Winter Projects in Denmark

DIMS
De-Icers Management System

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Vejdirektoratet

The national road network

Consists of **3,801***
1,188 km of which are motorways

This corresponds to
approximately
of the total **5%**
public road network in Denmark (74,407 km)

Approximately **45%**
of road traffic runs on
the national road network

Motorways
Motorway (Sund & Bælt)
Expressway
Other national roads
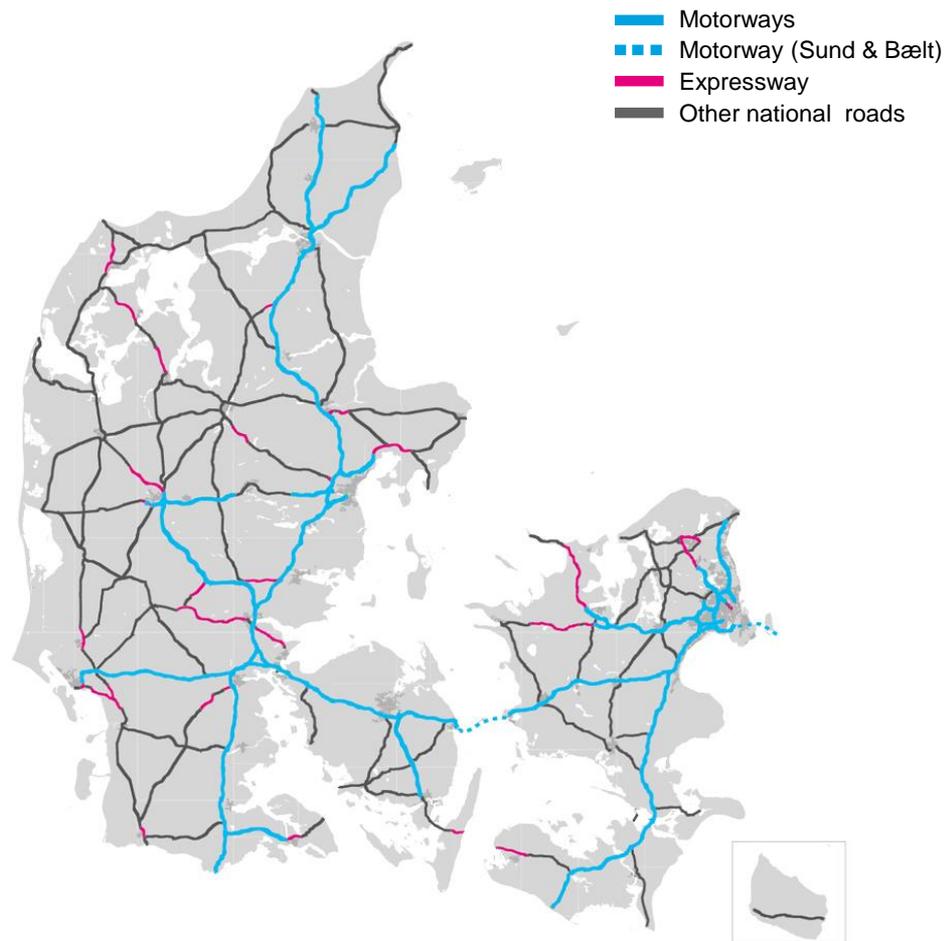
Excluding Sund & Bælt Holdings 41 km

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Winter in Danmark...

- **Winter season:**
  State: 1/10 – 30/4
  Municipalities: ?
- **Winter road classes:**
  State roads: class 1 (eks. Bornholm)
  Municipal roads:…
- **Call-out**
  State: 100 call-outs
  Municipalities: 60-80 call-outs
- **Salt consumption:**
  State: 55.000 tons annually
  Municipalities: 245.000 tons annually
- **Salt consumption:**
  State roads: 1,10 kg/m^2 ~ 150 kg/passenger car
  Municipal roads: ?
- **Economy:**
  State roads ~ 33 mio. €. (3.800 km.)
  Municipal roads ~ 107 mio. €. (70.000 km.)

  Saltning: 540 t€. per. saltning
  Snow clearing: 6,7 mio.€. per. day

Salt consumption and the number of call-outs on the state road network

Tons of salt

Call-outs

Average salt consumption

Average call-outs

Season	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16
Tons of salt	35.536	49.662	100.835	104.024	45.489	90.230	33.533	51.877	45.430
Call-outs	69	93	179	202	93	161	70	92	79

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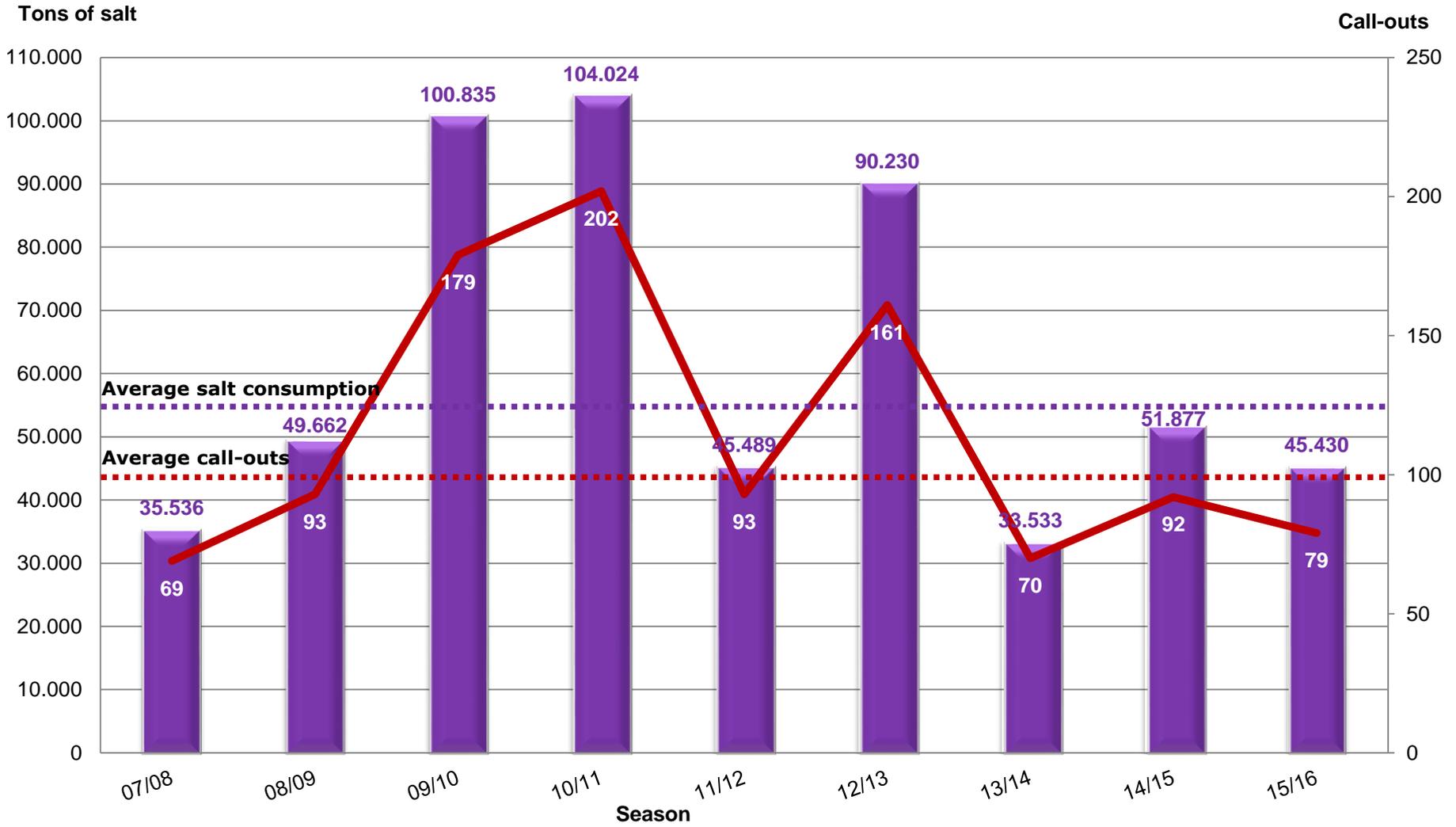
Winter service – Road Directorate

Winter control center in Aalborg

Callout, controlling and monitoring

State roads - Winter:

$\cong$ 3.800 km (6.096 km route length)

$\cong$ 125 salt routes

$\cong$ 50 km in avg. length

$\cong$ 97 contracts

$\cong$ 150 contractors

$\cong$ 225 salt spreaders

$\cong$ 550 snow plough

Tender process for:
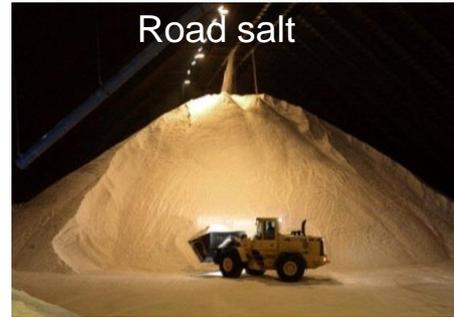
Road salt

Road weather stations

Workshops

Equipments

Winter Routes (Truck + driver)

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INTEGRATED WINTER DEVELOPMENT PROJECT

- De-icers Dosage
- Residual salt
- Vinterman
- Equipment development
- GPS-controlled spreading
- DIMS
- RWIS Vejvejr.dk
- ROad STate MOnitoring System
- Section based-weather forecasts
- Standards
- WINTER STRATEGI
- Road sector Knowledge dissemination
- COST BENEFIT
- EDUCATION
- WINTER TRAFIK
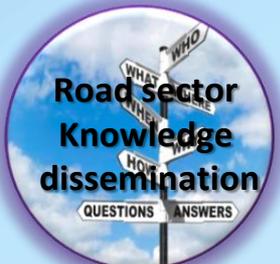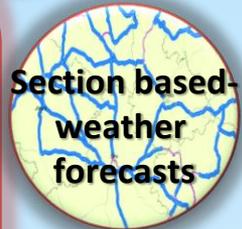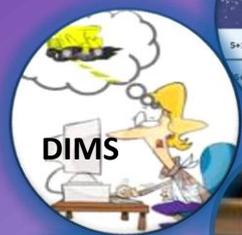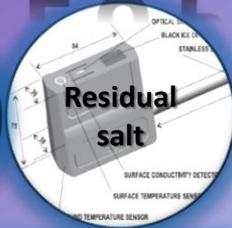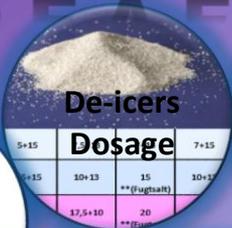
DIMS
De-Icers Management System

What is DIMS ?
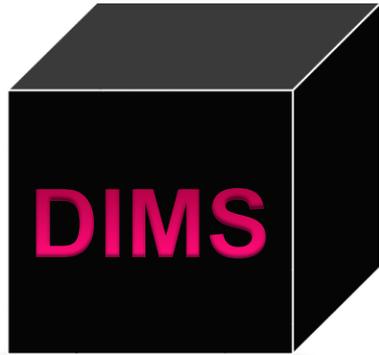
Different definitions found on the web:

- For women: Inventories at building market
  For men: The closing mechanism of a bra
- For drivers: The smallest DIMS on a Lada sits between the ears of the one who bought it

Our DIMS:

Existing knowledge is gathered and assessed for active dosage as correctly as possible

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Today we use tables

Select a dosage	Cause of call-out	Pre-wetted 30%		
		Setting (Pre-wetted) (g)	dry salt (g)	Brine (ml)
1	Preventively against frost to -3 degrees	8	6,1	1,6
2	Preventively against excessive / prolonged frost	10	7,7	2,0
	Salting during snowfall (dry snow / powdery snow)			
3	Preventively against freezing wet roads over -3 degrees	12	9,2	2,4
4	Preventively against freezing wet roads below -3 degrees	15	11,5	3,1
	Against ice, freezing rain, jammed snow after snowfall			
5	Preventively against snow/freezing rain	20	15,3	4,1
6	Salting during snowfall (wet snow, slush, sleet)	8	8,0	0,0

Analyses
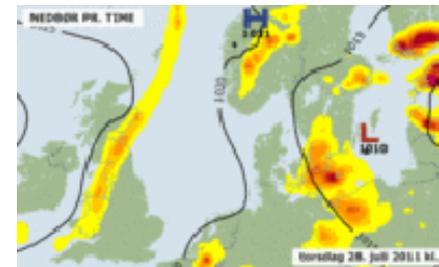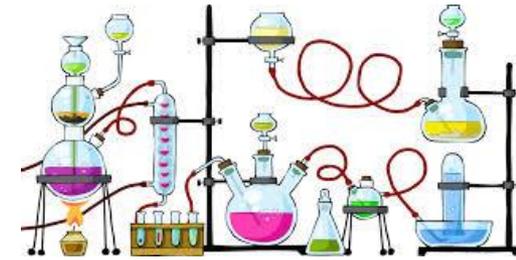
Weather models

Testing of devices

Thick reports

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DIMS

A decision support system to handle all parameters:

partly because of the <u>amount of data</u> that is now available

partly because of the <u>short notice</u> that is to make decisions about call-out

DIMS implemented in Vinterman where the winter crew can let the system take several parameters in determining the dosage

DIMS

Vejdirektoratet

DIMS

Service level

Roadways			
Road Class	**Type**	**Road type**	**Service level and method**
Freeways/Motorways	Class I	Includes all lanes on state roads, including continuous track on service areas.	Salting respectively snow-clearing performed at any time of day. • Salting aim made by preventive salt as needed. • Snow removal initiated as appropriate, so that the traffic flow as far as possible be settled without inconvenience for road users.
Distribution roads	Class II	Includes all other tracks, parking service motorv	Salting respectively snow-clearing is

Roadways			
Road Class	**Type**	**Road type**	**Service level and method**
Local roads	Class III	Includes all other tracks, including parking areas, service areas other roads excluding motorways.	Salting/gritting respectively snow removal is performed only on weekdays during normal working hours. Efforts carried out when the tasks in class I to II roads permits and only within mentioned time period.
Other roads	Class IV	Not in use.	Salting/gritting and snow-clearing only occasionally.

**1. Service level:**

Aim conditions on the carriageway, depending on winter road classes

(closely related to the level of expenditure)

DIMS

Weather

Service level

Information

OFF   ON – 5 g/m²   OFF   OFF   ON – 10 g/m²   OFF
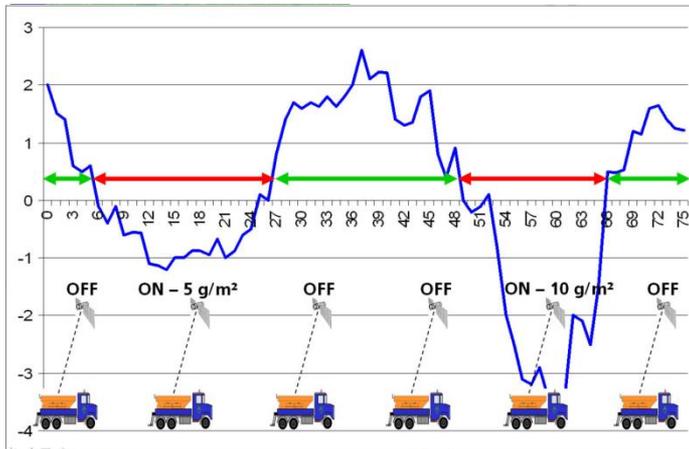
2. Weather:

”VejVejr” supplies with:
- Air temperature
- Humidity
- Precipitation
- Clouds
- Wind speed and direction

DIMS
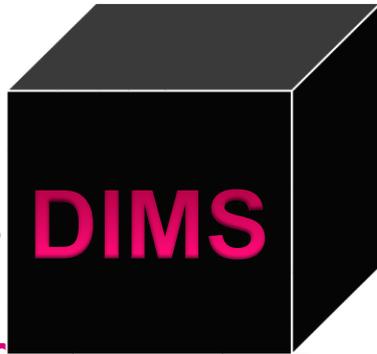
Road condition

Weather

Service level

Fugtig: 20 ml/m2

Meget fugtig: 50 ml/m2

Let våd: 100 ml/m2

Våd: 200 ml/m2

3. Vejtilstand:

"Vejvejr" supplies with:

- Road temperature

- Humidity/water/snow/ice on roadway
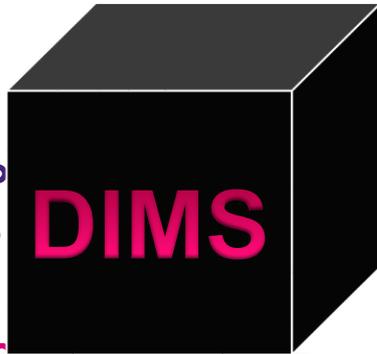
In wheel track

Between wheel track

Residual salt (g/m²) in wheeltrack (Wt)

Residual salt (g/m²) inbetween wheeltracks (Bt)

Accumulated traffic (120 vehicles per hour)

Accumulated traffic (120 vehicles per hour)

Resídual salt

Road condition

Weather

Service level

DIMS
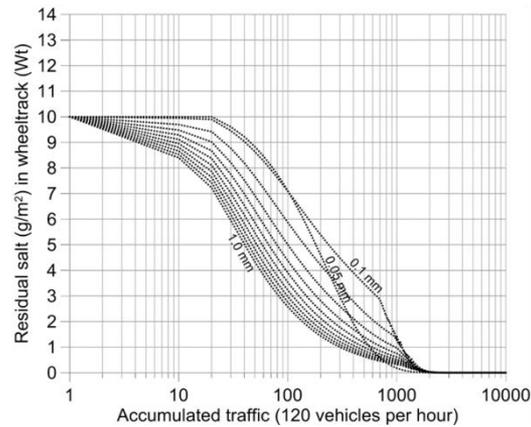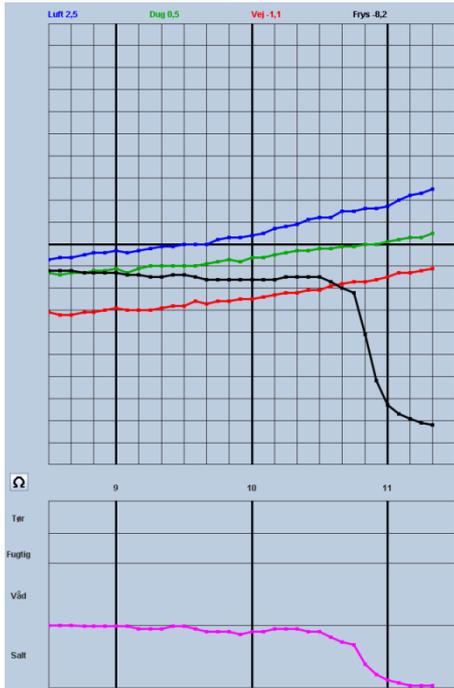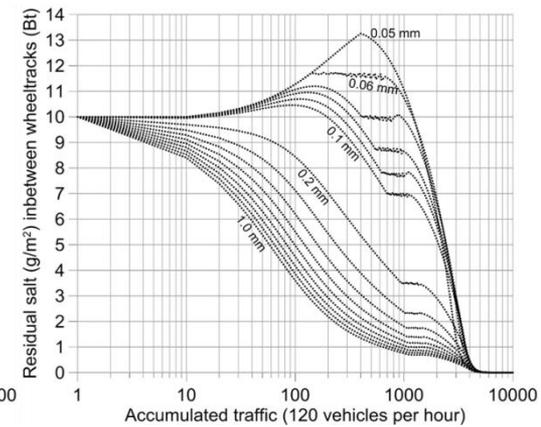
4. Residual salt:

"VejVejr" supplies with:

- Residual salt

- Freezing Point

MORS: Model of residual salt

Traffic

Residual salt

Road condition

**Weather**

Service level

DIMS
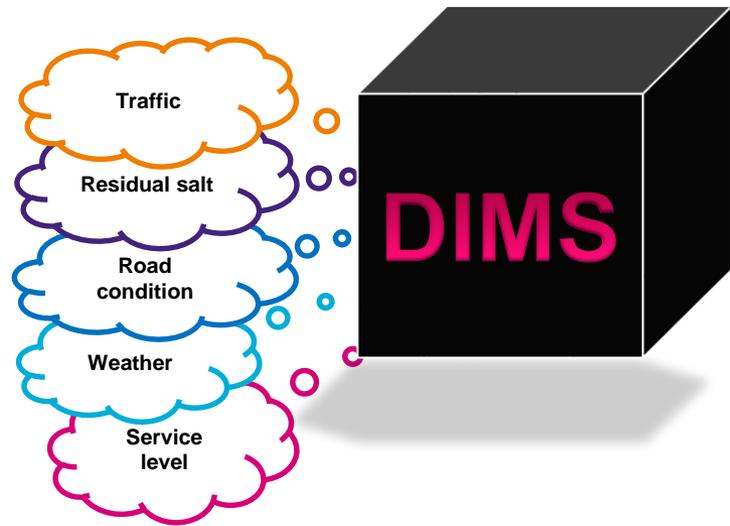
5. Traffic:

Known parameteres by measurements:

- Traffic volume, vehicle type

The traffic impact examined:

- Ice-carousel at Bygholm

- Test field at Bygholm

Pavement type

Traffic

Residual salt

Road condition

Weather

Service level

DIMS
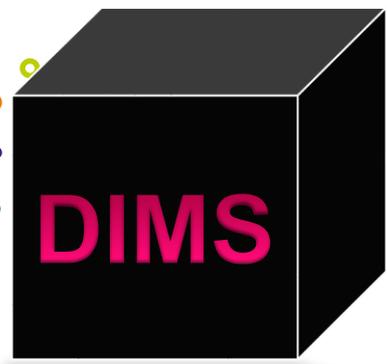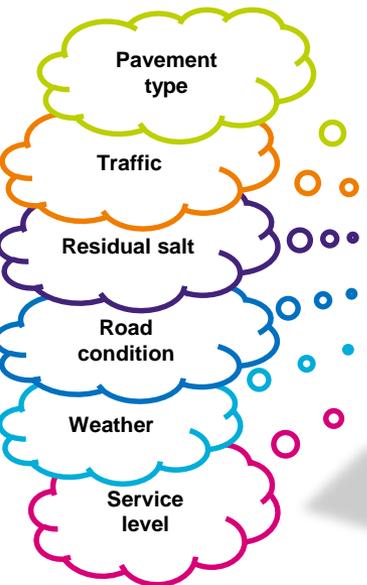
6. Pavement type:

Road texture ("Run Off")

Porous asphalt (frequency of salting)

Trace'

Pavement type

Traffic

Residual salt

Road condition

Weather

Service level

DIMS
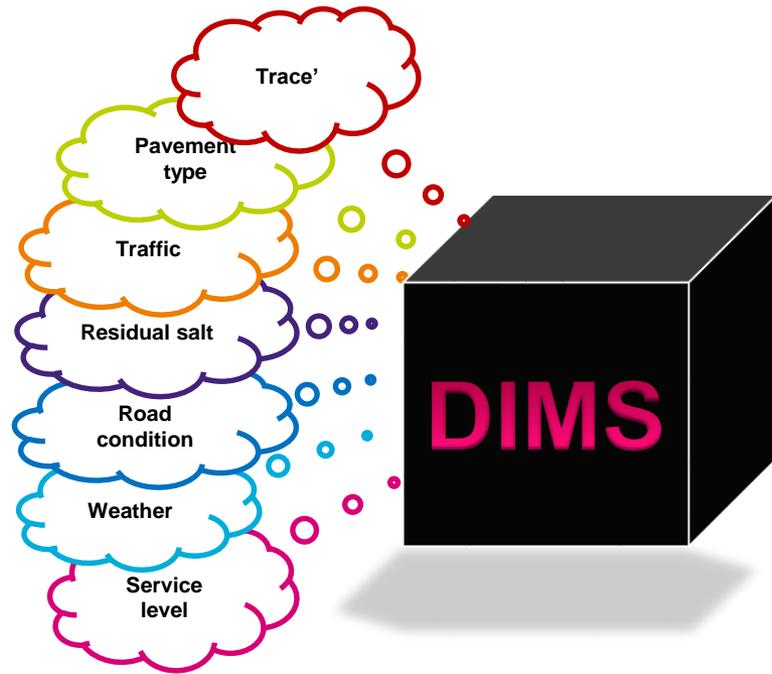
7. Trace':

Longitudinal profile and side slope
(Affects how long the salt gets on the road)

Environment

Trace'

Pavement type

Traffic

Residual salt

**Road condition**

Weather

Service Level

DIMS
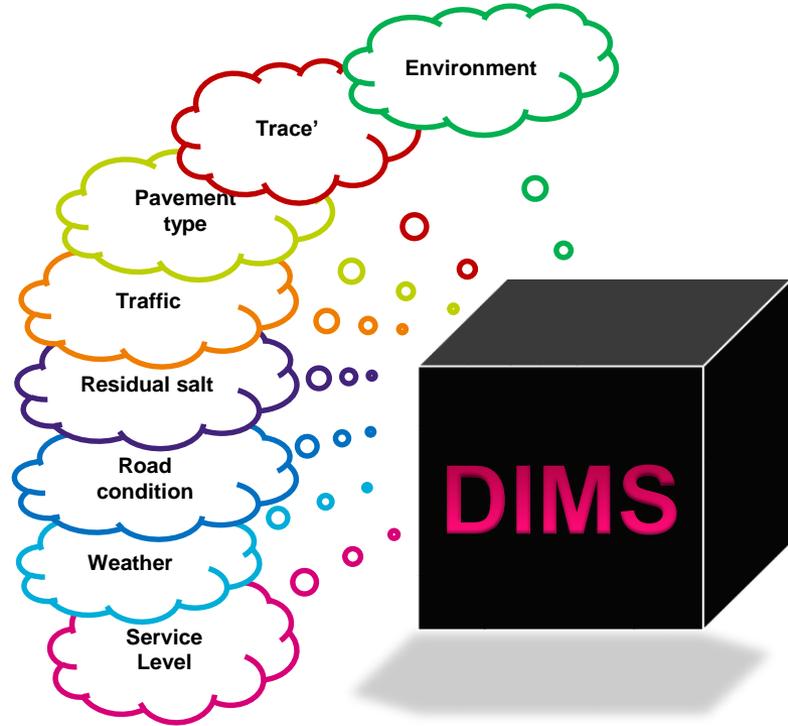
8. Environment:

- Nature reserves

- Plantation

- Ground water

Can result in:

- The salt dosage to be minimized

- Alternative de-icers agents

Environment

De-icers agents properties

Trace'

Pavement type

Traffic

Residual salt

Road condition

Weather

Service level

DIMS
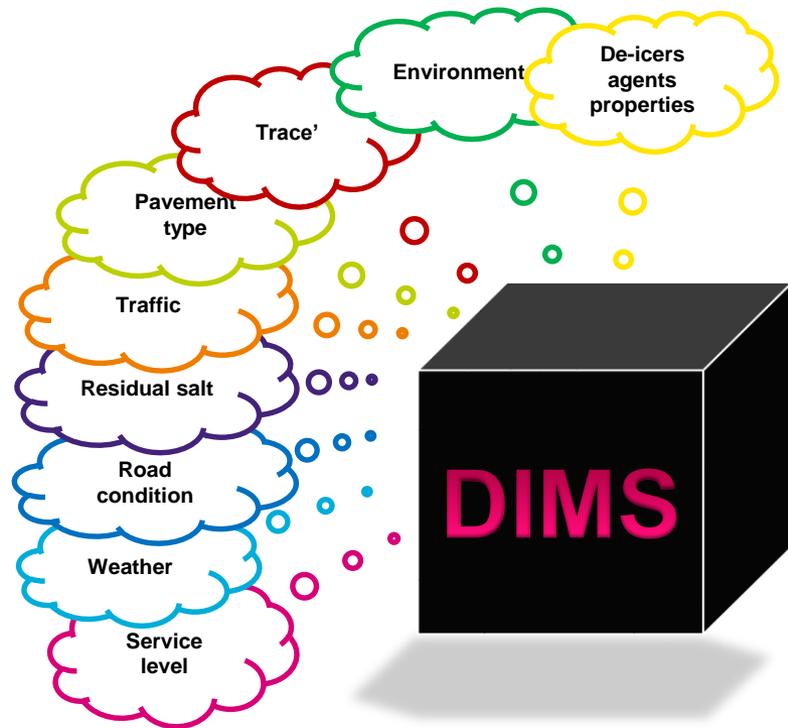
Tømiddel	Smelteeffekt g is/g tømiddel			
	-2 °C	-5 °C	-10 °C	Eutektisk temperatur °C
Natriumklorid, tørstof	28,6	11,3	6,1	-21,1
Natriumklorid, 22 % lage	5,5	1,7	0,6	-
Calciumklorid, vandfrit	21,9	10,2	6,1	-51,0
Calciumklorid, som skæl CaCl₂,2H₂O	16,6	7,7	4,6	-
Magnesiumklorid, vandfrit	27,2	12,7	7,6	-33,6
Magnesiumklorid, hexahydrat MgCl₂,6H₂O	12,8	6,0	3,5	-
Urea, tørstof	13,3	5,3	2,7	-11,5
CMA, vandfrit	15,7	7,3	4,2	-26
CMA 25 % lage	3,0	1,0	0,3	-

Fasediagram med fasekurver for NaCl

°C

Faseområde med én flydende fase: lage

Faseområde med to faser: fast: is ("uopløst vand") flydende: lage

Faseområde med to faser: fast = salt (uopløst) flydende: lage

Faseområde med én fast fase: is og salt

Vægt% NaCl
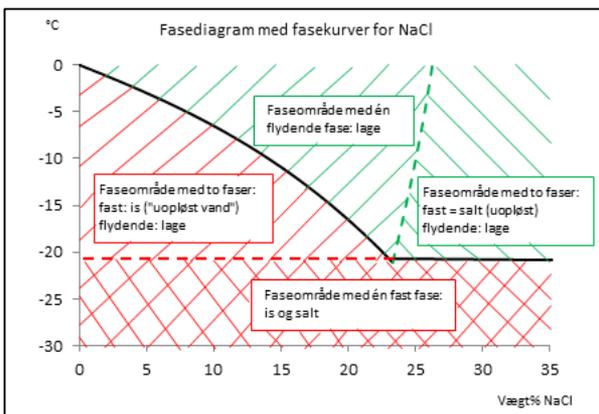
**9. De-icers agents properties:**

- Melting capacity

- Environmental impact

- Economy

- Damage to structures

- Storage and Handling

DIMS

- Trace'
- Environment
- De-icers agents properties
- Spreading effectiveness
- Pavement type
- Traffic
- Residual salt
- Road condition
- Weather
- Service level

Gram pr metre vs Measuring area (road), m

- 4. run
- 3. run
- 2.run
- 1.run
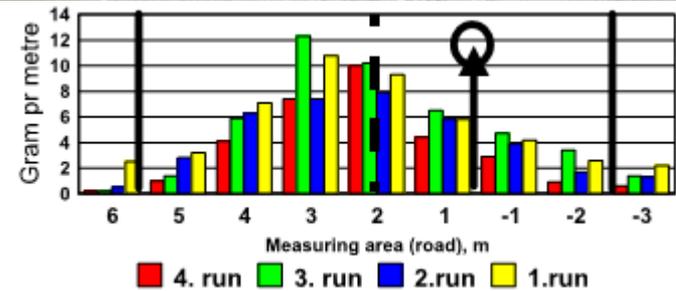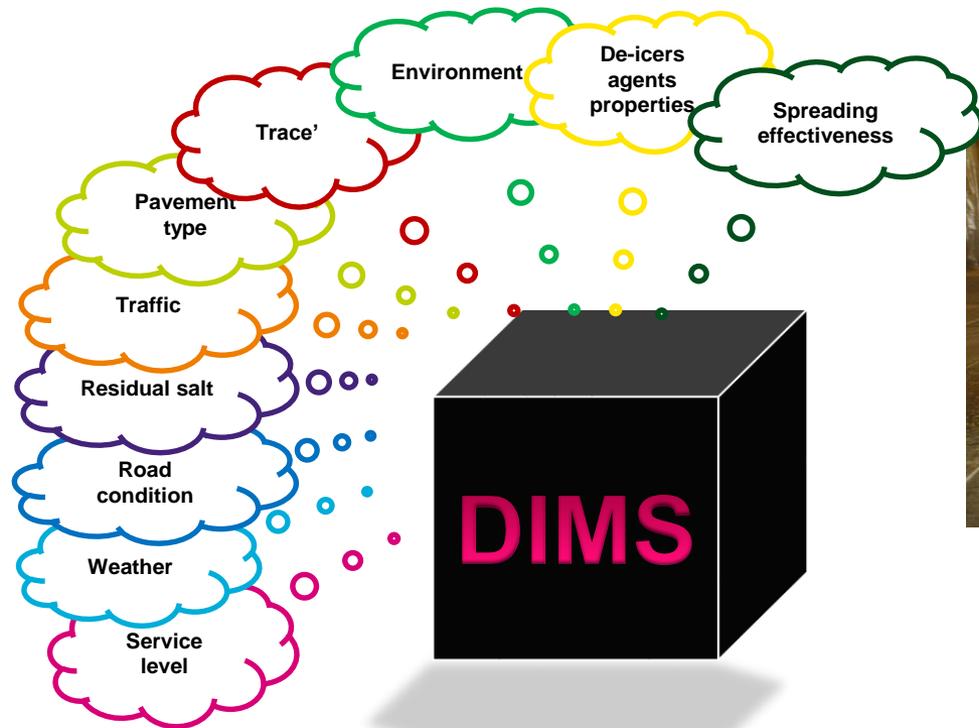
10. Spreading effectiveness:

- Spreader type
- Dosage (Calibration)
- "Spreading pattern" (Cross distribution)
- Salting method
- Types of Salt

Thought bubbles connected to DIMS cube:
- Trace'
- Environment
- De-icers agents properties
- Spreading effectiveness
- Dynamic spreading
- Snow clearing
- Pavement type
- Traffic
- Residual salt
- Road condition
- Weather
- Service level

DIMS

Quantity of snow before and after clearing

Sne mængde i mm

	Før	Efter
40 km/t	7,4	0,1
60 km/t	7,4	1,4
80 km/t	7,4	3,8
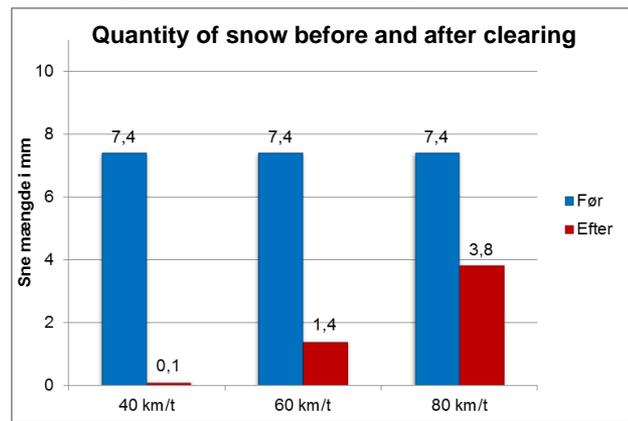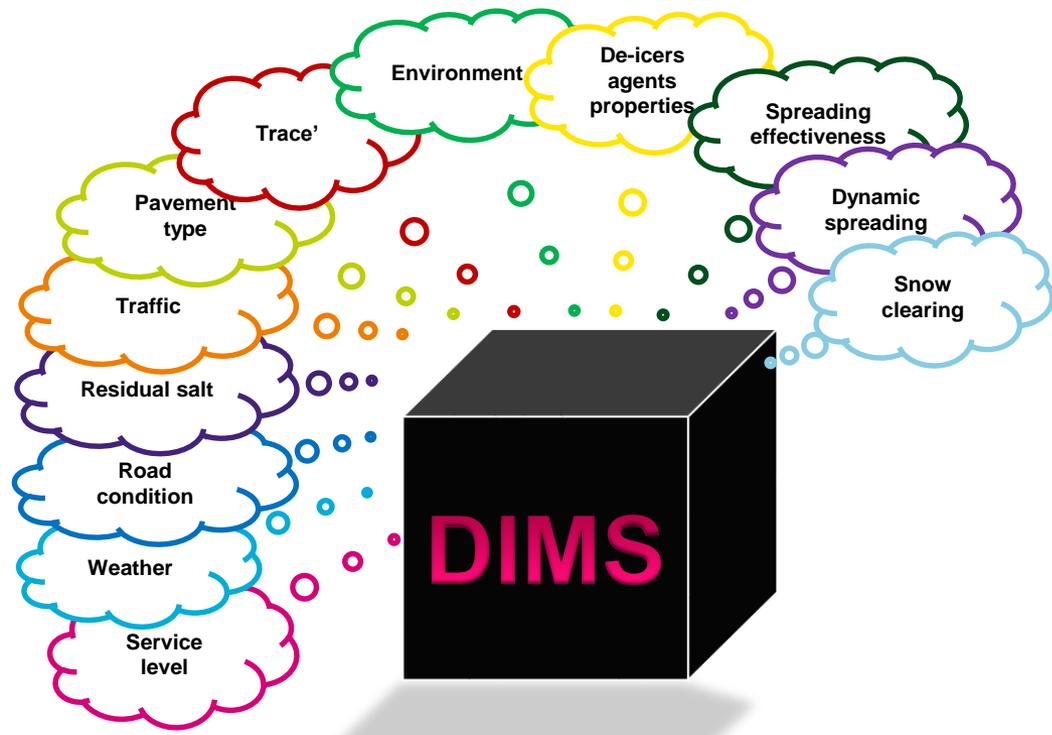
12. Snow clearing:

The plough blade: type, sections, etc.

The ploughshare: quantity, material, etc.

Snow clearing speed

Need for subsequent salting

DIMS

Trace'

Environment

De-icers agents properties

Spreading effectiveness

Pavement type

Dynamic spreading

Traffic

Snow clearing

Residual salt

Other

Road condition

Weather
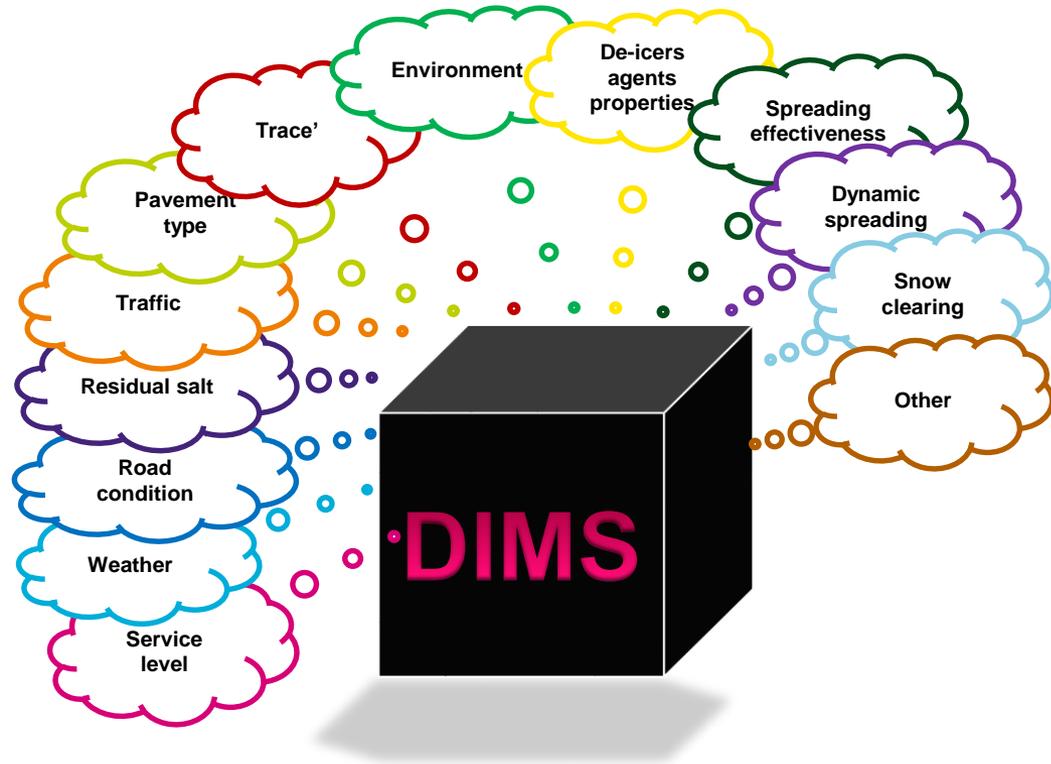
Service level

13. Other:

Gaps in knowledge!

DIMS

Trace'
Environment
De-icers agents properties
Spreading effectiveness
Pavement type
Dynamic spreading
Traffic
Snow clearing
Residual salt
Other
Road condition
Economy
Weather
Service level
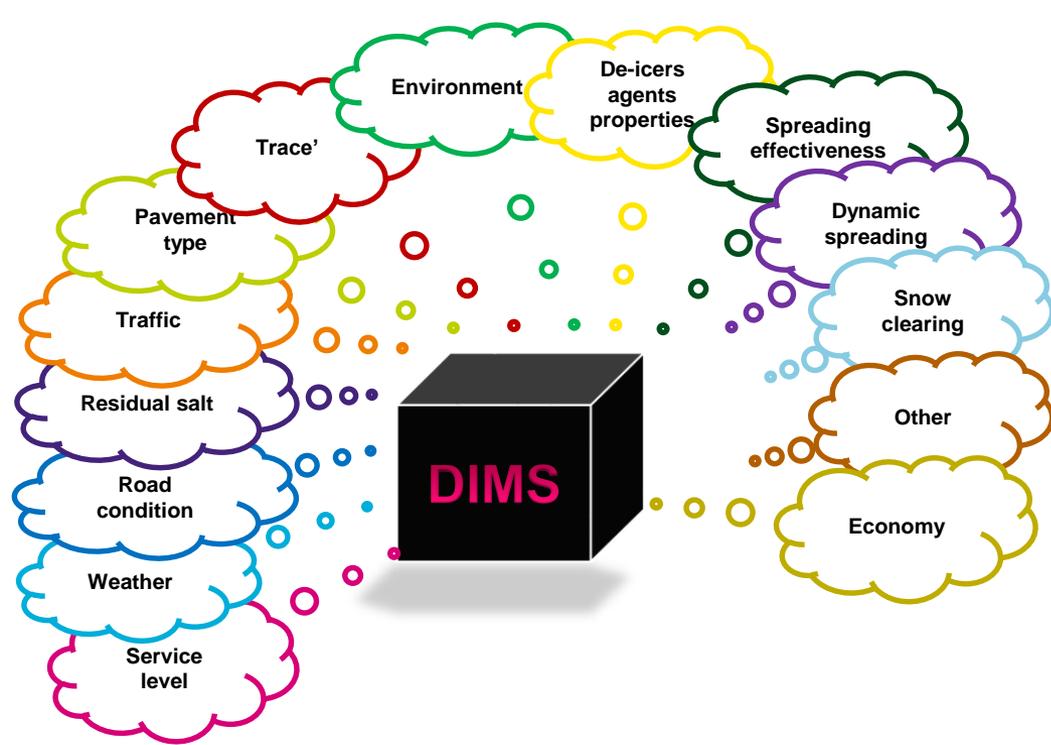
14. Economy:

- Number of measures (call-out)
- Scope of action
- equipment
- cycle time

(Closely related to service level)

Two types of parameters
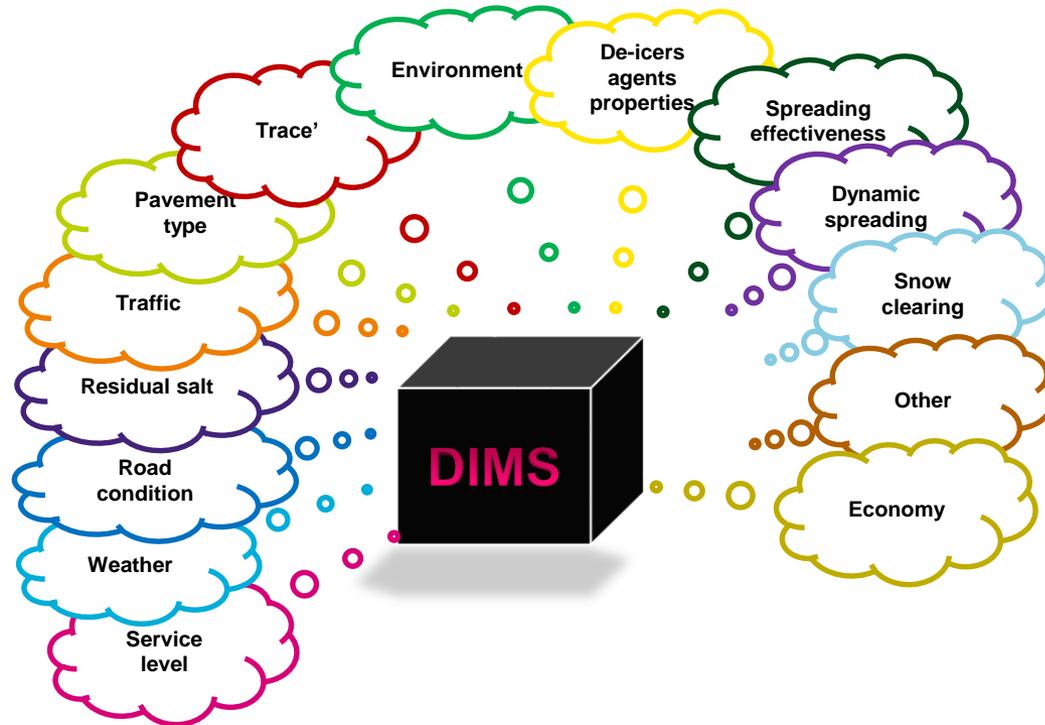
Parameters that are known prior to the season:

- Service level
- Traffic
- Pavement type
- Trace '
- Environment
- De-icers properties
- Spreading efficiency
- Snow clearing equipment
- Economy

Variable parameters on the call-out time:

- The weather
- Road condition
- Residual salt
- Equipment condition

# Three ways to adjust the dosage

DIMS
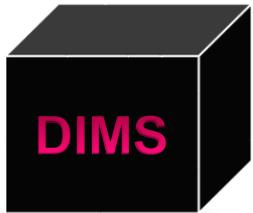
- Manual. The driver manually adjust the dosage on spreader

- Semiautomatic. The driver selects a GPS Control Route with a fixed dosage

- Fully automatic through Dynamic spreading. The driver selects a route that is prepared for him

Dynamic spreading is the key to exploiting many parameters

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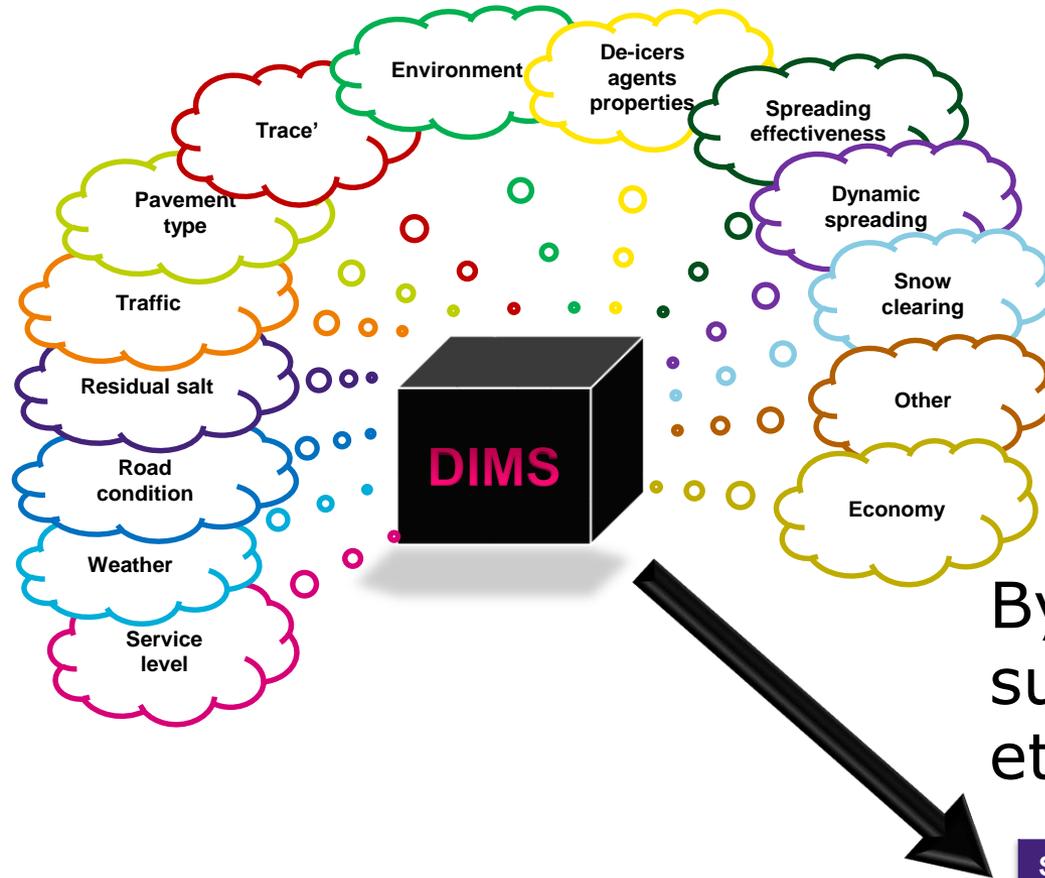
How does it work - #1

By callout will DIMS suggest specific dosage etc. per. section

Suggested dosage:		
Route - Kmt	**Dosage**	**De-icer**
1 - km. 0,0 – km 3,0	10 g/m^2	Salt 30/70
1 - km. 3,0 – km 7,5	15 g/m^2	Salt 10/90
1 - km. 7,5 – km 15,0	7 ml/m^2	Kaliumformiat
1 - km. 15,0 – km 25,0	12 g/m^2	Salt 20/80

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How does it work - #2

Trace'

Environment

De-icers agents properties

Spreading effectiveness

Pavement type

Dynamic spreading

Traffic

Snow clearing

Residual salt

Other

Road condition

Economy

Weather

Service level
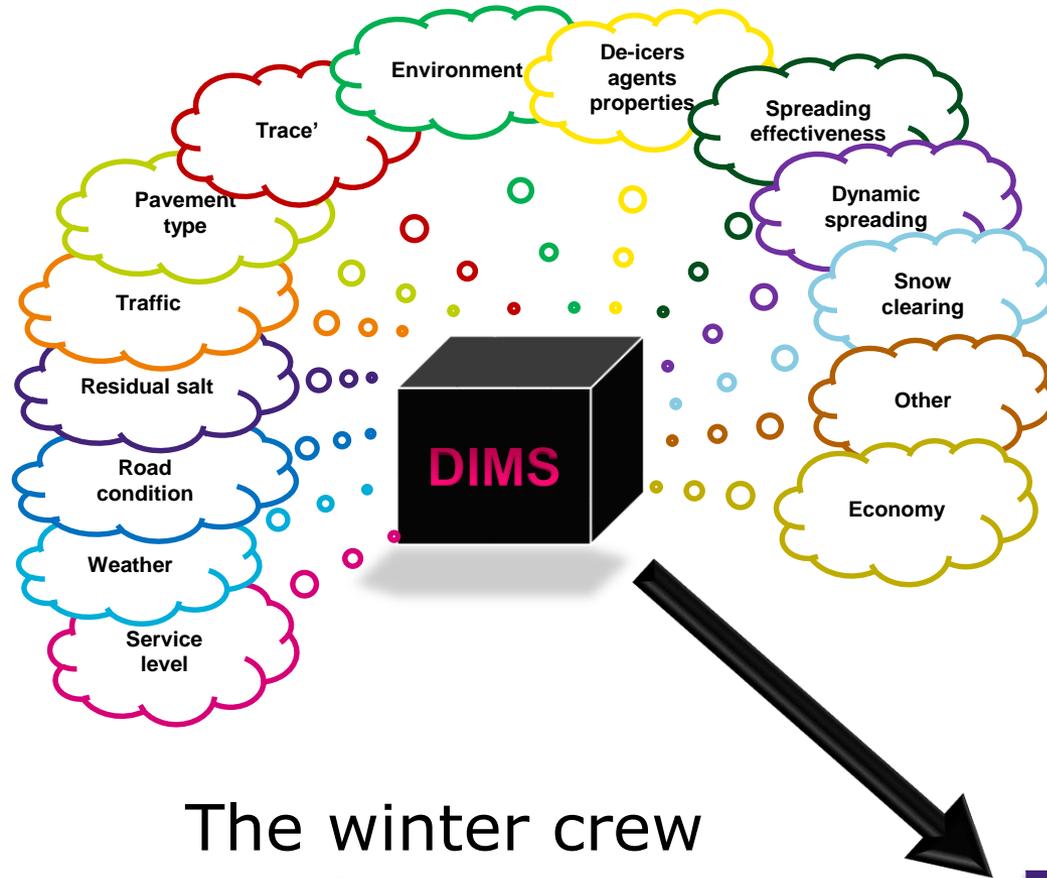
DIMS

The winter crew considers, whether, DIMS may decide

Suggested dosage:		
Route - Kmt	**Dosage**	**De-icer**
1 - km. 0,0 – km 3,0	10 g/m^2	Salt 30/70
1 - km. 3,0 – km 7,5	15 g/m^2	Salt 10/90
1 - km. 7,5 – km 15,0	7 ml/m^2	Kaliumformiat
1 - km. 15,0 – km 25,0	12 g/m^2	Salt 20/80

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How does it work - #3
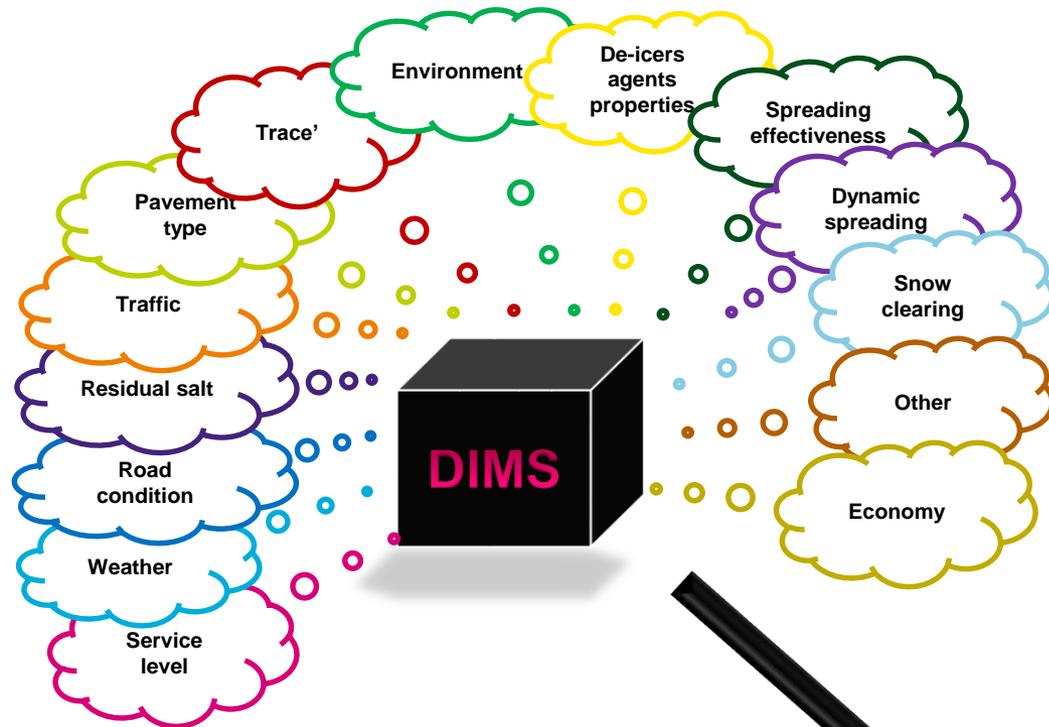
Vinterman ensures that the variable dosing is performed through Dynamic spreading

Suggested dosage:		
Route - Kmt	**Dosage**	**De-icer**
1 - km. 0,0 – km 3,0	10 g/m^2	Salt 30/70
1 - km. 3,0 – km 7,5	15 g/m^2	Salt 10/90
1 - km. 7,5 – km 15,0	7 ml/m^2	Kaliumformiat
1 - km. 15,0 – km 25,0	12 g/m^2	Salt 20/80

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Implementation

Season 2015-16:

- Dynamic spreading is tested on at least one route
- Current model for section-based weather will be used
- New service level - mostly for municipalities

Season 2016-17:

- The section-based weather will be reviewed
- New test the calibration/maintenance
- Different dosage for snow depending on snow plow efficiency
- Dynamic spreading adjusted and extended to more units

Vejdirektoratet

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