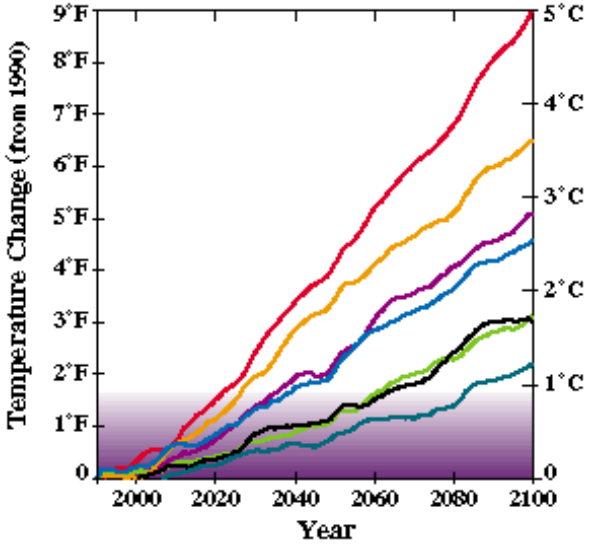
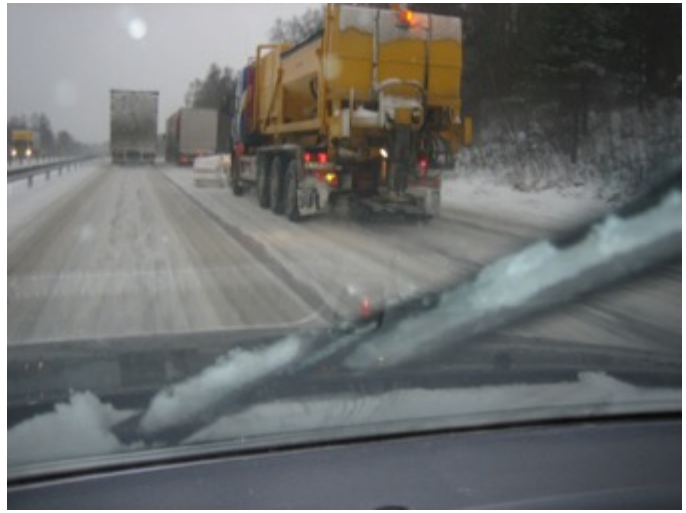
IRWIN

Improved winter index for maintenance and climate scenarios

Torbjörn Gustavsson



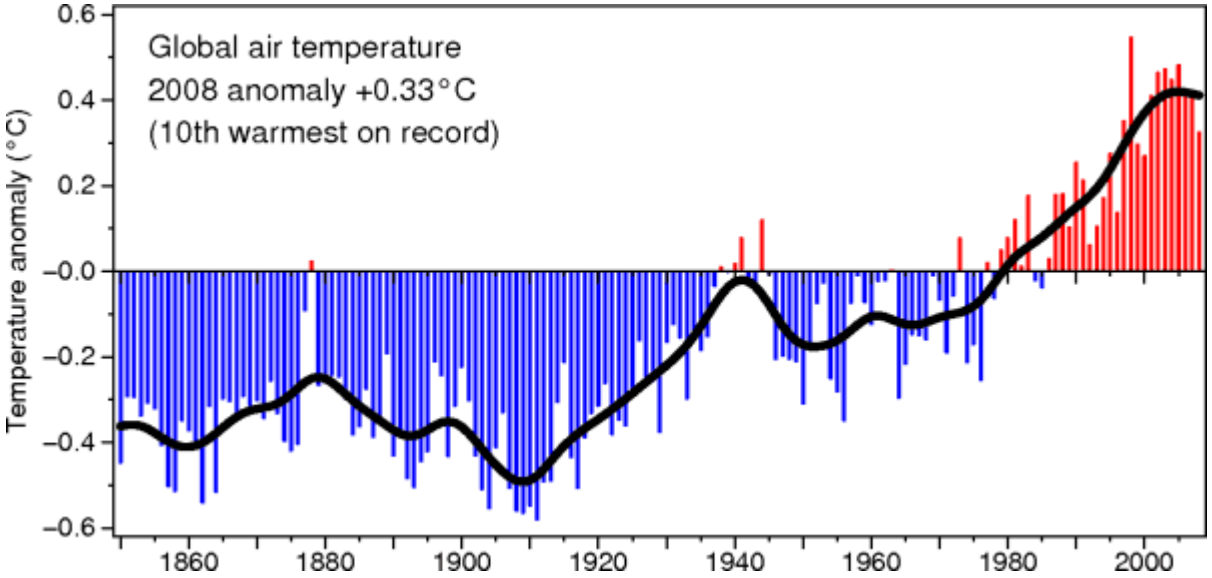


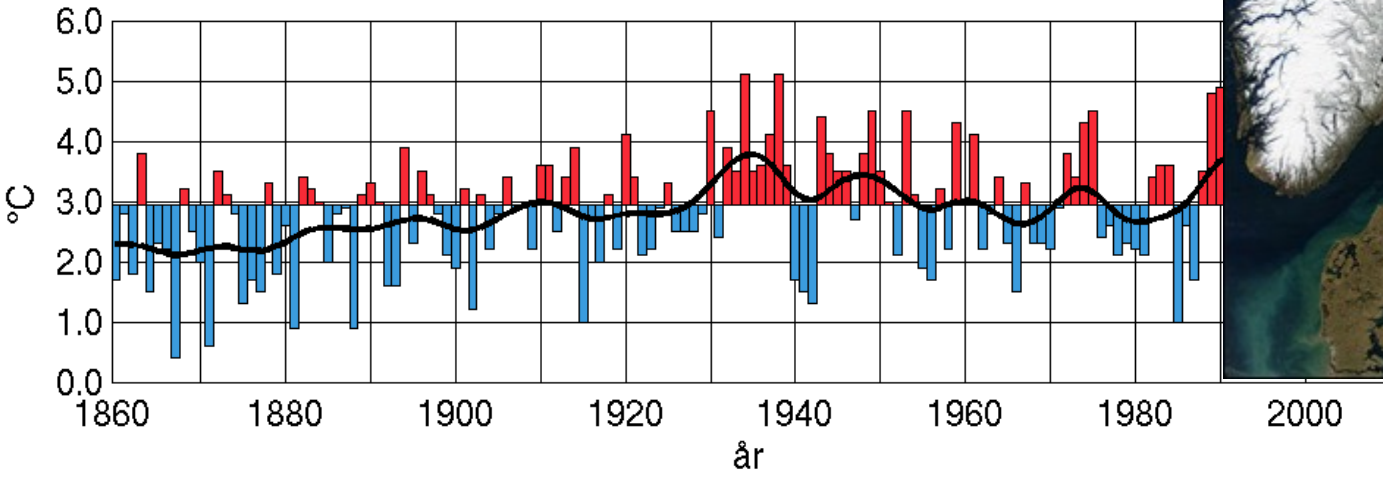
Pirkko Saarikivi, Dave Rayner, Jörgen Bogren, Caroline Tengroth

IRWIN in brief

- ERA-NET Road project IRWIN from November 2008 to December 2009 with three partners:
- Foreca Consulting Ltd, Finland
- Klimator AB, Sweden
- University of Gothenburg Regional Climate Group

- Aim: Downscaling climate scenarios on road network to develop locally accurate winter index, ideal for road maintenance assessments

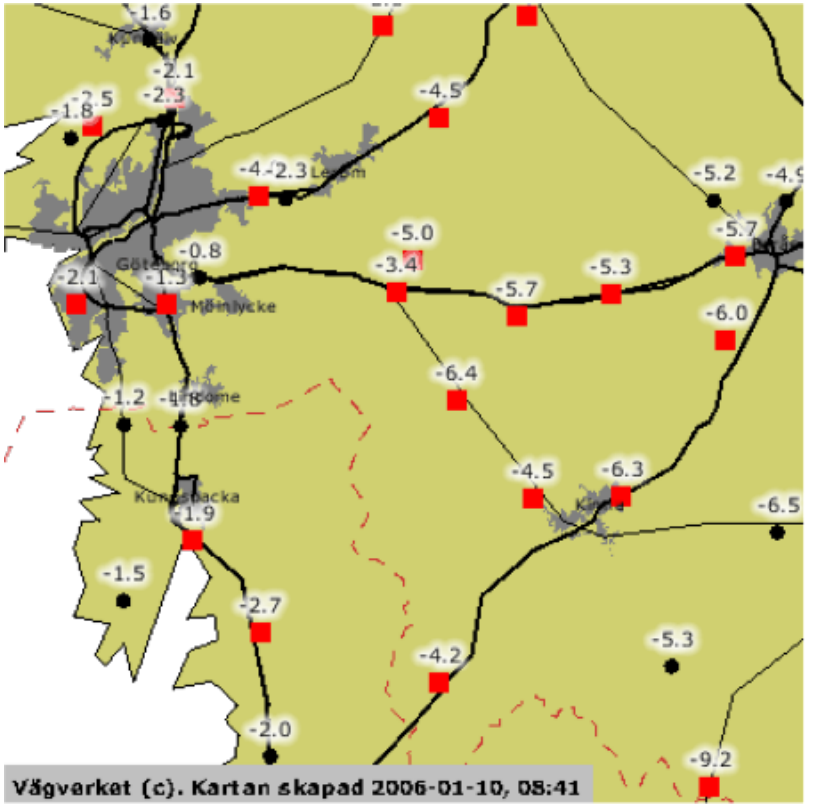

Global air temperature
2008 anomaly +0.33°C
(10th warmest on record)
Temperature anomaly (°C)
0.6
0.4
0.2
−0.0
−0.2
−0.4
−0.6
1860
1880
1900
1920
1940
1960
1980
2000


°C
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1860
1880
1900
1920
1940
1960
1980
2000
år

Road Weather Information Stations

RWIS station

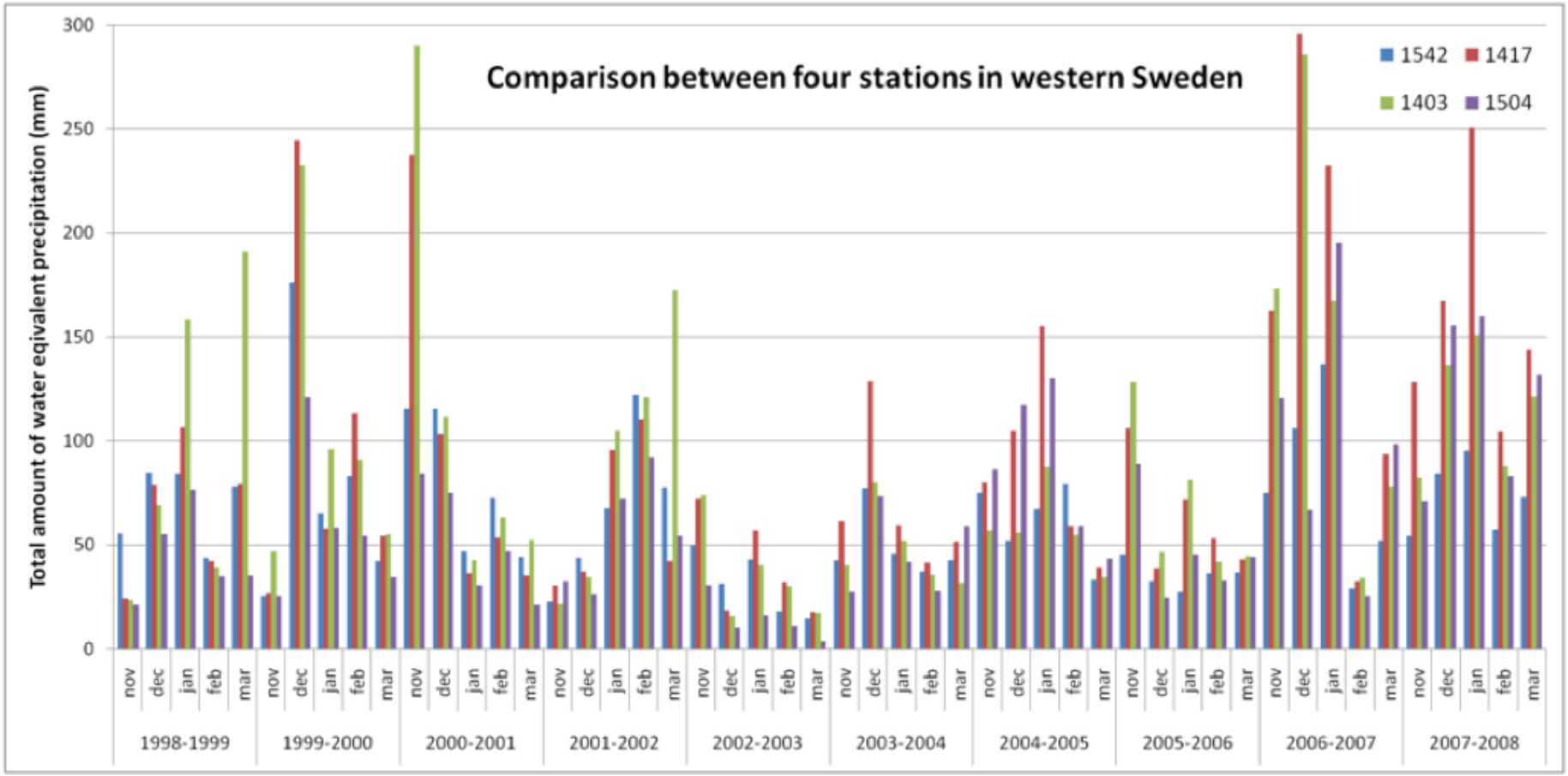
Synoptic station



Advantages of RWIS data

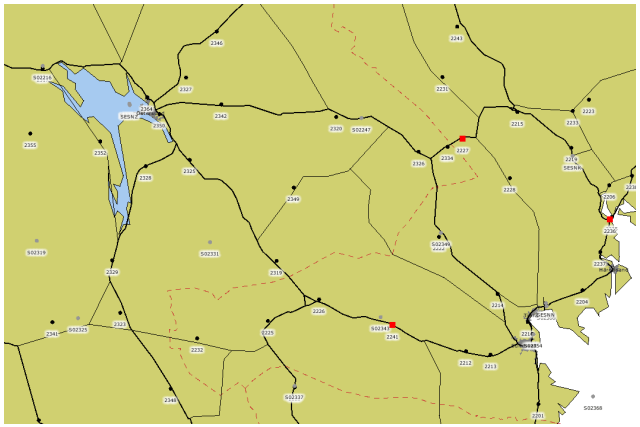
- Measurements close to the road
- Data used by maintenance for decisions
- Frequent measurements (30 minutes)
- High frequency of field stations

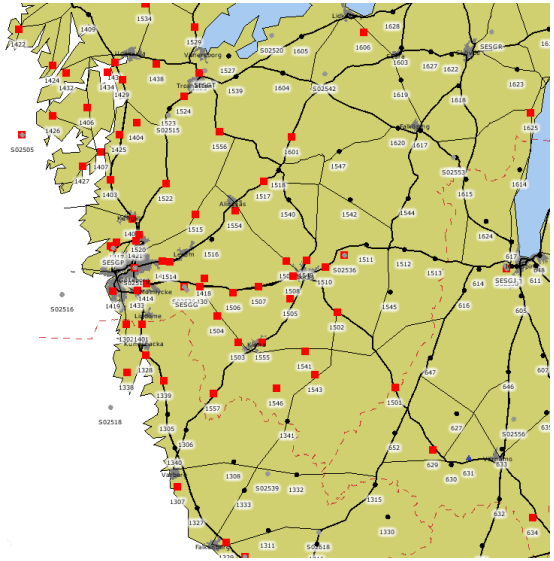
RWIS-data

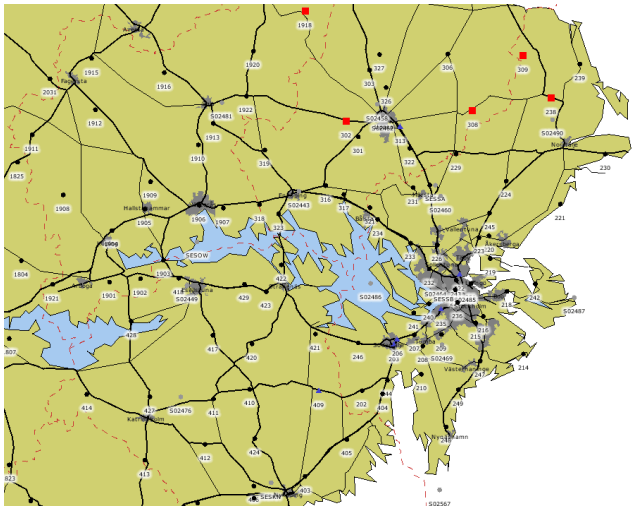

Comparison between four stations in western Sweden
1542
1417
1403
1504
Total amount of water eqivalent precipitation (mm)
300
250
200
150
100
50
0
nov dec jan feb mar
1998-1999
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
2005-2006
2006-2007
2007-2008

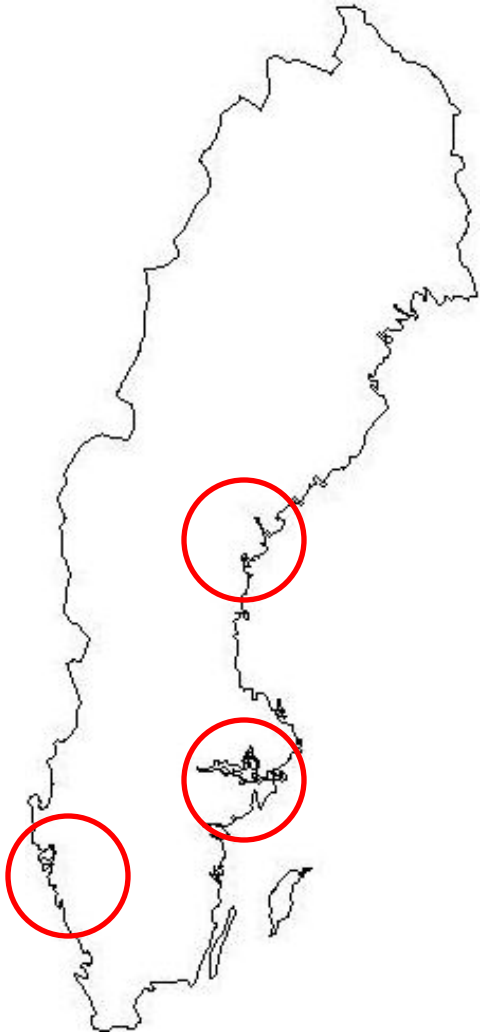
Three areas in Sweden

- Gothenburg
- Stockholm
- Sundsvall



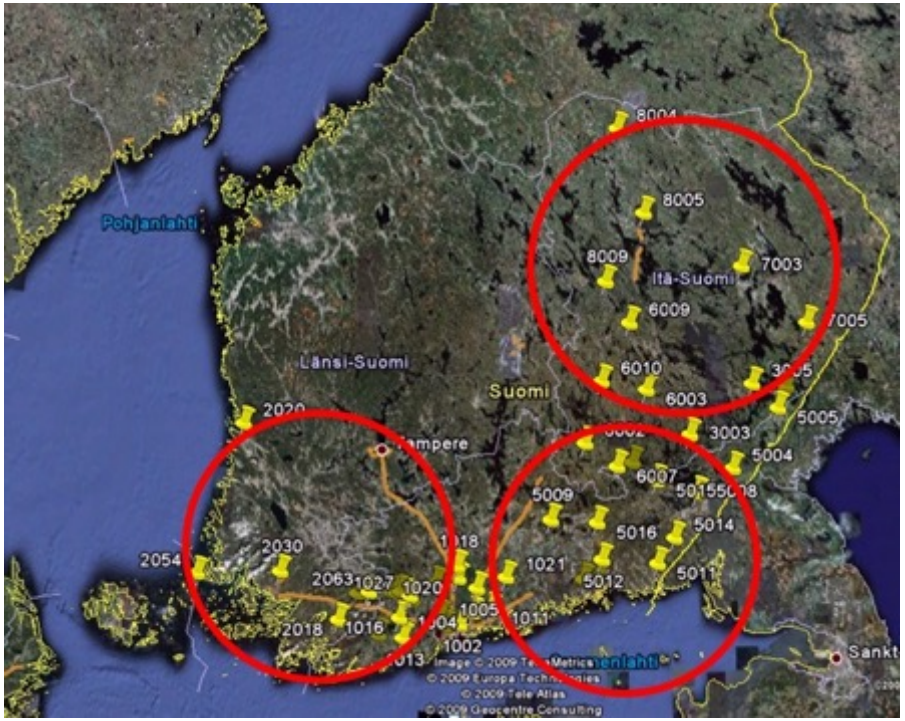






Three areas in Finland

FinnRA stations



IRWIN stations and areas

The climate scenarios generated in *IRWIN* are based on outputs from two GCMs:

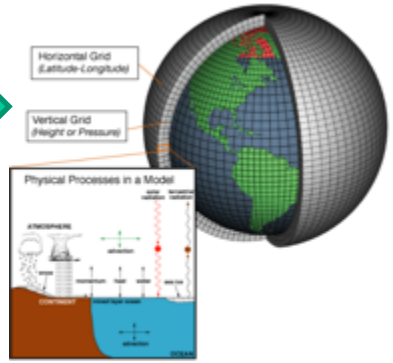
- CCSM3 - *Community Climate System Model, version 3.0, from the National Center for Atmospheric Research (NCAR) in US*

- ECHAM5 - *ECHAM5/MPI-OM model from Max Planck Institute for Meteorology*

Climate scenario to 2025-2055

Method

RWIS – database 1998 - 2008



RWIS – database 2025 - 2055

Index calculations

Adaptation cost analyse

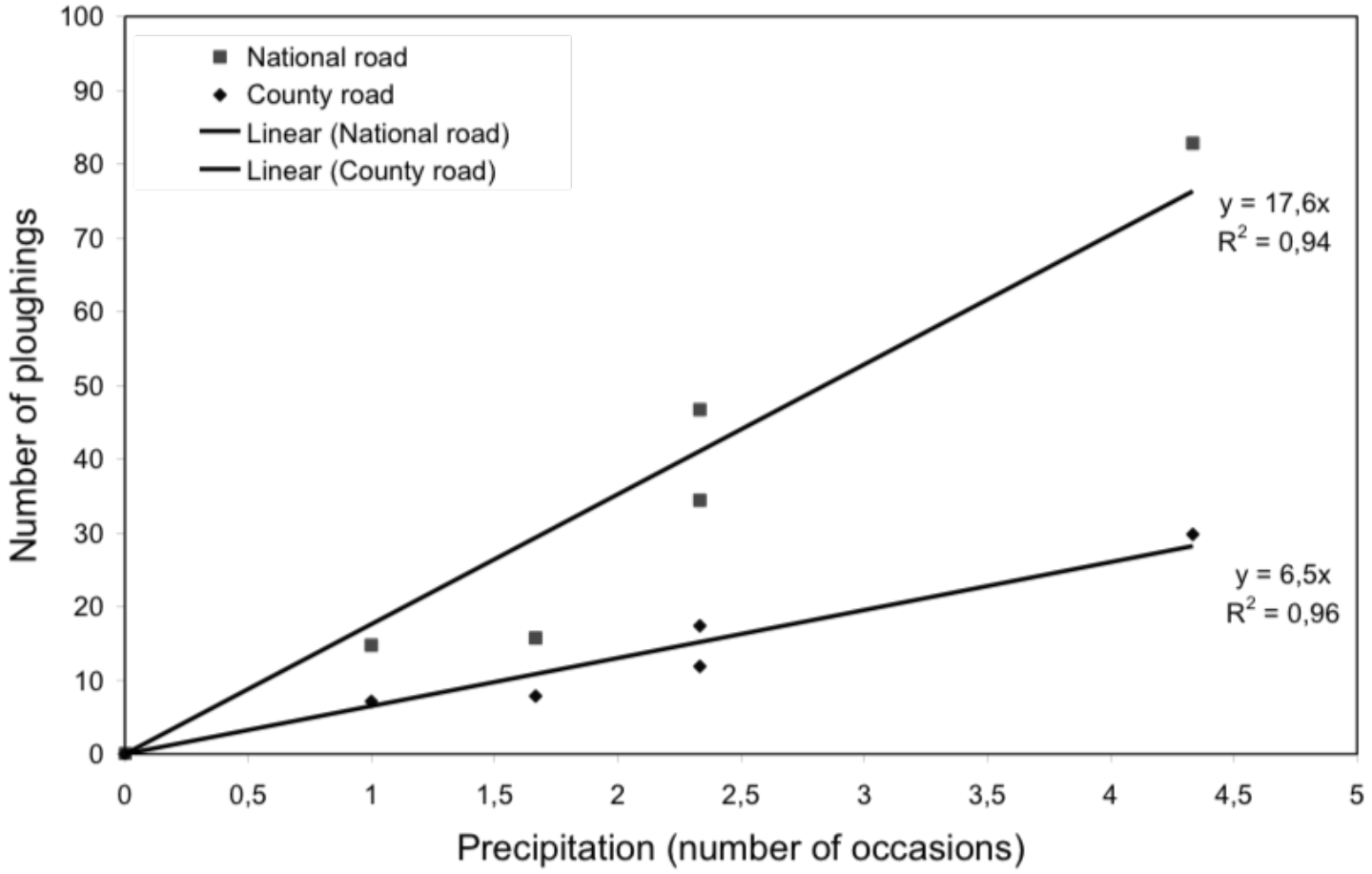
Winter Index

$$WI = \sum (A_{ice} + B_{frost} + C_{Prec} + D_{drift})$$

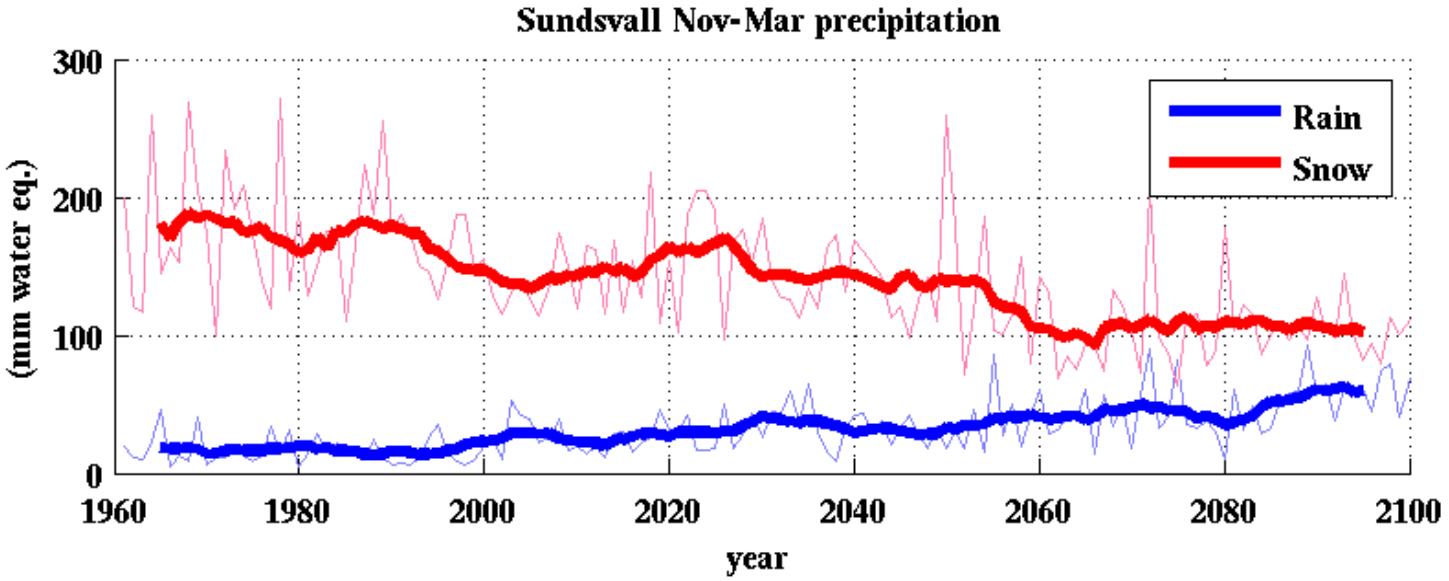
- A_{ice} – situation with risk of road icing
- B_{fost} – situation with risk of hoar frost
- C_{Prec} – situation with precipitation
- D_{drift} – situations with drifting snow

- Index measures need for Salting and Plowing
- Takes into account also strong winds and extreme precipitation for design and planning

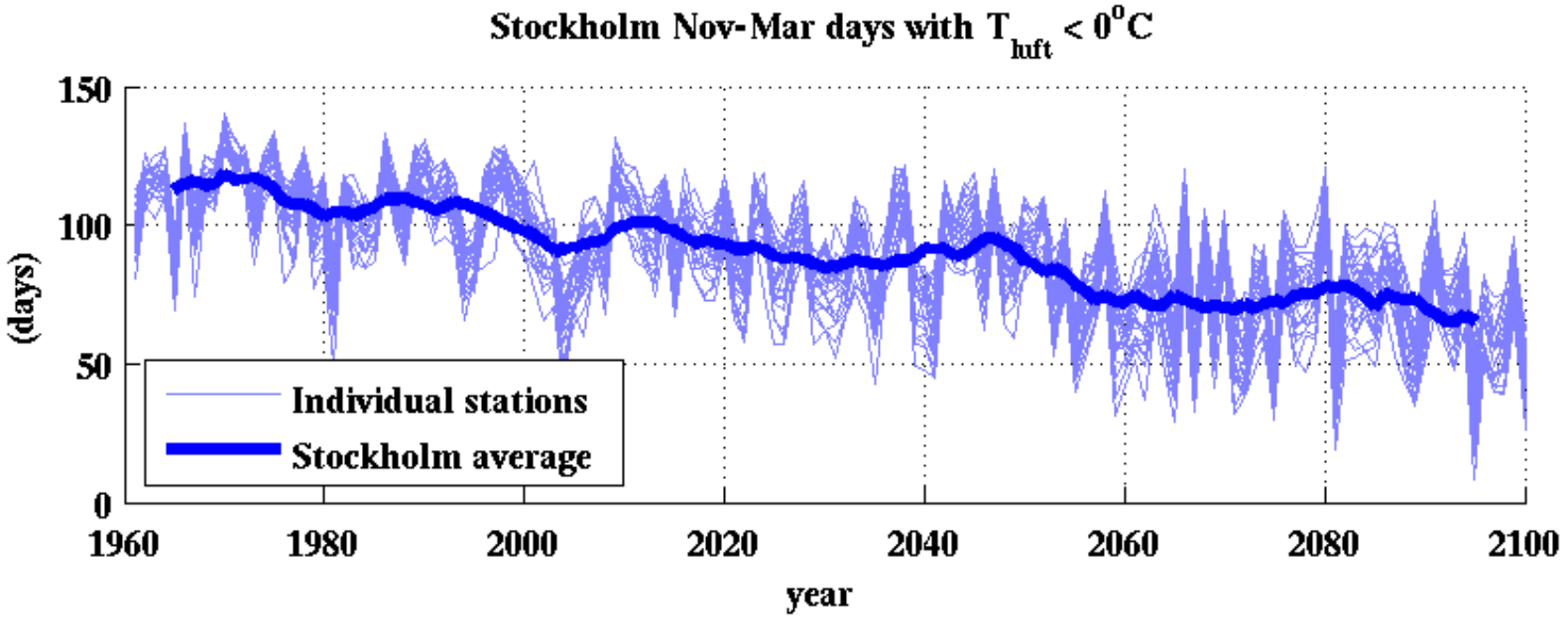
Use of index calculation to determine need of maintenance activities



Example of data/output

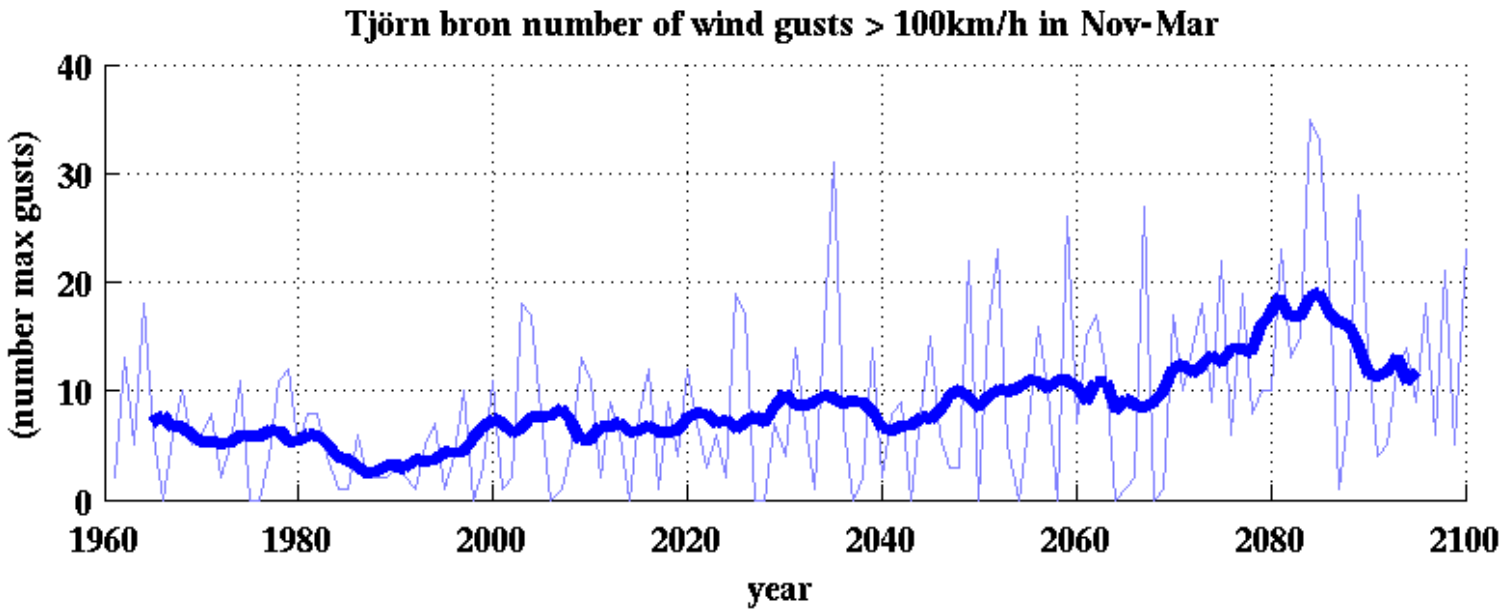


Average November-to-March rain- and snowfalls for all stations in the Sundsvall region for the ECHAM-5 based scenario. Thin lines are annual means, thick lines are 10-year averages. Under this scenario, the amount of snow declines by nearly 50% by year 2100, whereas the rainfall increases by over 100%. This demonstrates the value of the IRWIN statistical downscaling methodology – the publicly available GCM outputs do not differentiate between rain and snow, only total precipitation is provided.



Number of days in the winter season (November-to-March) in the Stockholm region where the air temperature falls below 0ºC.

Under this ECHAM-5 based scenario the number of days where temperature falls below freezing will decrease by ~30% by 2100.



Number of 30-minute periods where the maximium wind gust exceeds 100km/h on the Tjörn Bridge, for the ECHAM-5 based scenario.

The number of wind gusts over 100km/h increase significantly in this scenario.

Change in snow events

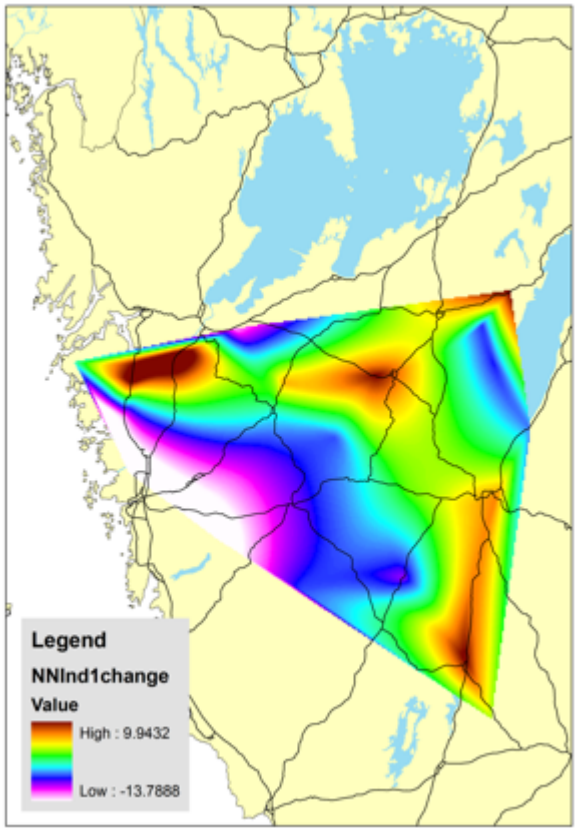
Area	Snow 1 – 3 mm	Snow 3 – 5 mm	Snow > 5 mm
S1	-8,9%	-8,3%	-7,5%
S2	-15,4%	-17,4%	-15,0%
S3	-3,0%	-4,2%	-8,5%
F1	-4,8%	-2,8%	-0,6
F2	-4,3%	-1,7%	2,5%
F3	-0,6%	0,5%	1,9%

Change in salting indexes

Area	% change Index 7	% change Index 8	% change Index 9
S1	-2 %	-2 %	-2 %
S2	-7 %	2 %	5 %
S3	15 %	16 %	23 %
F1	-5 %	3 %	6 %
F2	12 %	10 %	16 %
F3	13 %	11 %	18 %

Index 7: road icing
Index 8: hour frost
Index 9: surface temp around 0°C

Local changes in ploughing need



	km 1980-2010	km 1980-2011	km change
Index1	51970	50209	-1761
Index2	4775	4569	-207
Index3	0	0	0
Index4	20603	14875	-5728
Index5	2062	1814	-248
Index6	0	0	0
Index7	14002	13693	-309
Index8	144543	141814	-2730
Index9	96934	94765	-2169

Index calculation in relation to:
road length, road type, topography, land use & Climate

Benefits of IRWIN project

- better linkage between weather and maintenance needs
- better understanding of variations to be expected
- better knowledge of impact from climate change on maintenance needs
- better coveradge of extreme events
- Final report IRWIN 2009: Improved local winter index to assess maintenance needs and adaptation costs in climate change scenarios. ENR SRO3 report, http://www.eranetroad.org

Advice to Road Owners

- Archive all your RWIS data with good meta-data on stations, sensors and formats
- Do not change station numbering or sites
- For climate studies, long and un-interrupted time series required (minimum 10 years)
- Raw data must be interpolated for analysis to regular 30 min intervals
- Similar index calculations can be made in other areas if good enough data available

Contact information

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