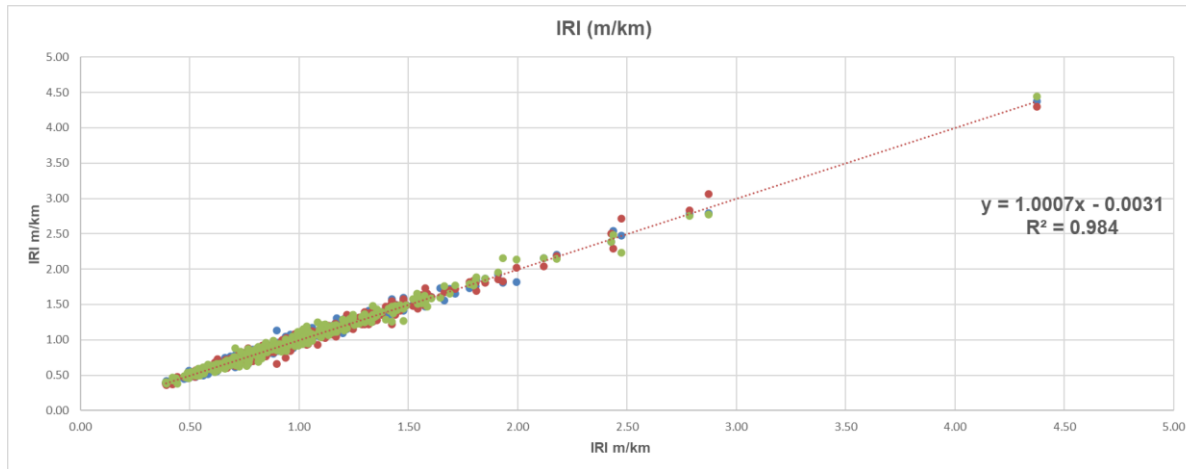
Simultaneous collection of Functional + Pavement layer + Structural data = **Comprehensive Pavement Assessment**

# We learned from repeatability tests in Slovenia in 2022:



Parameter	Regression	R <sup>2</sup>
IRI	$0,96*x+0,123$	0,98
Rutting	$1,02*x-0,141$	0,98
MPD	$0,98*x+0,009$	0,97
Surface Curvature Index 300 (SCI 300)	$1,01*x+2,604$	0,98
Center deflection D0	$0,98*x-0,028$	0,94

# And confirmed with repeatability tests in Sweden in 2023:



# Repeatability tests in Sweden in 2023:



Parameter	Regression	R <sup>2</sup>
IRI	$1,0007*x-0,0031$	0,98
Rutting	$0,98*x-0,2122$	0,98
MPD	$1,0041*x+0,0049$	0,94
Surface Curvature Index 300 (SCI 300)	$0,99*x+0,152$	0,95
Center deflection D0	$0,96*x$	0,98

# Approval of TSD measurements Danish Road Directorate 2023:



Section	SCI300		SCI900		d200-d300		d300-d600		d600-d900		d900-d1500	
run	slope	R <sup>2</sup>	slope	R <sup>2</sup>	slope	R <sup>2</sup>	slope	R <sup>2</sup>	slope	R <sup>2</sup>	slope	R <sup>2</sup>
522-1												
1 vs 2	0,99	0,97	1,02	0,98	1,03	0,99	1,04	0,98	0,92	0,96	1,01	0,82
2 vs 3	1,01	0,98	1,00	0,98	1,01	0,99	1,00	0,98	0,98	0,97	0,74	0,71
3 vs 4	1,02	0,97	1,05	0,98	1,04	0,99	1,07	0,98	0,93	0,95	1,04	0,83
522-2												
1 vs 2	0,90	0,98	0,93	0,98	0,95	0,99	0,95	0,98	1,03	0,93	0,85	0,90
2 vs 3	0,99	0,99	0,99	0,99	1,01	0,99	1,01	0,99	0,93	0,92	0,93	0,89
3 vs 4	1,05	0,98	1,03	1,00	1,03	0,98	1,01	0,97	1,07	0,93	0,91	0,85
M12												
1 vs 2	1,08	0,95	1,06	0,94	1,10	0,96	1,05	0,93	0,97	0,86	0,88	0,67
2 vs 3	1,02	0,95	1,02	0,95	1,03	0,97	1,03	0,96	0,91	0,88	0,85	0,67
3 vs 4	1,09	0,96	1,09	0,96	1,09	0,98	1,08	0,96	1,06	0,88	0,97	0,68

**June 2023**

**September 2023**

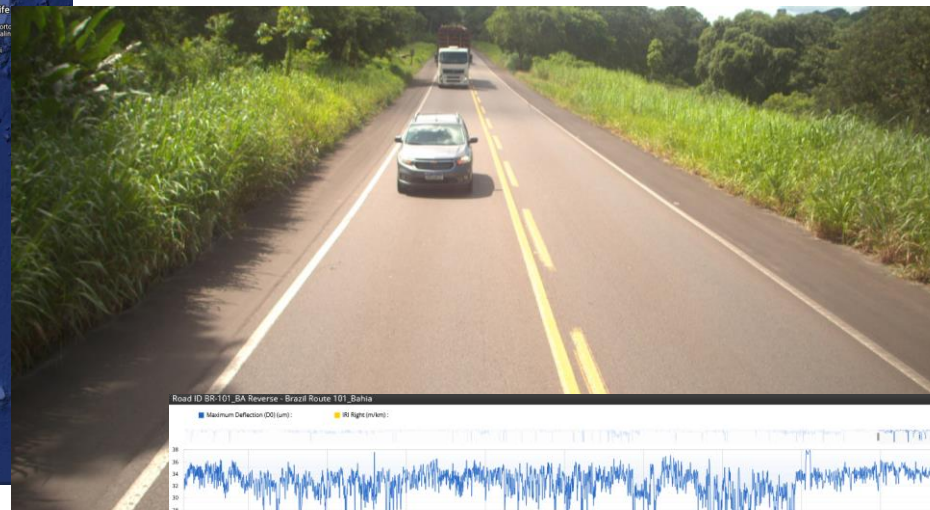
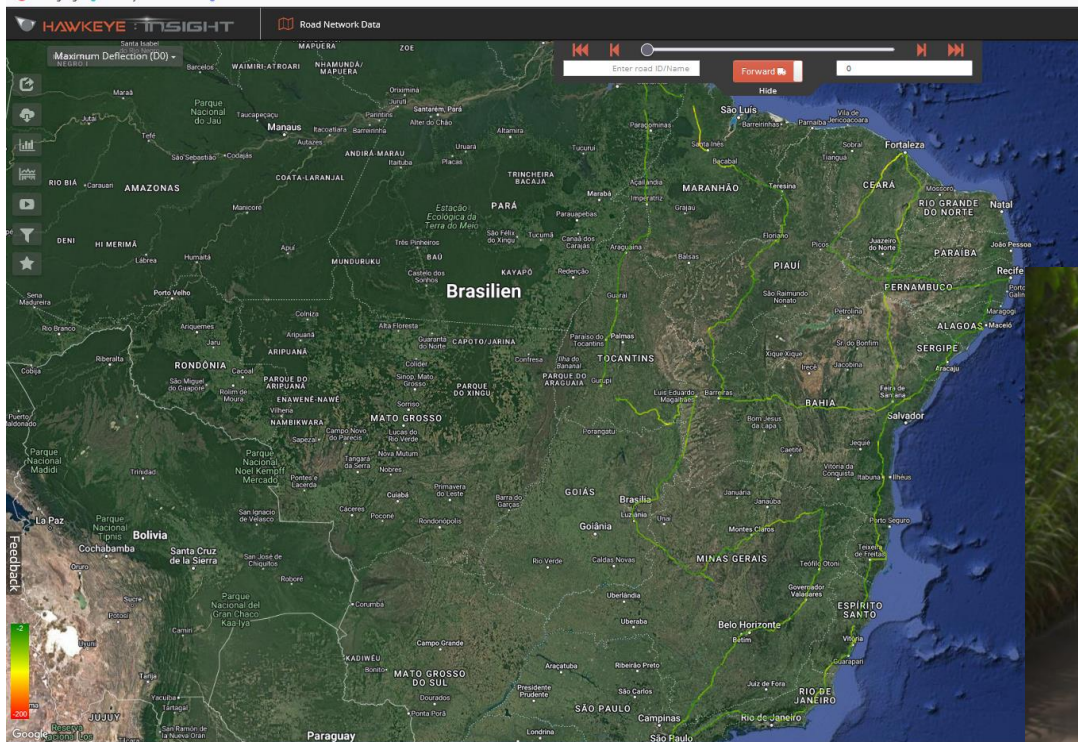
Section	SCI-300		SCI-900		d200-d300		d300-d600		d600-d900		d900-d1500	
Run	slope	R2	slope	R2	slope	R2	slope	R2	slope	R2	slope	R2
522-1												
1 vs 2	1.05	0.97	1.06	0.97	1.03	0.97	1.05	1.0	1.06	0.93	1.00	0.83
3 vs 2	0.95	0.98	0.98	0.99	0.98	0.99	1.00	1.0	1.00	0.96	0.91	0.86
522-2												
1 vs 2	1.10	0.95	1.09	0.96	1.07	0.97	1.07	0.97	1.09	0.93	1.11	0.80
3 vs 2	1.02	0.96	1.01	0.97	1.00	0.98	1.00	0.98	1.03	0.96	1.09	0.87
M12												
1 vs 2	1.09	0.93	1.09	0.94	1.06	0.95	1.06	0.94	1.09	0.90	1.18	0.83
3 vs 2	0.98	0.90	1.01	0.93	0.98	0.93	1.00	0.93	1.04	0.90	1.10	0.82



# E-iPAVe Road Infrastructure measurements in 2023:



Brazil: Over 4 month in 2022/2023, the iPAVe surveyed approximately 12,600 km of Federal Highways. Data delivered to the client.





# Filtering data from 12.000 km of roads:

The screenshot displays the HAWKEYE INSIGHT software interface. The main map shows a road network in Brazil, with various states and cities labeled. A color scale on the left indicates road condition, ranging from -200 (red) to -2 (green). A dialog box titled "Create Advanced Filter Query" is open, showing the following filter criteria:

- Select Filter: Asphalt Poor\_DNIT
- IRI Lane  $\geq 3$
- Total Cracking Percent  $\geq 20$
- or
- IRI Avg  $\geq 3$
- Rut Depth Lane  $\geq 10$
- or
- Total Cracking Percent  $\geq 20$
- Rut Depth Lane  $\geq 10$
- or
- Add new group

The Filter Query Description is:  $(IRI Lane \geq 3 \text{ AND Total Cracking Percent} \geq 20) \text{ OR } (IRI Avg \geq 3 \text{ AND Rut Depth Lane} \geq 10) \text{ OR } (Total Cracking Percent} \geq 20 \text{ AND Rut Depth Lane} \geq 10)$

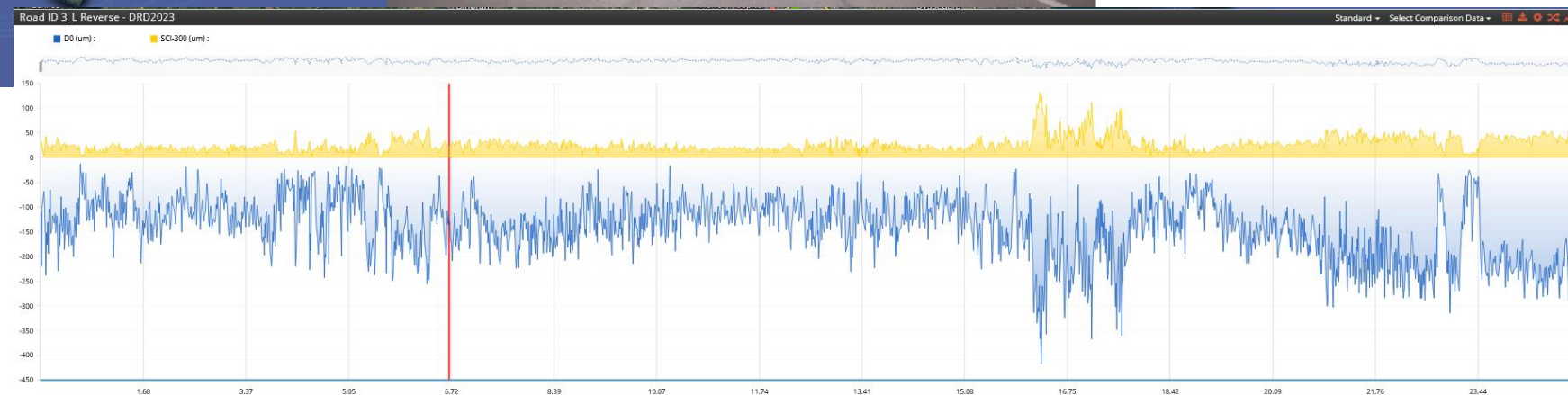
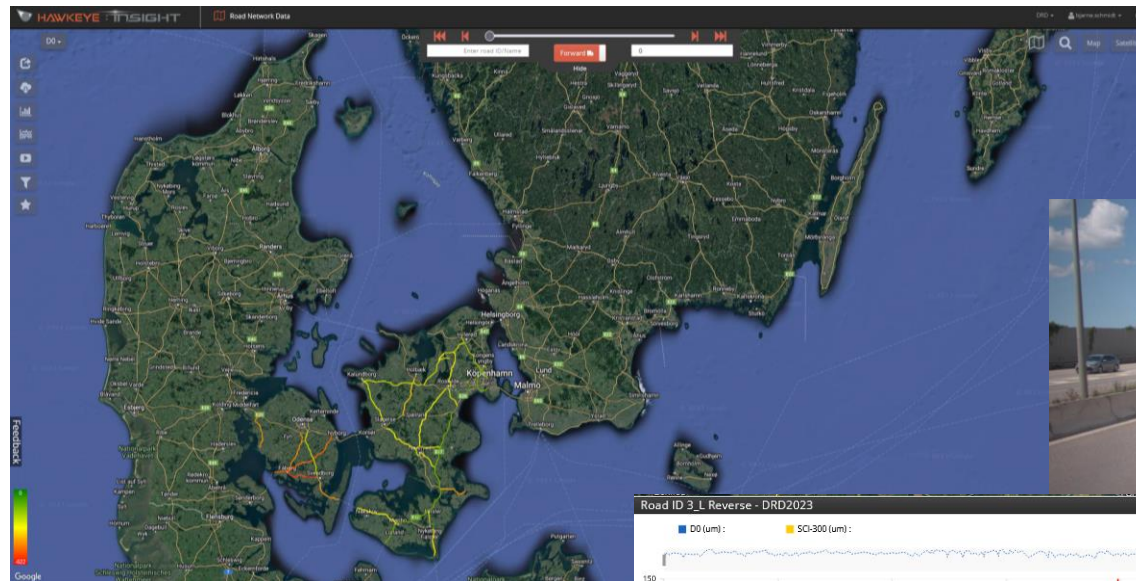
Buttons: Apply, Disable, Save



# E-iPAVe Road Infrastructure measurements in 2023: ERPUG

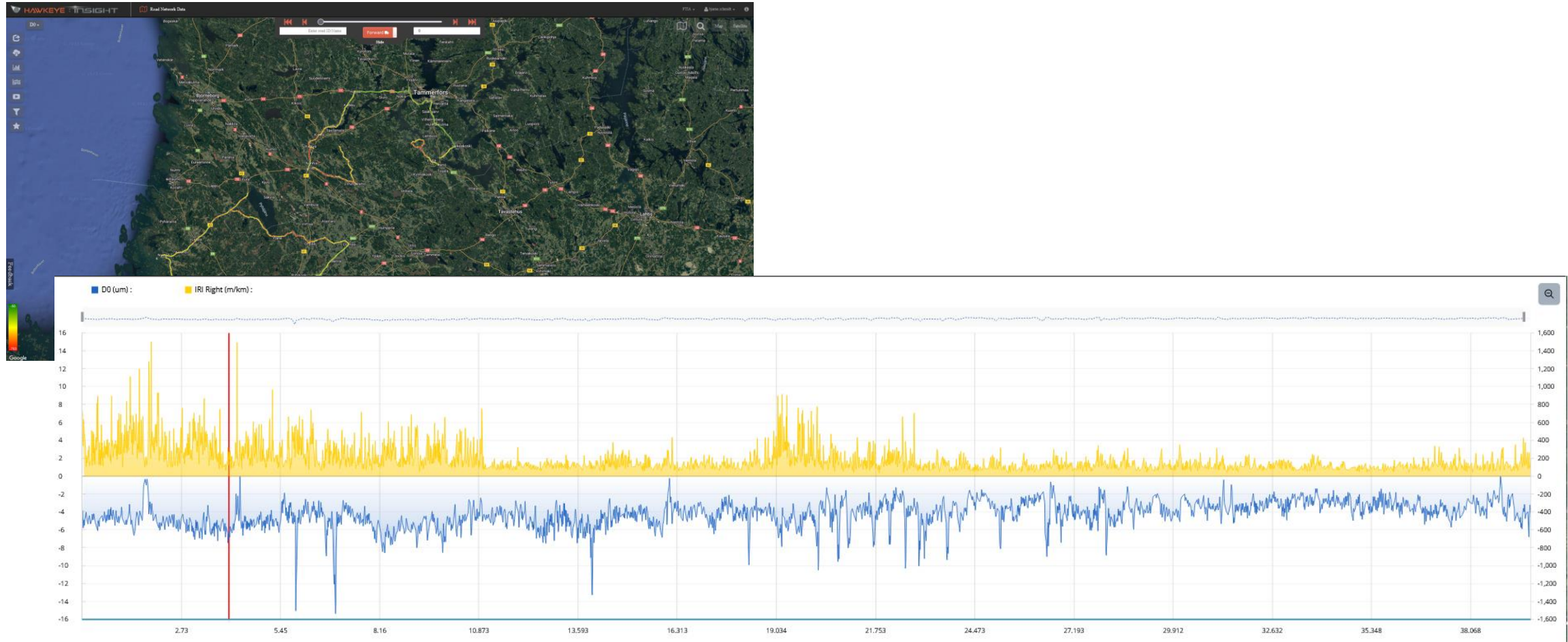
Denmark: 2023/2024, the iPAVe will survey approximately 7,700 km of state roads, TSD measurements.

1600 km were collected in 2023 and the remaining approx. 6000 will be collected in 2024



# E-iPAVe Road Infrastructure measurements in 2023: ERPUG

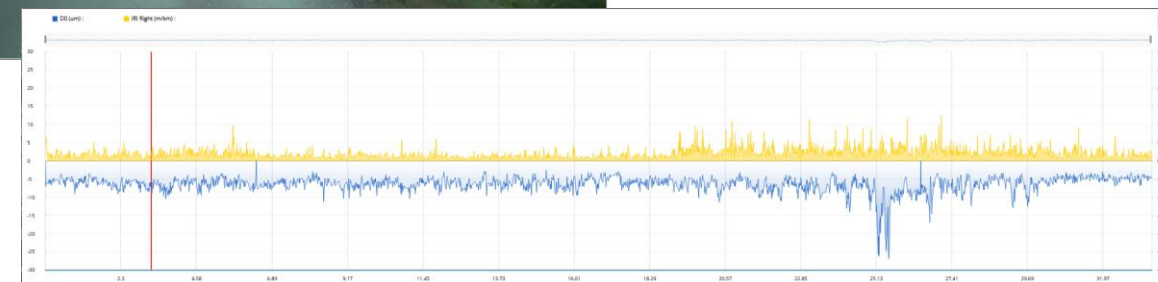
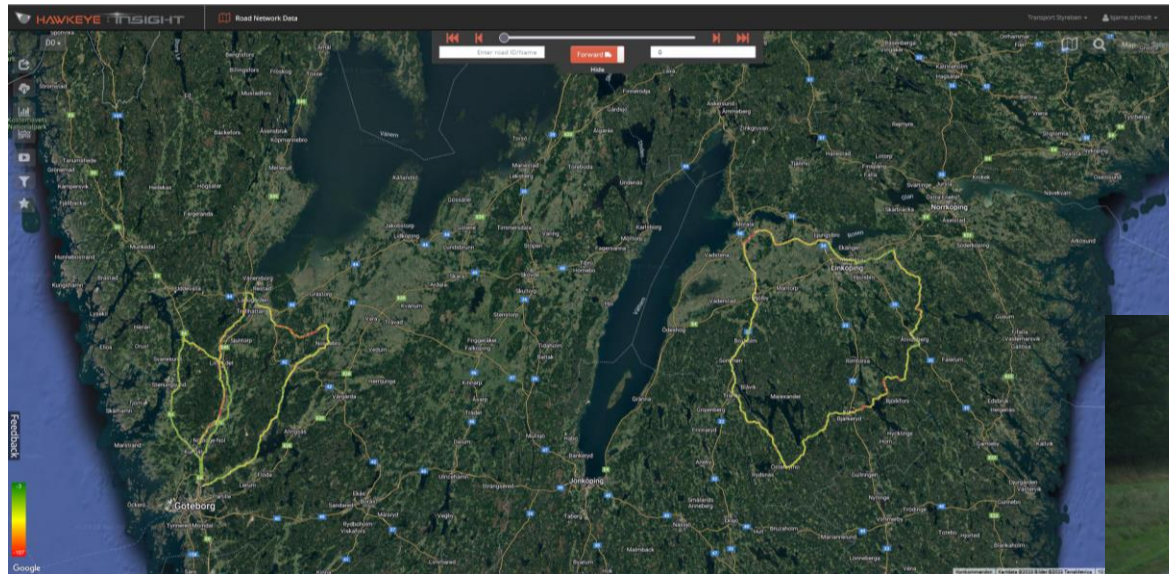
Finland: 2023, Another two rounds on the roads that was measured in 2022 was conducted. This means that measurements has been conducted in May, July and August 2022 and May and September 2023.





# E-iPAVe Road Infrastructure measurements in 2023: ERPUG

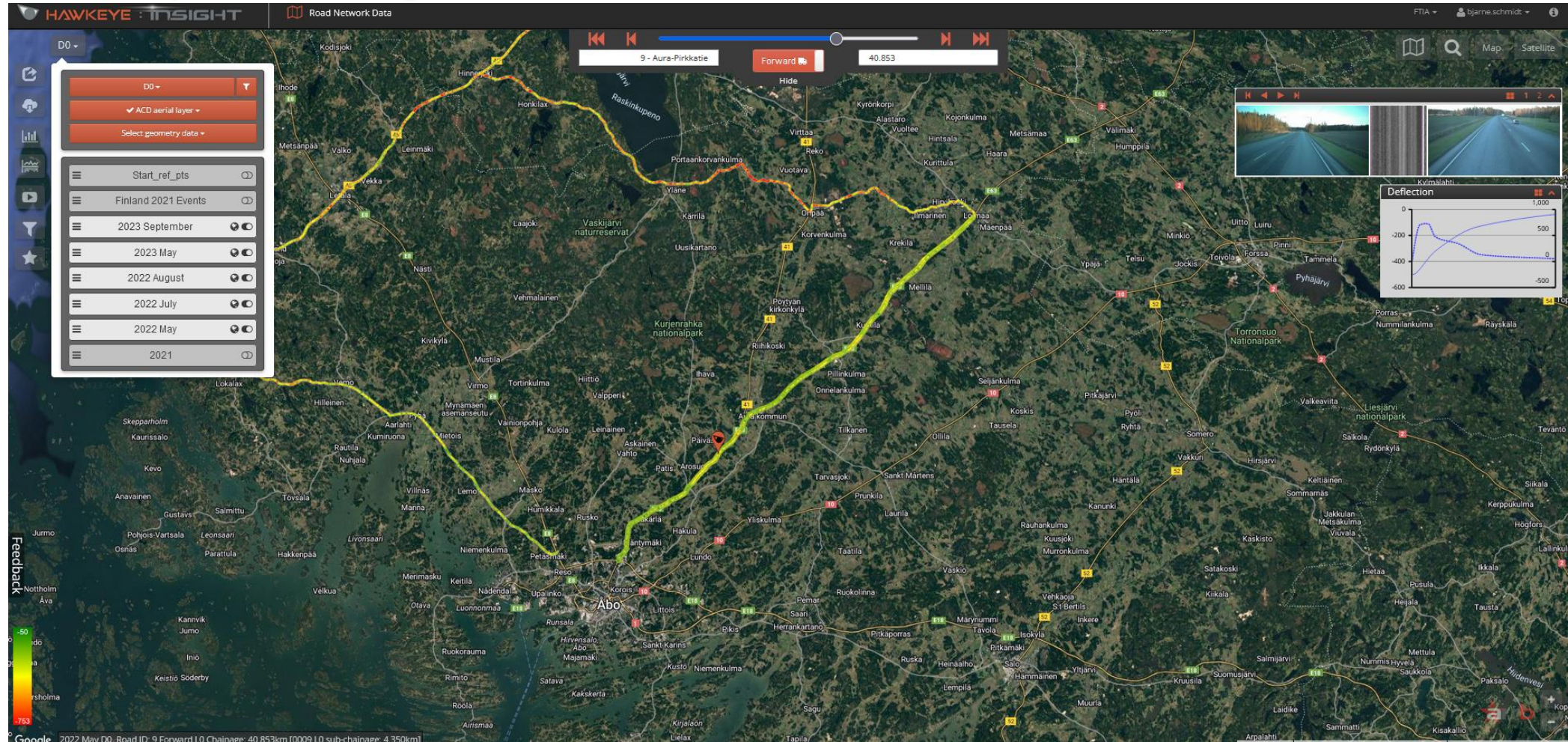
Sweden: 2023, Another round on the roads that was measured in 2022. Both rounds were measured end of August/early September. Also, three LTPP sections were measured





# E-iPAVe Road Infrastructure measurements:

## Reliability: Looking at data from Finland





**HAWKEYE INSIGHT** Road Network Data FTIA bjarnschmidt

249 - Aetsantie Forward 10.943 Hide

Map Satellite

Deflection

Road ID 249 Forward - Aetsantie

Standard Select Comparison Data

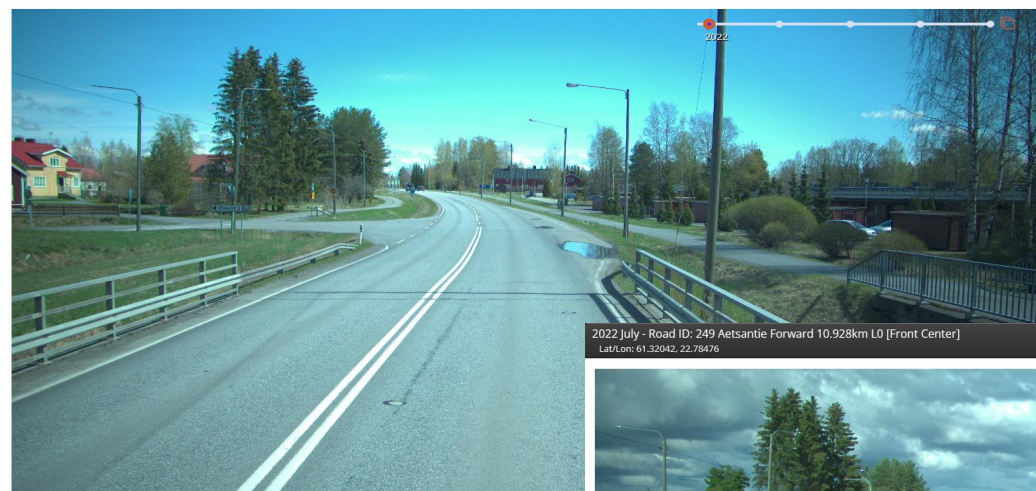




Collected: 13 May 2022

hawkeye:::1566804137305550:10.916452863840735





Collected: 13 May 2022

2022 July - Road ID: 249 Aetsantie Forward 10.928km L0 [Front Center]  
Lat/Lon: 61.32042, 22.78476



2022 August - Road ID: 249 Aetsantie Forward 10.928km L0 [Front Center]  
Lat/Lon: 61.32042, 22.78476



2022 September - Road ID: 249 Aetsantie Forward 10.928km L0 [Front Center]  
Lat/Lon: 61.32042, 22.78476



2023 September - Road ID: 249 Aetsantie Forward 10.928km L0 [Front Center]  
Lat/Lon: 61.32042, 22.78476



2023 September - Road ID: 249 Aetsantie Forward 10.928km L0 [Front Center]  
Lat/Lon: 61.32042, 22.78476

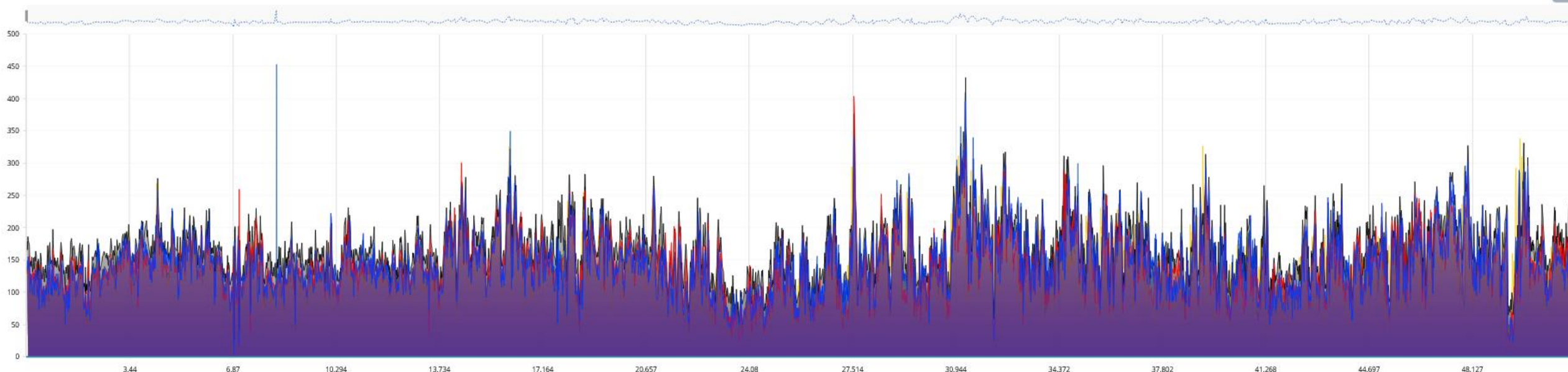
Collected: 6 Sep. 2023

# E-iPAVe Road Infrastructure measurements: Reliability comparing data from 2022 and 2023 : SCI300

Road ID 43 Forward - Eurantie

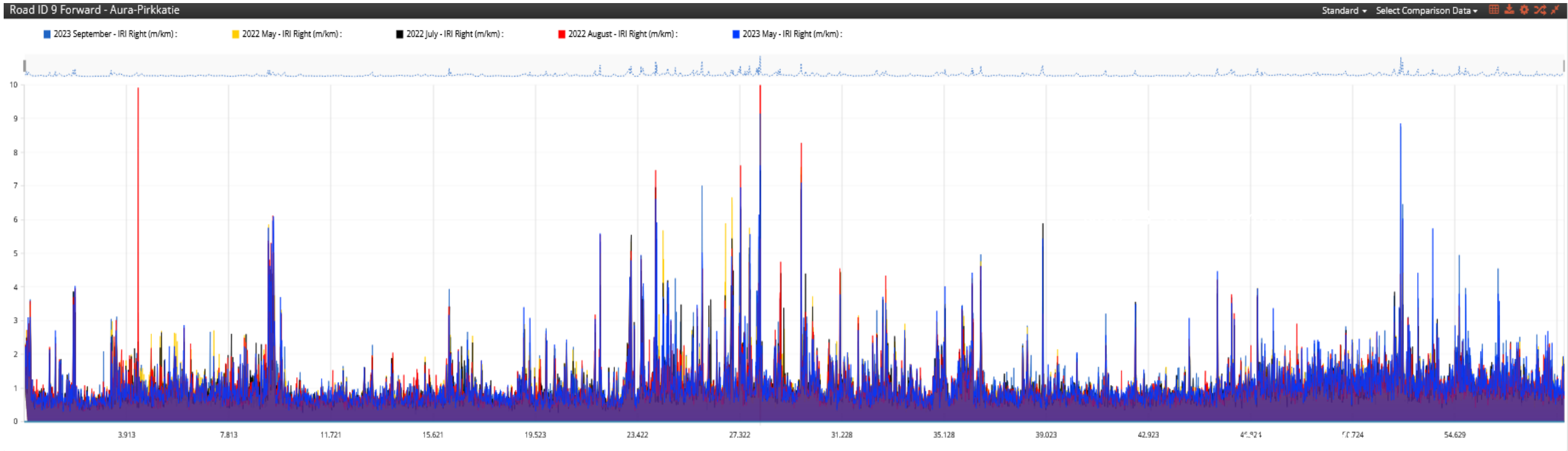
Standard Select Comparison Data

2023 September - SCI-300 (um) : 2022 May - SCI-300 (um) : 2022 July - SCI-300 (um) : 2022 August - SCI-300 (um) : 2023 May - SCI-300 (um) :

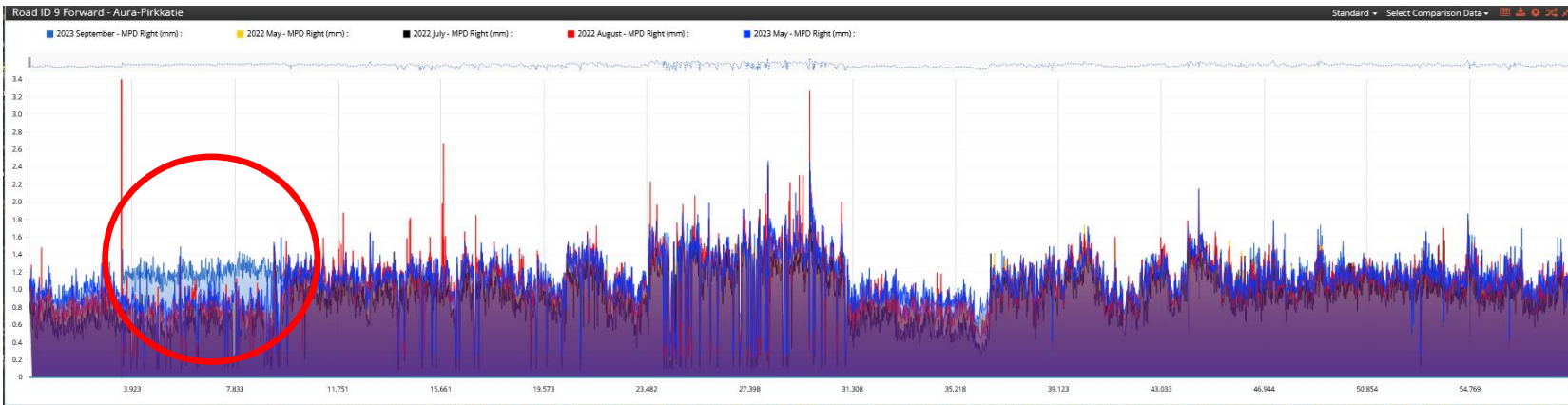
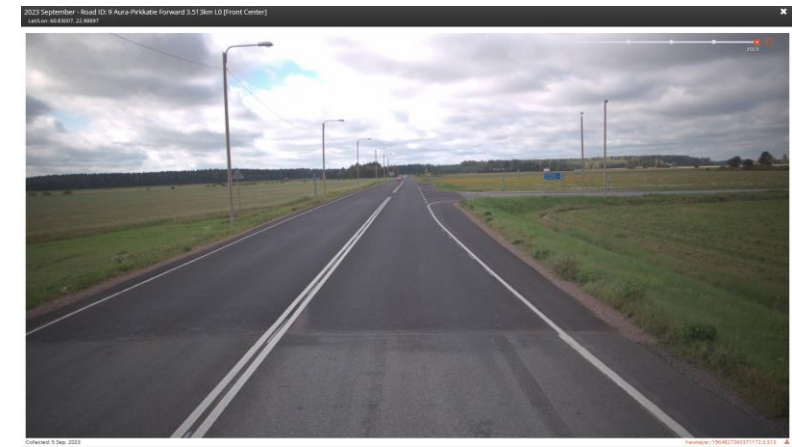




# E-iPAVe Road Infrastructure measurements: Reliability, comparing data from 2022 and 2023 : IRI

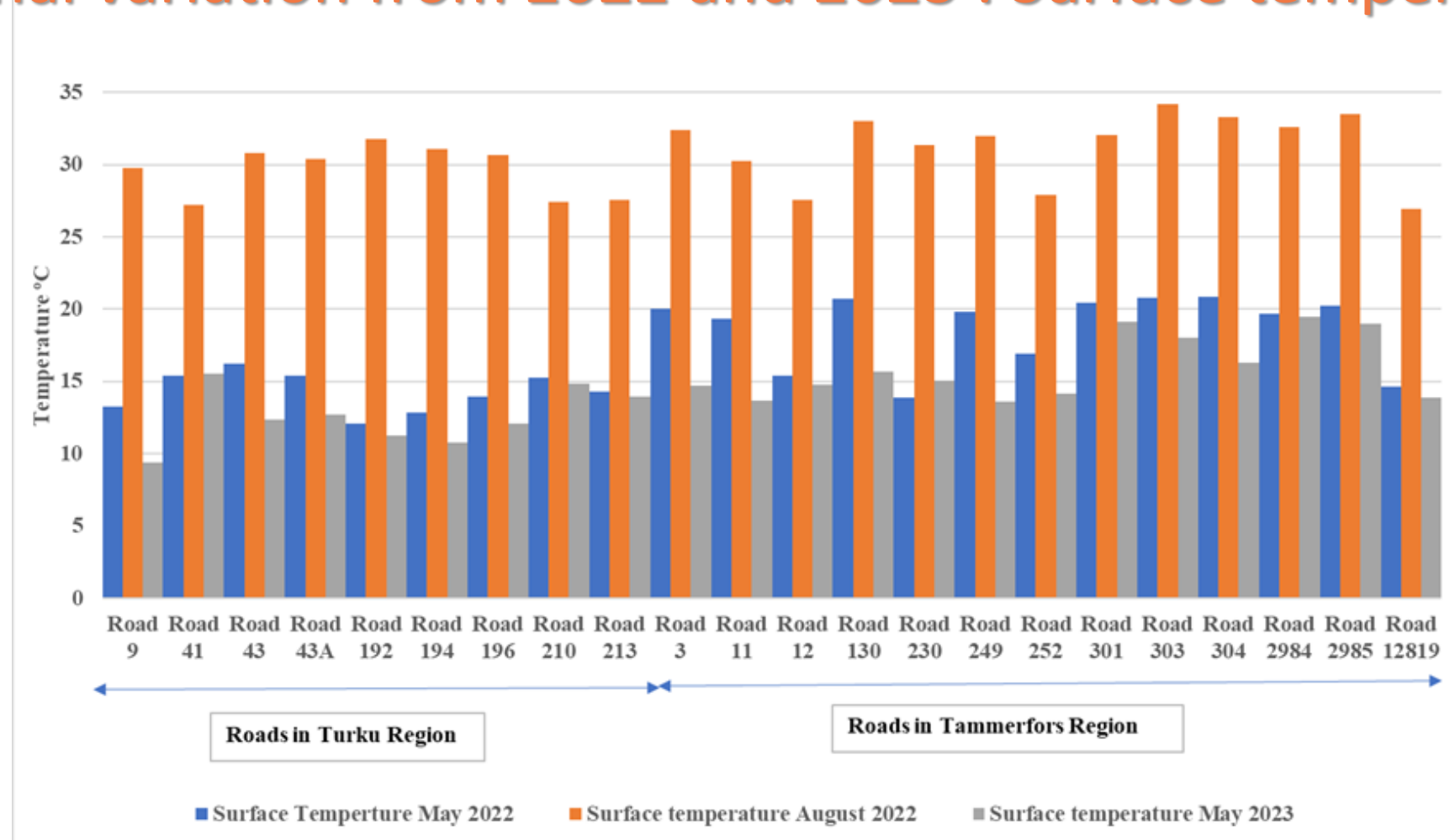


# E-iPAVe Road Infrastructure measurements: Reliability comparing data from 2022 and 2023 : Texture





# E-iPAVe Road Infrastructure measurements: Seasonal variation from 2022 and 2023 : Surface temperature

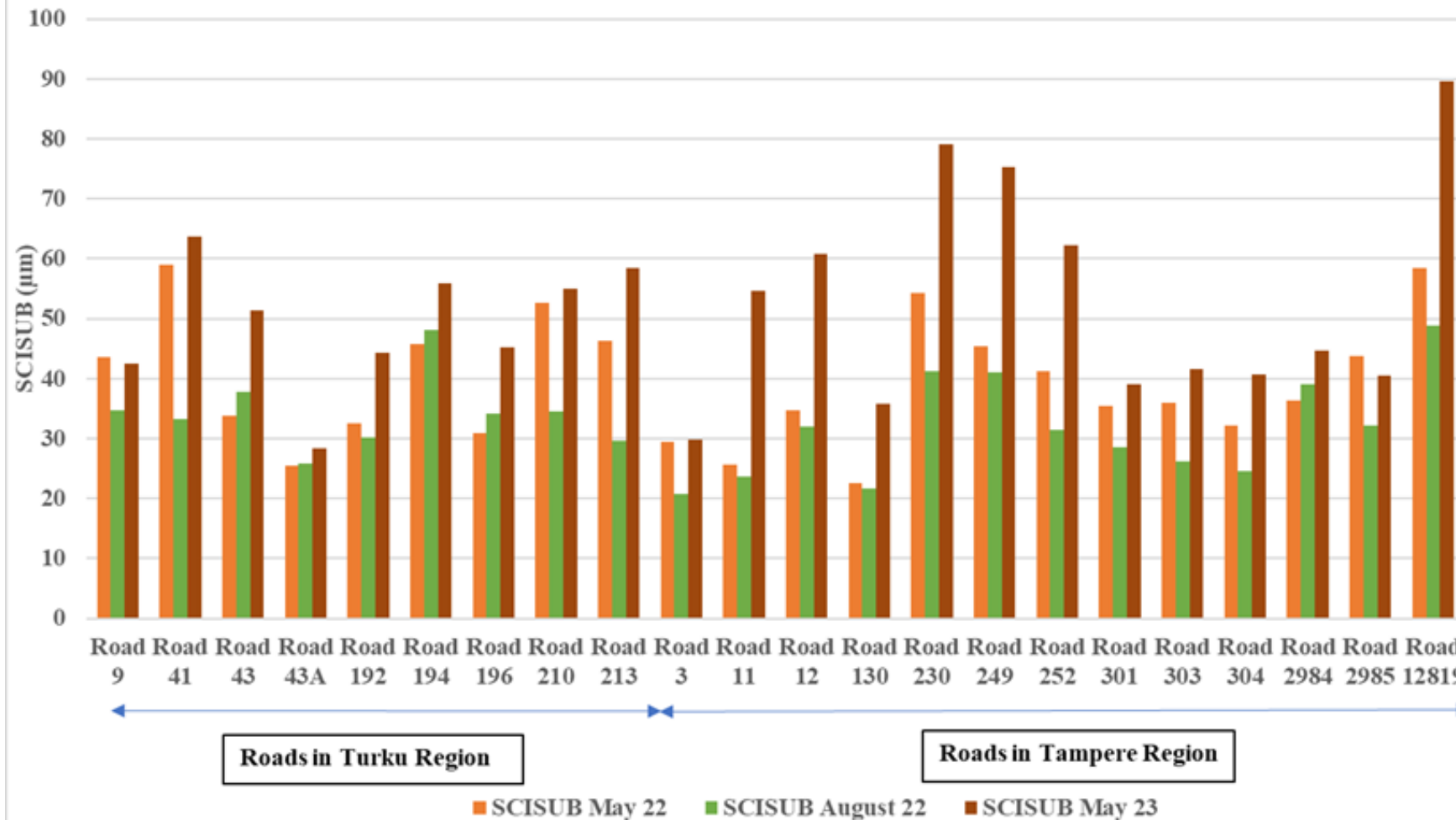


# E-iPAVe Road Infrastructure measurements: Seasonal variation from 2022 and 2023 : Structural capacity

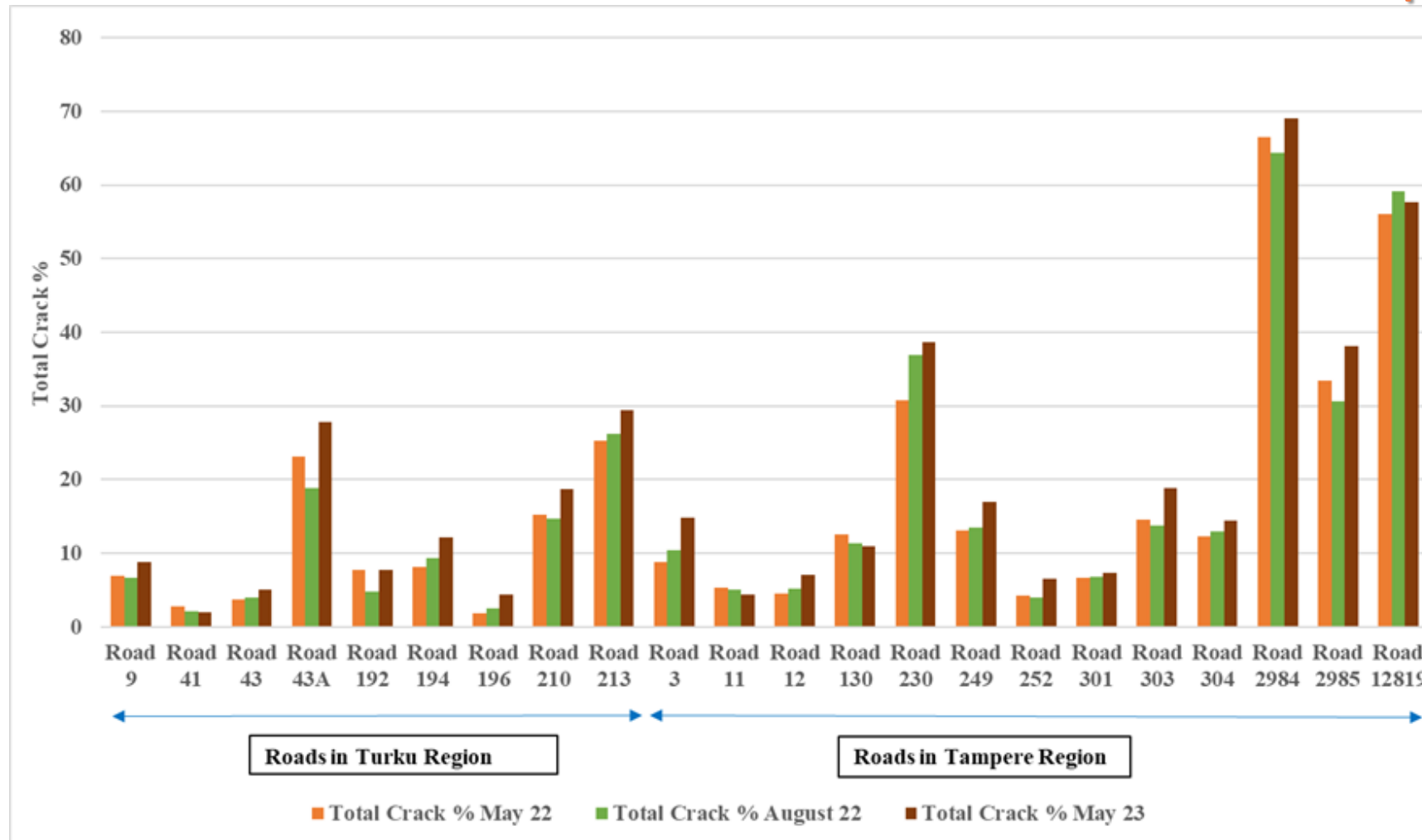




# E-iPAVe Road Infrastructure measurements: Seasonal variation from 2022 and 2023 : Structural capacity

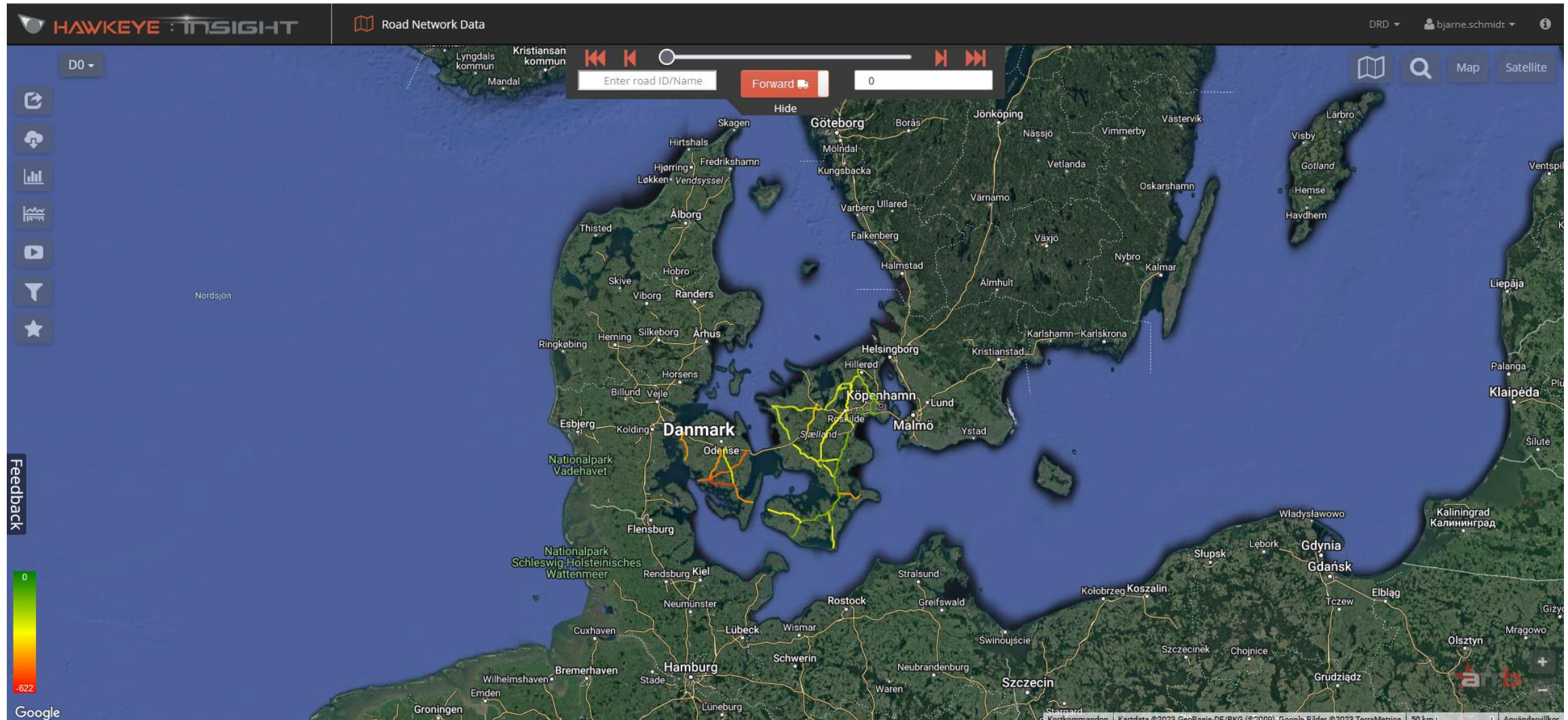


# E-iPAVe Road Infrastructure measurements: Seasonal variation from 2022 and 2023 : Crack development



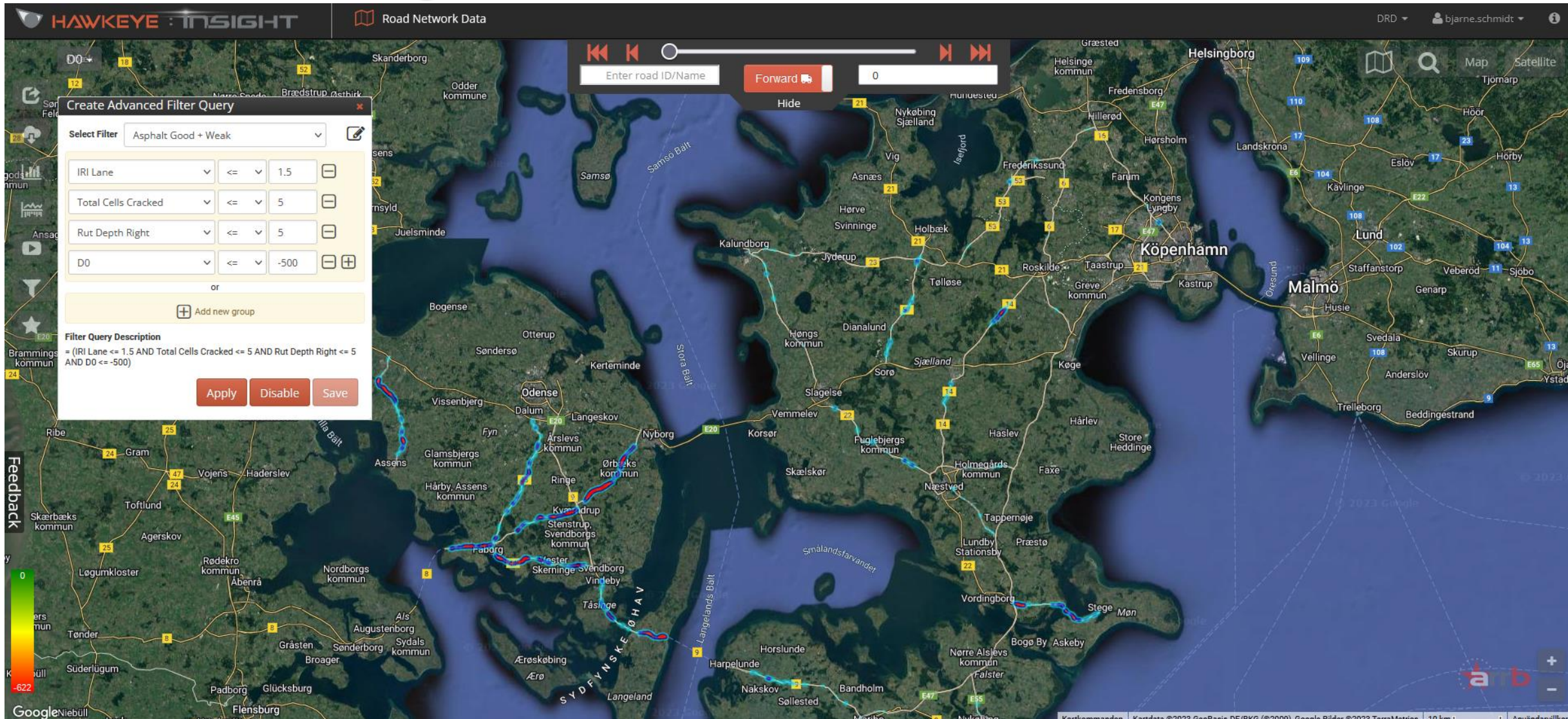


# E-iPAVe Road Infrastructure measurements:





# E-iPAVe Filtering data



**HAWKEYE INSIGHT** Road Network Data

DRD | bjarne.schmidt

Enter road ID/Name | Forward | 0 | Hide

**Create Advanced Filter Query**

Select Filter: Asphalt Good + Weak

IRI Lane	<=	1.5
Total Cells Cracked	<=	5
Rut Depth Right	<=	5
D0	<=	-500

or

+ Add new group

**Filter Query Description**  
= (IRI Lane <= 1.5 AND Total Cells Cracked <= 5 AND Rut Depth Right <= 5 AND D0 <= -500)

Apply | Disable | Save

Feedback

0 | -622

Google | Niebüll

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- Questions?

## Data driven pavement people.

While we're driven by a passion for data and technology, our purpose is people and the pavements that take them smoothly and safely from A to B.

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**PAVEMENT MANAGEMENT INTELLIGENCE**