



A new model for a winter index to estimate and evaluate consumption of salt

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4. Further steps



1. INTRODUCTION

Motivation for the development

In the winter 2009/10 Germany experienced unusually intensive winter weather. The salt suppliers were not able to fully meet the additional demand.

→ question: How many tons of de-icing agents are required for the winter service in a strong winter?

Traditional indexes work with relative values.

New: Model for calculation with the amount of salt

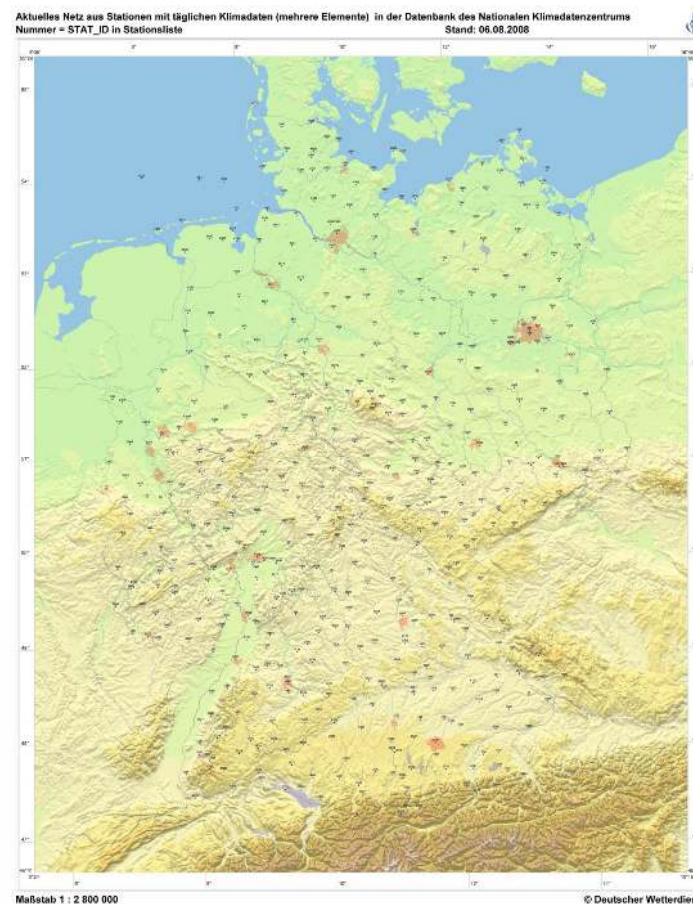


**Aim: Improve planning for salt storages
and the subsequent delivery quantities to avoid shortage of supply**

2. Basics: Meteorological data

from about 500 measurement stations of the climatically measuring network of the weather service (DWD)

- Daily maximum air temperature
- Daily minimum air temperature
- Relative air humidity at 06:00 a.m.
- Relative air humidity at 12:00
- Relative air humidity at 06:00 p.m.
- Height of precipitation per day
- Height of new snow per day
- Existing snow height during the day



2. Basics: Spreading scenarios

Black ice or icy condition:

Condition: Minimum air temperature $\leq 0^{\circ}\text{C}$, height of precipitation > 0 mm (no snowfall)

Spreading scenario:

2x20 g/m² (one prevented application, once after precipitation)

40 g/m² per day

Packed snow:

Condition: Snowfall

Spreading scenario:

One prevented application of 20 g/m², per 2 cm snowfall 20 g/m², maximum 7x per day

20 g/m² + 10 g/m² per cm snowfall, maximum 160 g/m² per day

Slippery frost:

Condition: Minimum air temperature $\leq 0^{\circ}\text{C}$, no precipitation, relative air humidity $> 90\%$

Spreading scenario:

one application with 10 g/m² per day

10 g/m² per day

All densities are for dry sodium chloride

2. Basics: Data of road surface area

Federal motorways: Length x 20 m width
Federal roads: Length x 8 m width
State roads: Length x 6 m width
District roads: Length x 5 m width
Urban streets: Length x 7 m width
(including sidewalks)



For the model calculation:
the surface data are equally distributed around
the meteorological measurement stations

2. Basics : Processing time – scope of treatment

Federal motorways:	0 h – 24 h (all areas)	= 100 %
Federal roads:	6 h – 22 h (all areas)	= 67 %
State roads:	6 h – 22 h (all areas)	= 67 %
District roads:	6 h – 22 h (all areas)	= 67 %
Urban roads:	different, not all areas	= 10 %

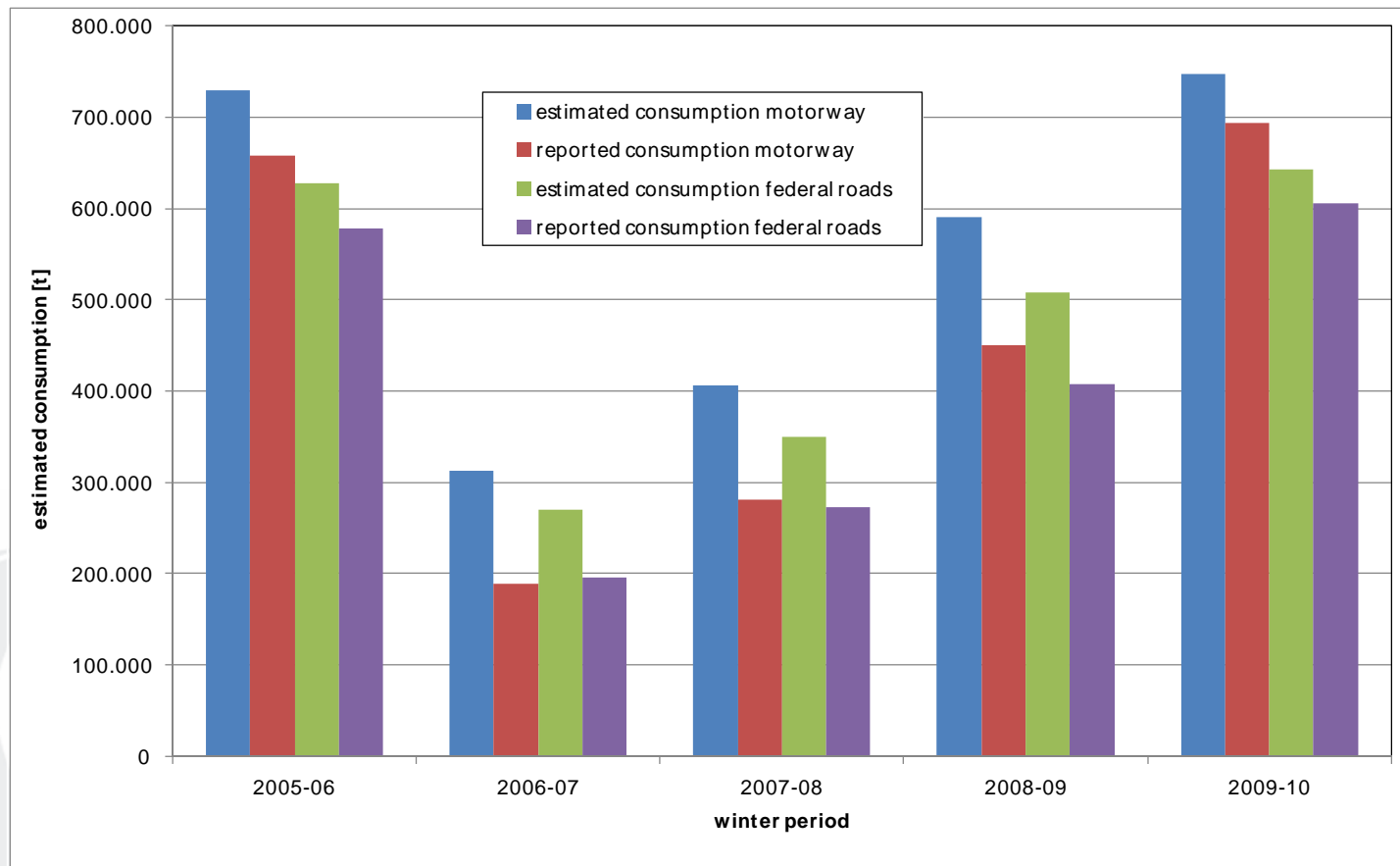


3. Application: Summary for all roads in Germany 2009/2010

		Motorway	Federal roads	State Roads	District roads	Local roads
	km	12.594	40.413	86.607	91.565	457.171
	Width [m]	20	8	6	5	7
	Surface area [m ²]	251.880.000	323.304.000	519.642.000	457.825.000	3.200.197.000
	Proportion per station (525)	479.771	615.817	989.794	872.048	6.095.613
Salting applikation density per day	Frequency of salting densities with regard to all stations	Application quantity [t]	Application quantity [t]	Application quantity [t]	Application quantity [t]	Application quantity [t]
10	9990	47.929	61.520	98.880	87.118	608.952
30	3438	49.484	63.515	102.087	89.943	628.702
40	20716	397.558	510.291	820.183	722.614	5.051.069
50	1542	36.990	47.480	76.313	67.235	469.972
60	1031	29.679	38.094	61.229	53.945	377.075
70	818	27.472	35.262	56.676	49.933	349.035
80	560	21.494	27.589	44.343	39.068	273.083
90	355	15.329	19.675	31.624	27.862	194.755
100	301	14.441	18.536	29.793	26.249	183.478
110	162	8.550	10.974	17.638	15.540	108.624
120	218	12.551	16.110	25.893	22.813	159.461
130	97	6.050	7.765	12.481	10.997	76.866
140	95	6.381	8.190	13.164	11.598	81.072
150	42	3.023	3.880	6.236	5.494	38.402
160	286	21.954	28.180	45.293	39.905	278.935
	Total per road type [t]	698.883	897.061	1.441.833	1.270.312	8.879.480
	treatment ratio [%]	100	67	67	67	10
	Total after discount	698.883	601.031	966.028	851.109	887.948
	Overall total [t]					4.004.999
	reported consumption	693.900	606.000	With 7% added due to lacking data		4.285.349

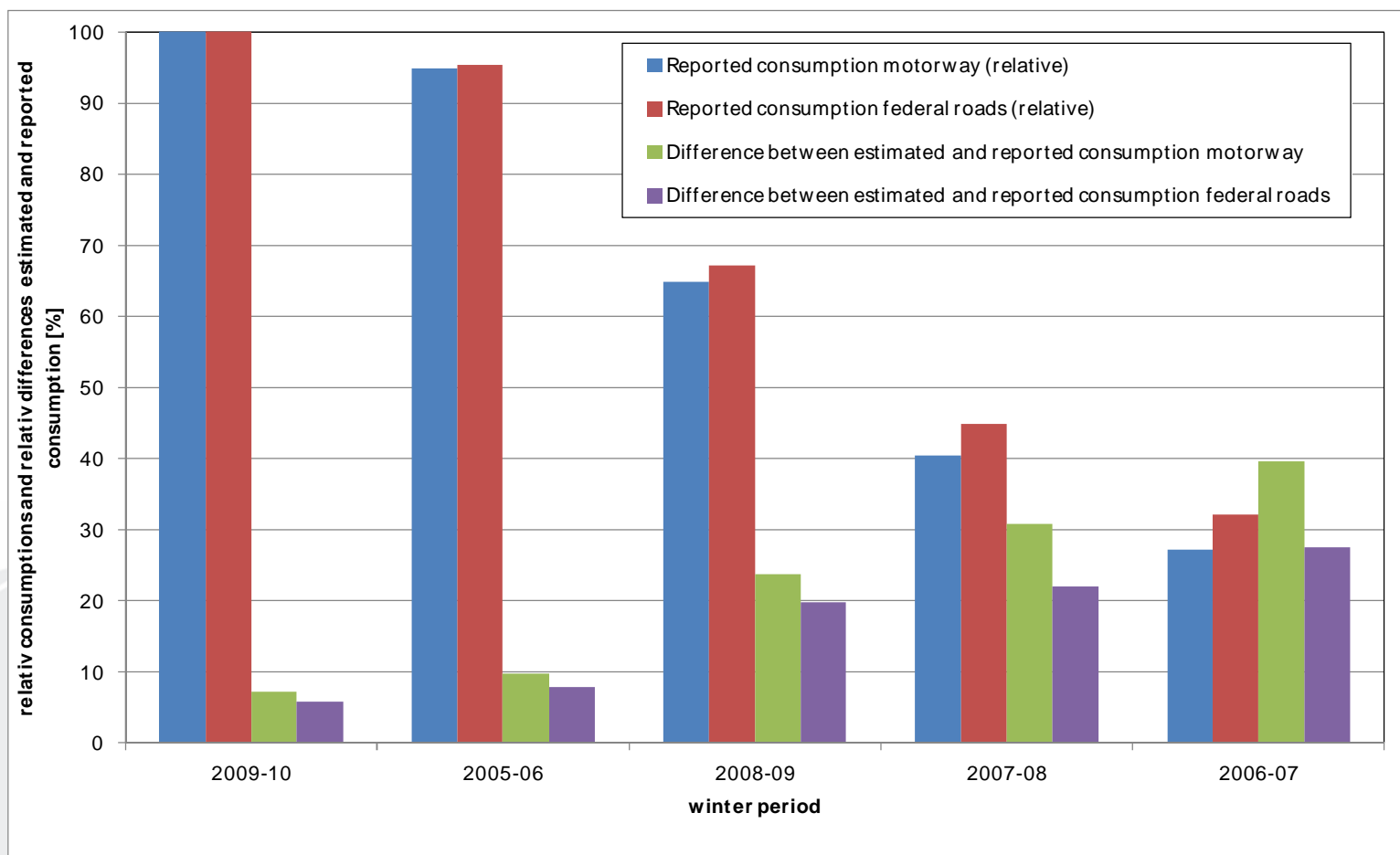
3. Application: Winter 2005 – Winter 2010

comparison of estimated and reported consumption
(only motorways and federal roads)



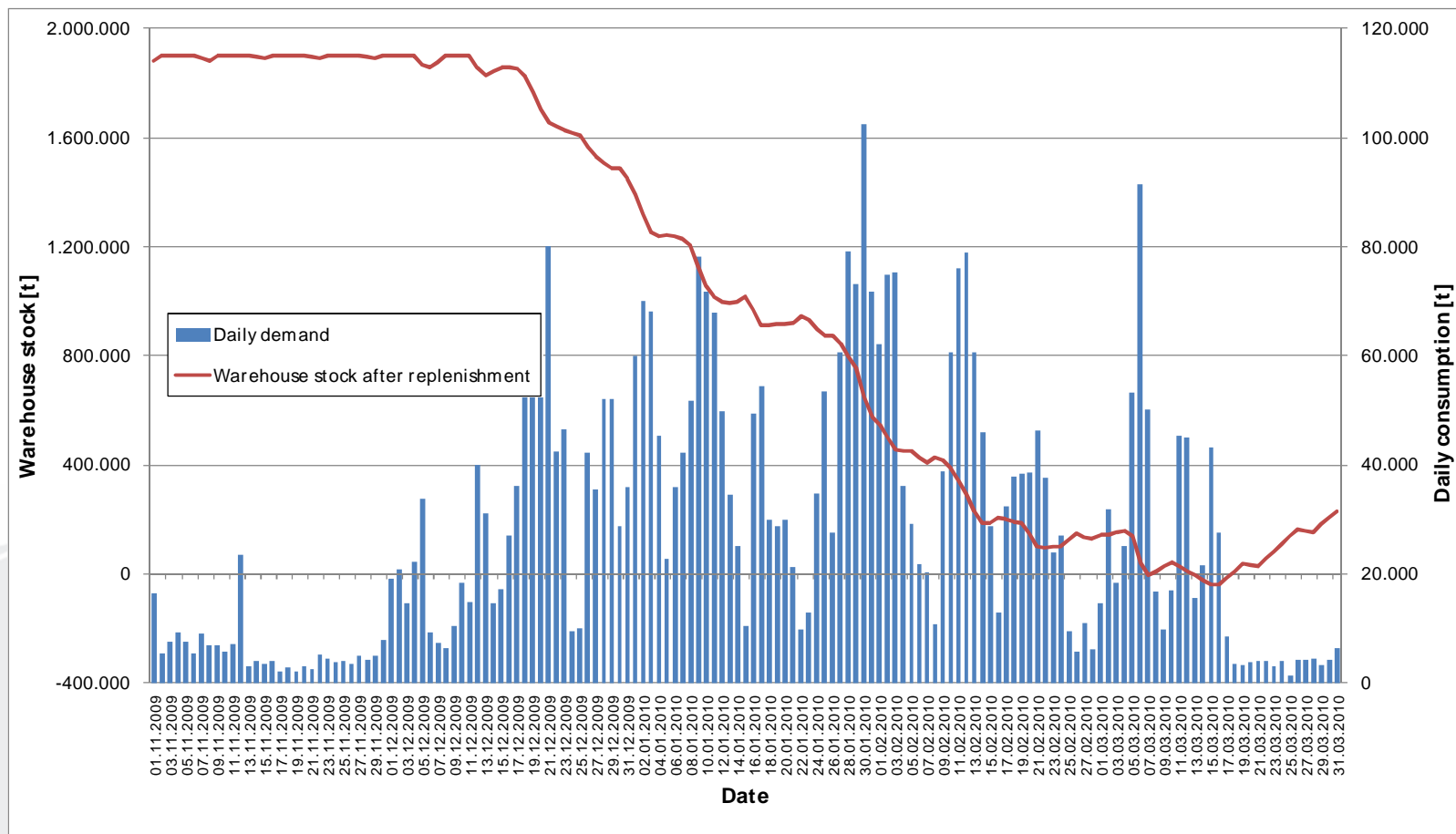
3. Application:

Differences between estimated and reported consumptions depending on consumption (all values are relative, only for motorways and federal roads)



3. Application: Estimated daily consumption of de-icing salt

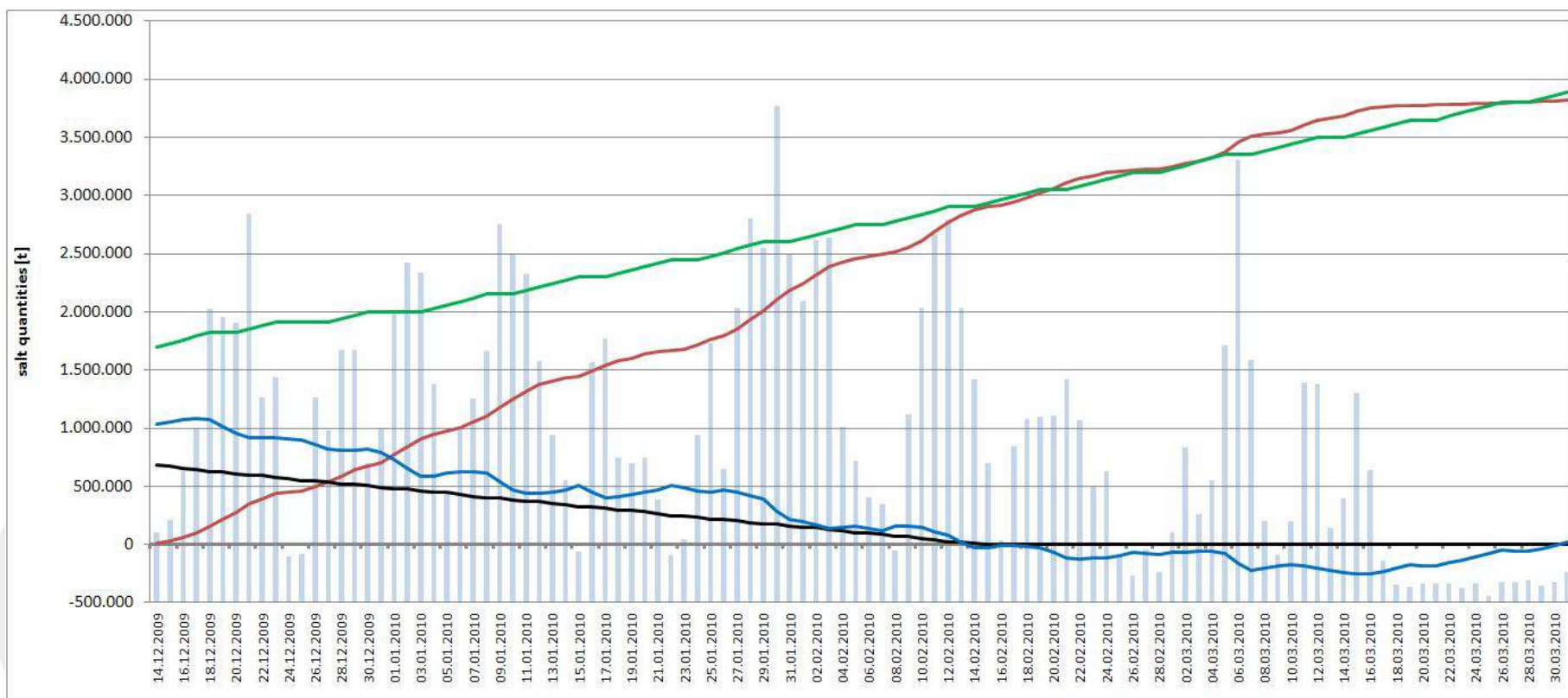
Winter of 2009/2010 for all roads: with the development of storage assuming ideal re-supplies of up to 30,000 tons daily



3. Application: scenario for all roads in winter 2009/10

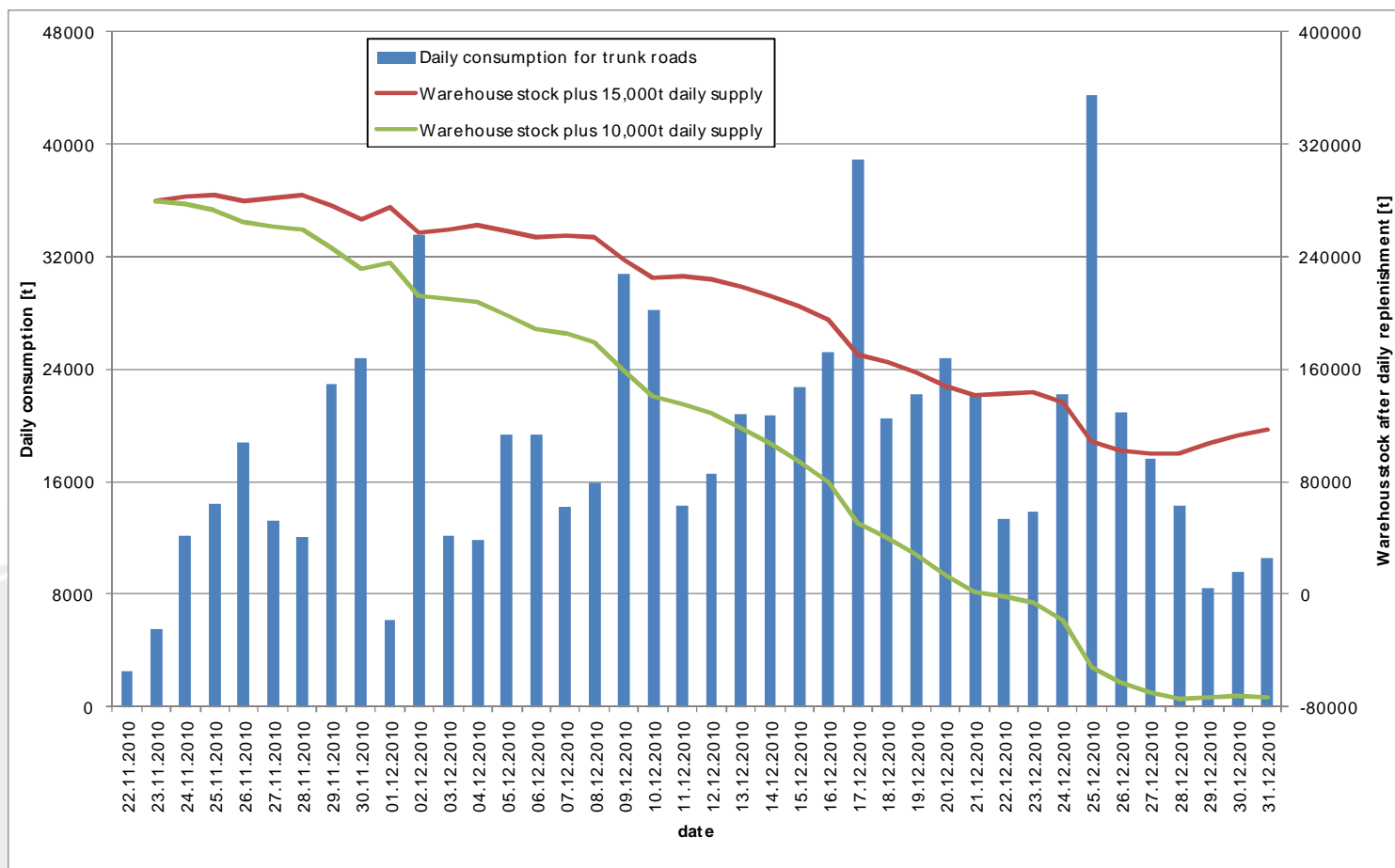
daily supply : 45.000 t
daily production : 30.000 t

- Daily demand
- Used quantity (cumulative)
- Warehouse and supply without consumption
- Warehouse stock salt industry
- Warehouse stock road construction administrations



3. Basics: Daily consumptions in the period 22 Nov – 31 Dec 2010

representations of the course of storage assuming ideal conditions of re-supplies for federal-wide average consumptions



3. Application: Calculation for federal motorways and federal roads

Estimation of savings of de-icing salt due to use of de-icing salt solutions

Salting application densities per day [g/m ²]	Number of deployment days	Total number of deployment	Salt quantities federal motorways [t]	Salt quantities federal roads (67% scope of treatment) [t]	Total federal trunk roads [t]
6	9.990	9.990	28.757	24.731	53.489
22	3.438	6.876	36.288	31.207	67.495
32	20.716	41.432	318.046	273.516	591.562
42	1.542	4.626	31.072	26.721	57.793
52	1.031	4.124	25.721	22.120	47.842
62	818	4.090	24.332	20.925	45.257
72	560	3.360	19.344	16.636	35.980
82	355	2.485	13.966	12.011	25.977
92	301	2.408	13.286	11.426	24.711
102	162	1.458	7.928	6.818	14.745
112	218	2.180	11.714	10.074	21.788
122	97	1.067	5.678	4.883	10.560
132	95	1.140	6.016	5.174	11.190
142	42	546	2.861	2.461	5.322
152	286	4.004	20.857	17.936	38.793
Total [t]	39.651	89.786	565.867	486.639	1.052.506
Proportionate percentage of deployment with solution:	44%	Consumptions without use of solutions (information from table 1)	698.883	601.031	1.299.914
				Savings de-icing salt:	247.408
			Cost savings of pur salt (80€/t):		19.792.665 €

4. Further steps

Conclusion of the first calculations:

- The model allows a rough estimate of the salt consumption for great networks
- An improvement should follow

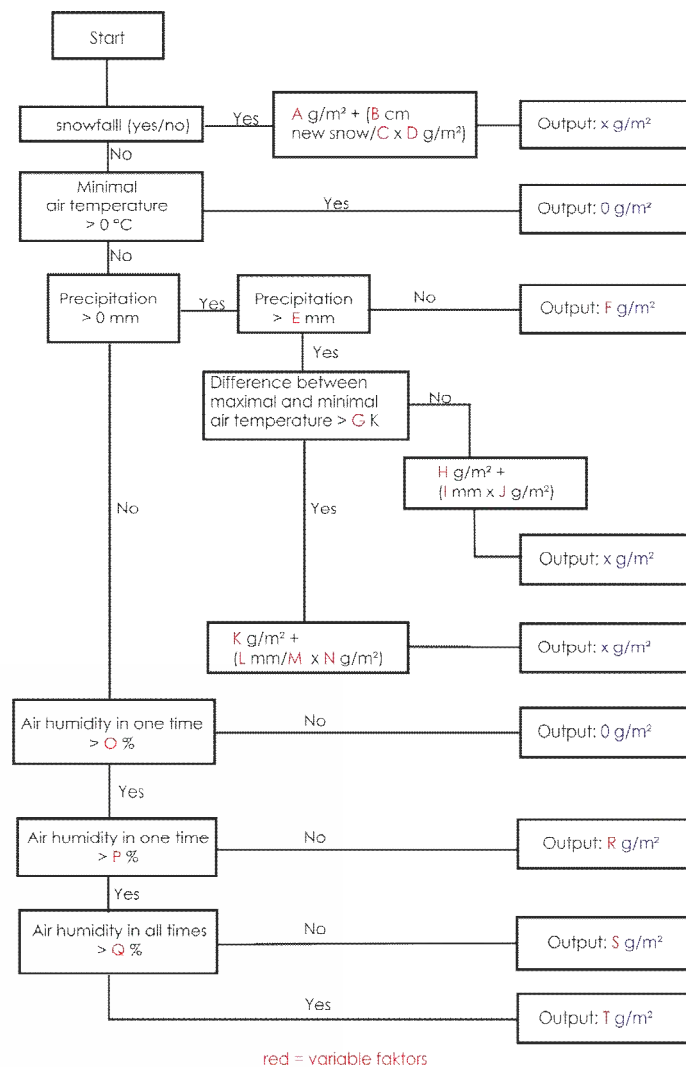
Further steps:

- Development of a software tool for fast calculation for different networks, for different time periods and with variable factors
- Using data from road weather stations
- Using of the index for rough forecast of the salt consumption for the next 10-14 days

4. Further Steps

Algorithm for a differentiated calculation of the spreading density

New:
9 different spreading-values



4. Further steps: development of a software tool

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Berechnung bundesweiter Verbrauch von Taustoffen

Bundesland

Wintersaison Oder Bundesautobahn %

von Bundesstrasse % Kreisstrasse %

bis Landstrasse % Gemeindestrasse %

▼ Konfiguration Verbrauch

Streudichte für vorbeugende Streuung bei Schneefall	<input type="text" value="20"/> g/m ²
Quotient für Häufigkeit der Streufahrten in Abhängigkeit von der Schneehöhe	<input type="text" value="1"/>
Streudichte bei Schneefall	<input type="text" value="20"/> g/m ²
Wert zur Unterscheidung schwacher oder intensiver Niederschlag	<input type="text" value="0.5"/> mm
Streudichte bei schwachen Niederschlag	<input type="text" value="20"/> g/m ²
Differenz Max-Min Lufttemperatur zur Bewertung der Bewölkung	<input type="text" value="5"/> K
Streudichte für vorbeugende Streuung bei längerandauernden Regen	<input type="text" value="20"/> g/m ²
Streudichte bei längerandauernden Regen	<input type="text" value="20"/> g/m ²
Streudichte für vorbeugende Streuung bei kurzen intensiven Regen	<input type="text" value="20"/> g/m ²
Quotient für Häufigkeit der Streufahrten in Abhängigkeit von der Niederschlagshöhe	<input type="text" value="2"/>
Streudichte bei kurzen intensiven Regen	<input type="text" value="20"/> g/m ²
Grenzwert für höchsten Wert von allen Luftfeuchtwerten für leichte Reifbildung	<input type="text" value="90"/> %
Grenzwert für höchsten Wert von allen Luftfeuchtwerten für starke Reifbildung	<input type="text" value="95"/> %
Grenzwert für alle Luftfeuchtwerte für extreme Reifbildung	<input type="text" value="95"/> %
Streudichte bei leichter Reifbildung	<input type="text" value="5"/> g/m ²
Streudichte bei starker Reifbildung	<input type="text" value="10"/> g/m ²
Streudichte bei extremer Reifbildung	<input type="text" value="20"/> g/m ²

4. Further steps: development of a software tool

