Road salt and environmental hazards
-Identification of vulnerable water resources

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NPRA-Project
Salt SMART
2007 - 2011

*Motivation: EUs water framework Directive*

The main objective

To sustain safe roads and traffic accessibility without significant environmental damage due to winter road maintenance

To achieve this there is a need to identify vulnerable water resources where special requirements need to be considered in the winter road maintenance contracts
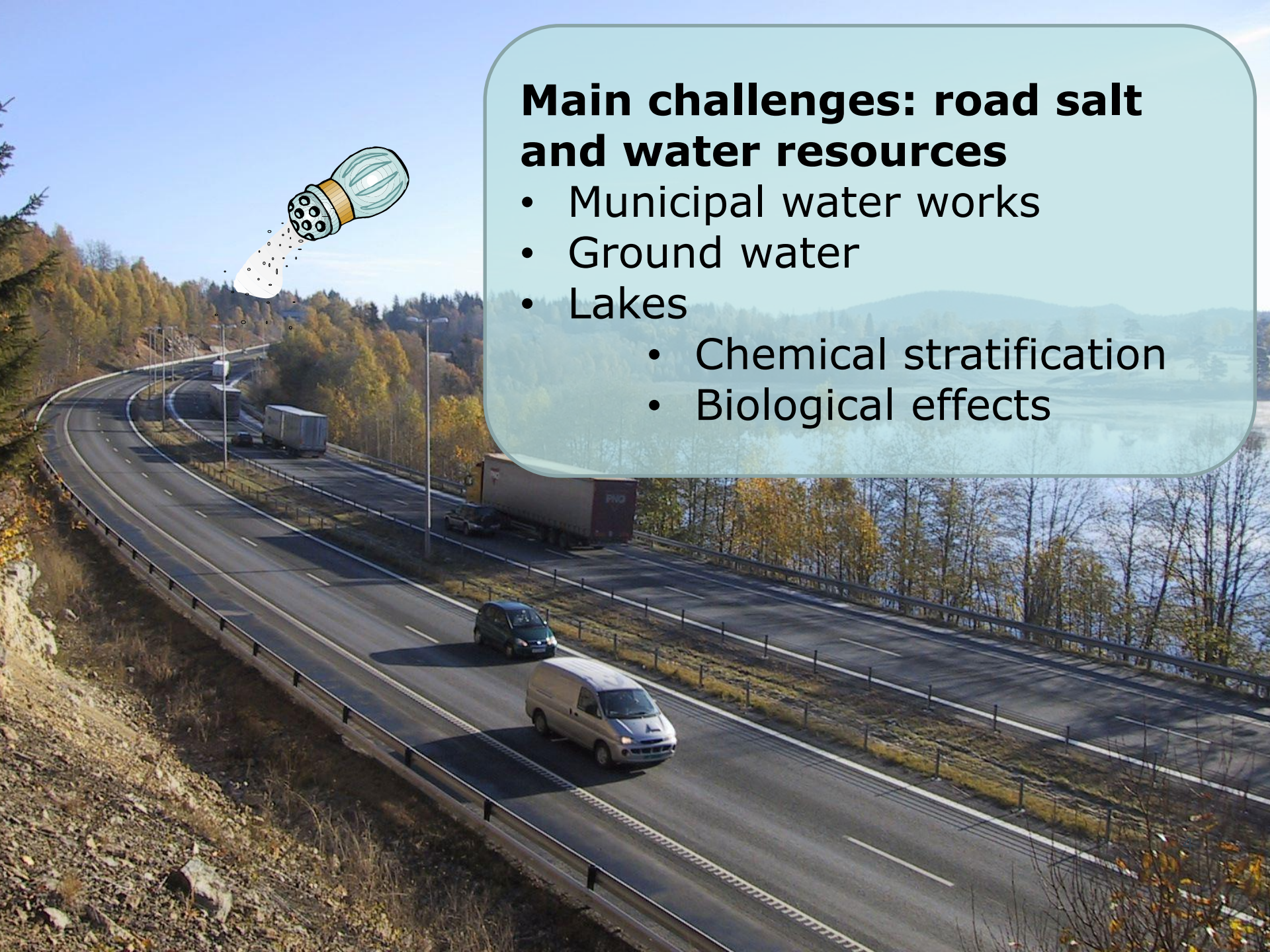
Annual applied amount of road salt (NaCl) in Norway

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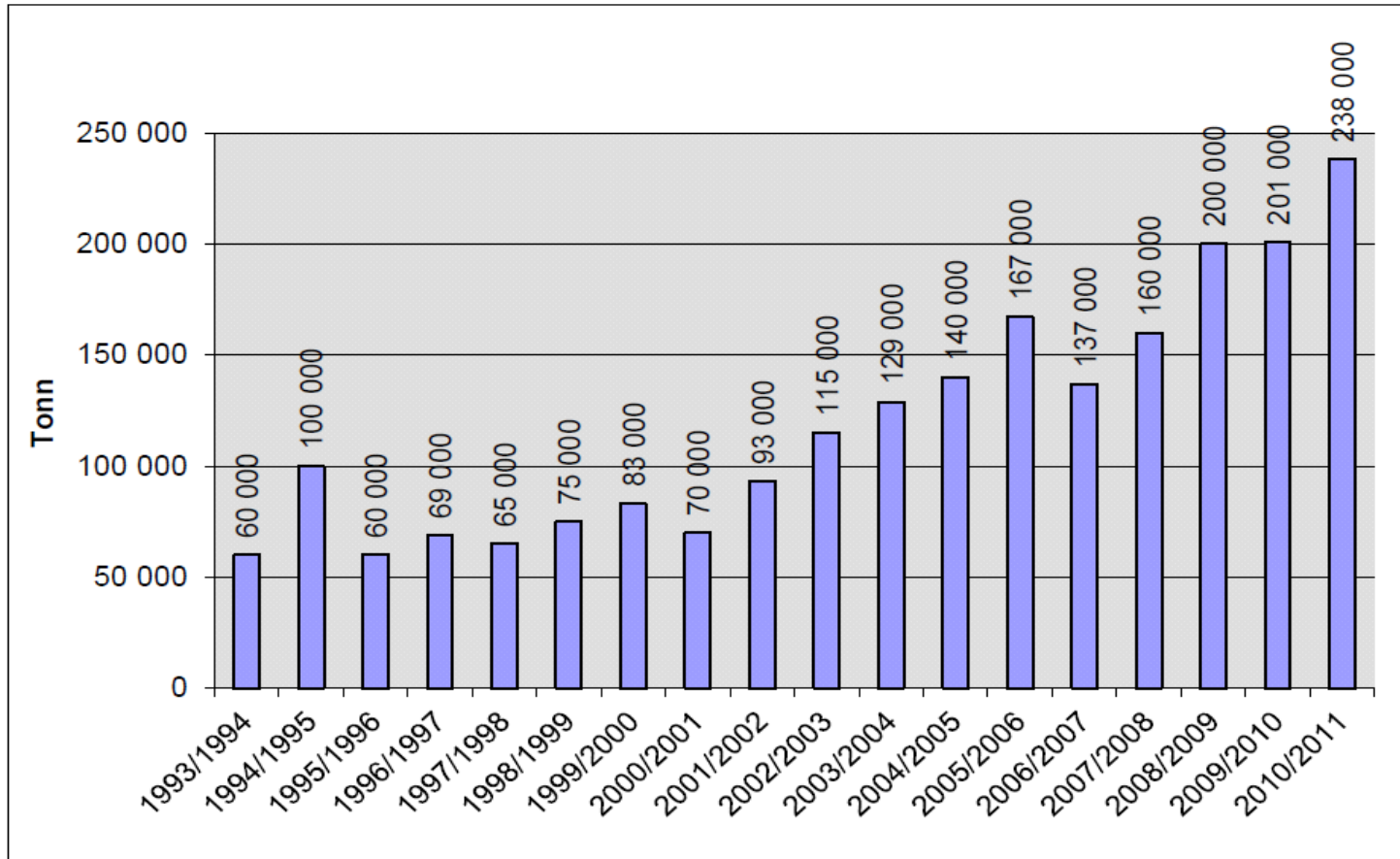
Main challenges: road salt and water resources
- Municipal water works
- Ground water
- Lakes
    - Chemical stratification
    - Biological effects

Where are the areas vulnerable to road salt?

Sampling all water resources or develope a classification tool?

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Data and Methods

1

- **Data collection**
- Roads, road salt consumption, lakes, groundwater, municipal water works, estimated salt conc in lakes[1], estimated background conc[2], method for risk classification of chemical stratification[3] and biological damage[4].

2

- **Identification of vulnerable water resources**
  - Ground water
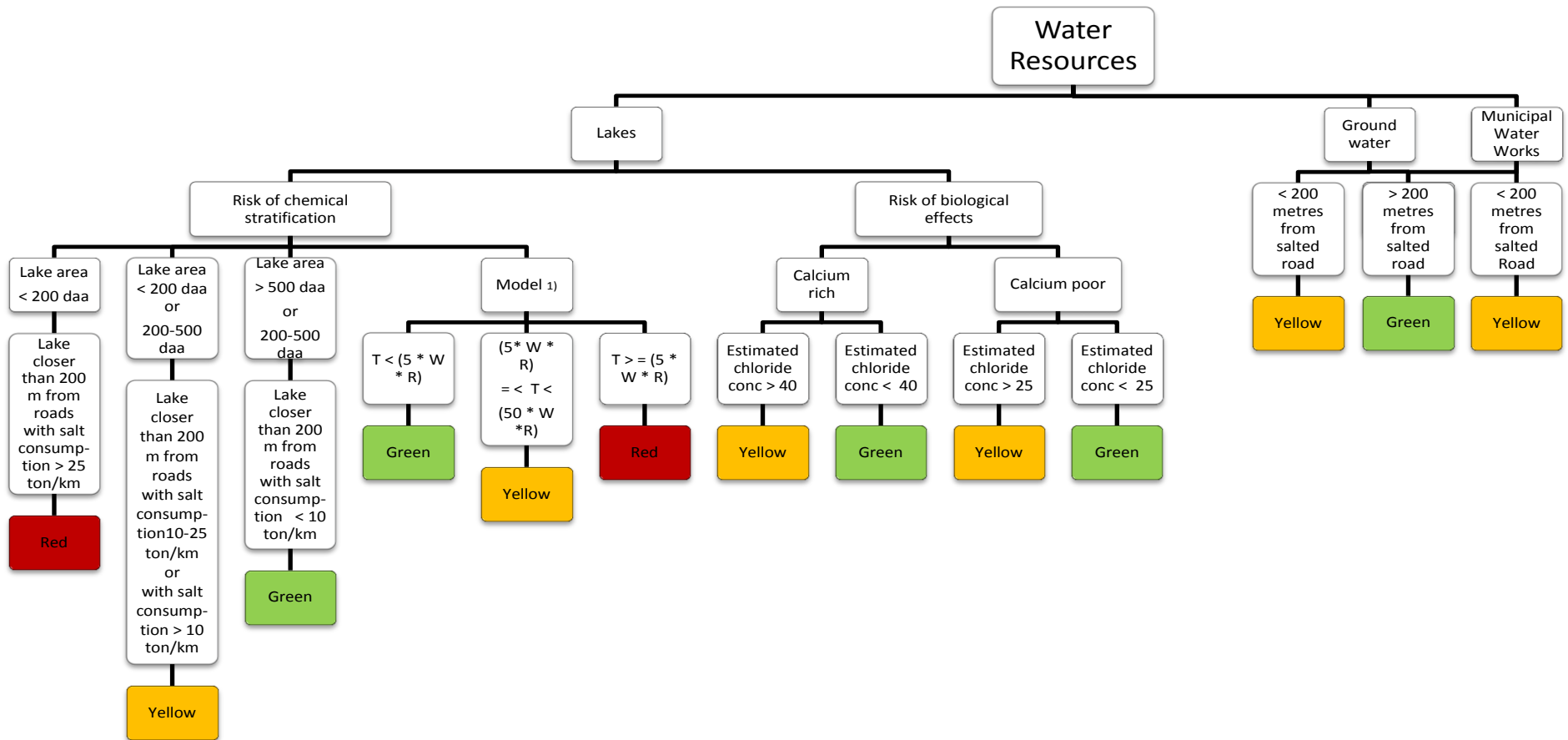 - Municipal water works
  - Lakes

1) Kitterød NO, Turtumøygard S, Aakerøy PA, Haaland S (2010) Estimation of the average saltflux from road to water body (in Norwegian). Department of Plant and Environmental Sciences, Norwegian University of Life Sciences and Soil and Environmental Division, Norwegian Institute for Agriculture and Environmental Research,
2) and 3) Haaland S, Turtumøygard S, Gjemlestad L-J, Nytrø T-E (2012) Salt SMART Road Salt in lakes -Threshold limitsregarding chemical stratification. Norwegian Public Roads Administration
4) Haugen TO, Bækken T, Hasle HH, Skjelbred B (2010) Salt tolerance in lake phytoplankton -statistical analyses and toxicity tests (in Norwegian). ISBN No.: 978-82-577-5749-6 edn. Norwegian Institute for Water Research.

Result
Flowchart to identify vulnerable water resources

Water Resources

Lakes — **Ground water** — **Municipal Water Works**

Lakes branch

Risk of chemical stratification

- Lake area < 200 daa
  - Lake closer than 200 m from roads with salt consumption > 25 ton/km → **Red**
- Lake area < 200 daa or 200-500 daa
  - Lake closer than 200 m from roads with salt consumption 10-25 ton/km or with salt consumption > 10 ton/km → **Yellow**
- Lake area > 500 daa or 200-500 daa
  - Lake closer than 200 m from roads with salt consumption < 10 ton/km → **Green**
- Model [1]
  - $T < (5 * W * R)$ → **Green**
  - $(5 * W * R) = < T < (50 * W * R)$ → **Yellow**
  - $T > = (5 * W * R)$ → **Red**

Risk of biological effects

- Calcium rich
  - Estimated chloride conc > 40 → **Yellow**
  - Estimated chloride conc < 40 → **Green**
- Calcium poor
  - Estimated chloride conc > 25 → **Yellow**
  - Estimated chloride conc < 25 → **Green**

Ground water

- < 200 metres from salted road → **Yellow**
- > 200 metres from salted road → **Green**

Municipal Water Works

- < 200 metres from salted Road → **Yellow**

[1] T = Total ion concentration: Cl (from road salt) + background Cl-concentration (distance from sea, ions in ground water, ions in precipitation and marine sediments)
W = Wind exposure (forest cover and lake shape)
R = Retention time

Categories of vulnerable water resources

|		
The salt consumption does not lead to environmental damages.	The salt consumption causes medium risk of environmental damages or the risk of environmental damage is not clarified. Measurements are implemented or further studies are needed.	The salt consumption causes high risk of environmental damages. Measurements are implemented.

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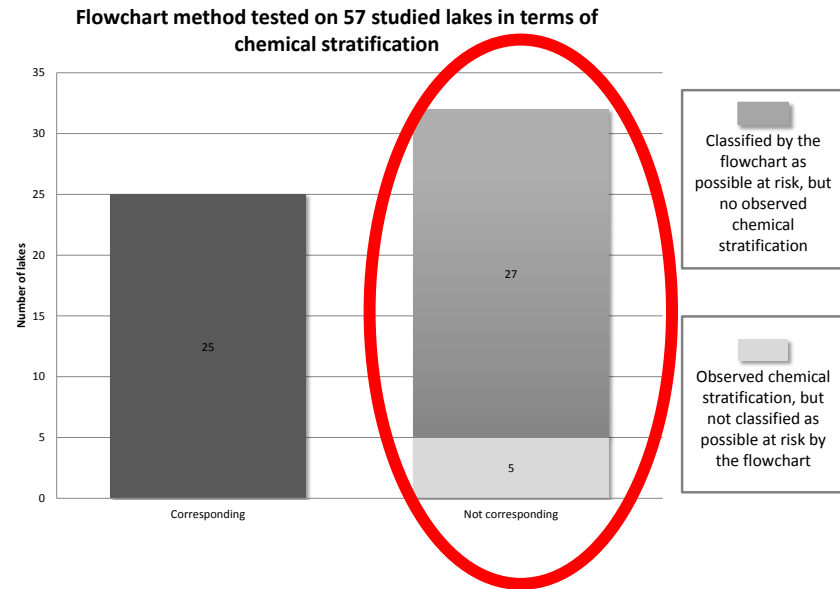# Input to winter road maintenance contracts

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Flowchart method tested on 57 studied lakes in terms of chemical stratification
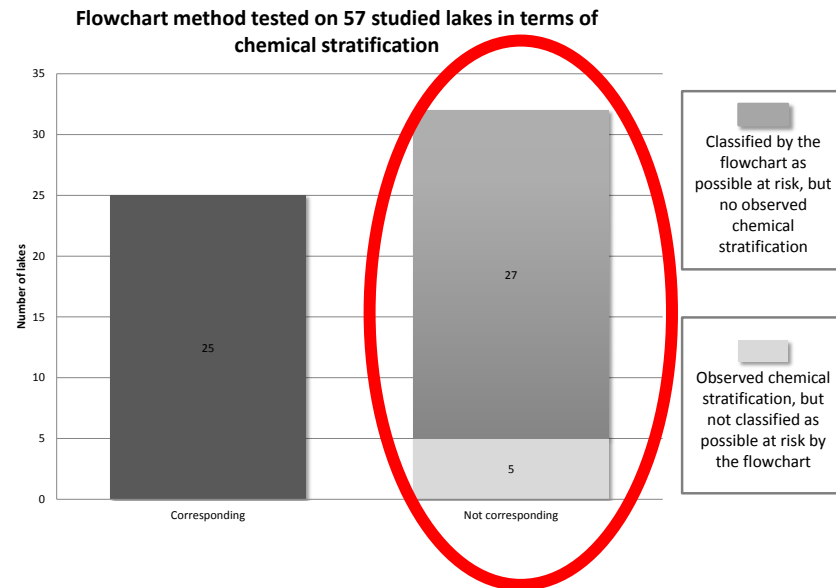
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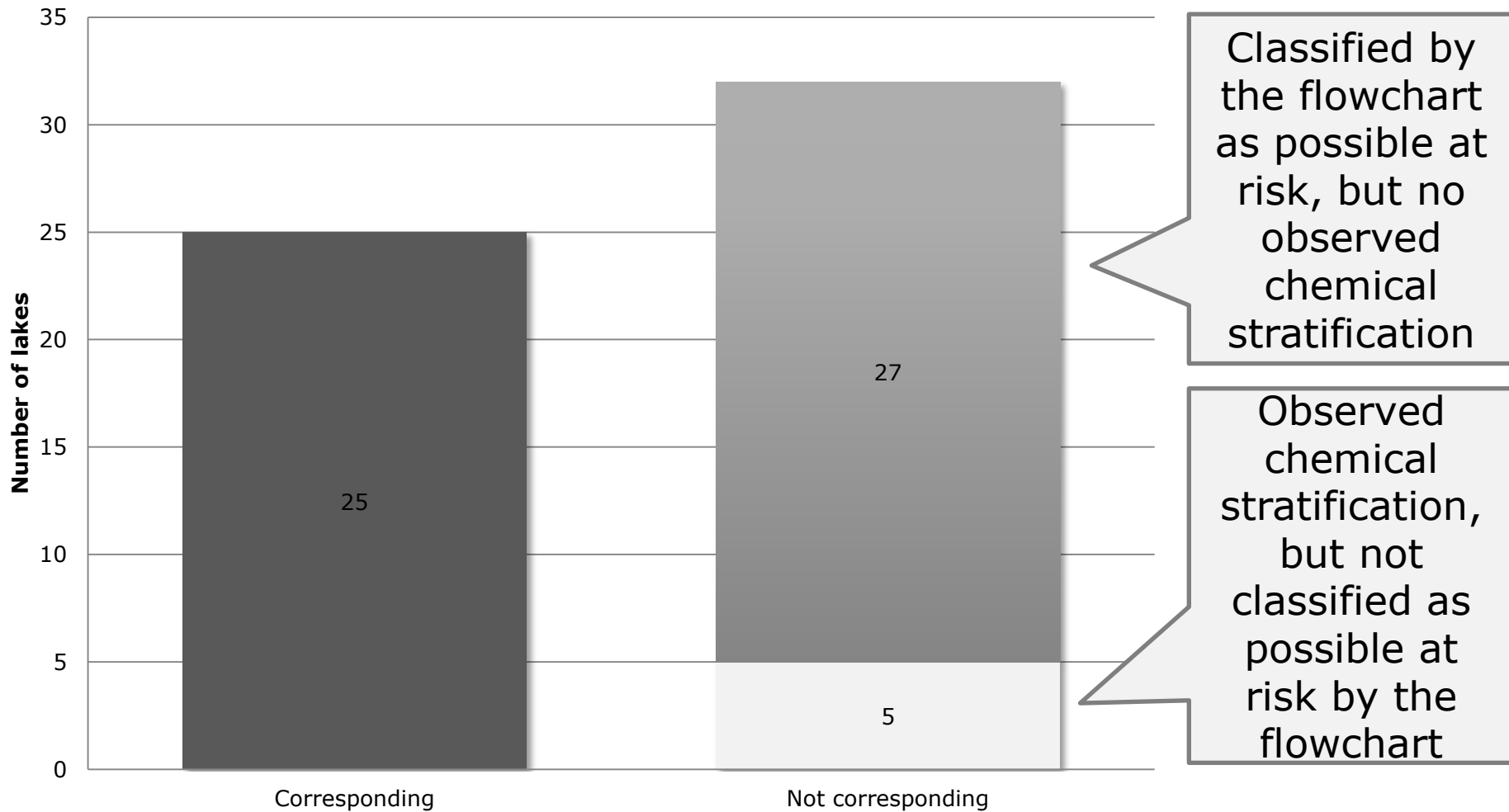
Why are 32/57 of the lakes not corresponding (1)?

«The model used in the flowchart method shows a steady state situation of the water and saltbalance, an equilibrium state where the concentration does not change. This means that if the salt supply to the lakes continues in the future, a chemical stratification might be observed in the future.”

Flowchart method tested on 57 studied lakes in terms of chemical stratification

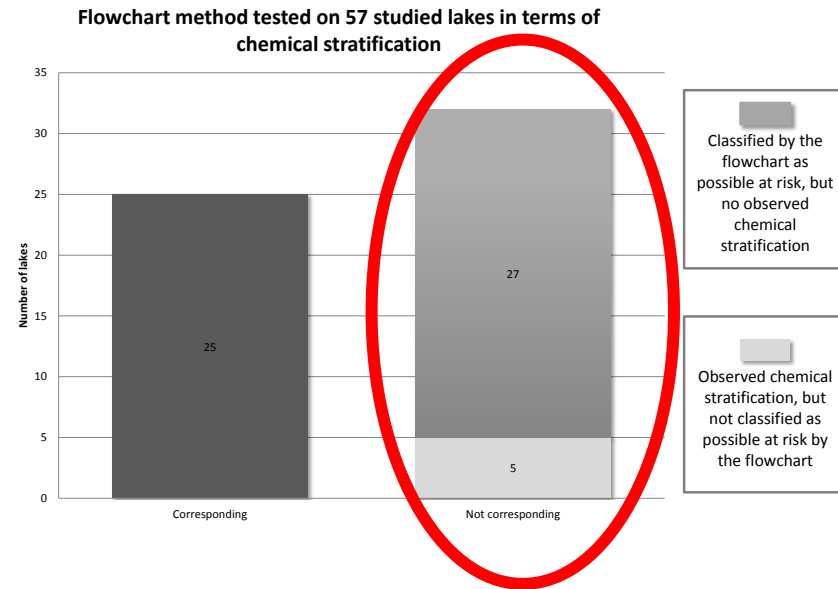|	
Classified by the flowchart as possible at risk, but no observed chemical stratification	
Observed chemical stratification, but not classified as possible at risk by the flowchart	

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Why are 32/57 of the lakes not corresponding (2)?

«In some areas the municipal salt consumption may be significant and can contribute to the chloride concentrations in lakes. In this study, the municipal salt consumption was not taken into account"

Flowchart method tested on 57 studied lakes in terms of chemical stratification

Classified by the flowchart as possible at risk, but no observed chemical stratification

Observed chemical stratification, but not classified as possible at risk by the flowchart

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Why are 32/57 of the lakes not corresponding (3)?

"A seasonal variation through the year would be expected since road salt is only used during winter season. Seasonal variation in chloride concentration is not taken into account in this study. The measured chloride concentration is based on only one measurement through one year."

Flowchart method tested on 57 studied lakes in terms of chemical stratification

Classified by the flowchart as possible at risk, but no observed chemical stratification

Observed chemical stratification, but not classified as possible at risk by the flowchart

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Why are 32/57 of the lakes not corresponding (4)?

"The registration of the salt consumption might be inaccurate, because it is manual and contract dependent."

Flowchart method tested on 57 studied lakes in terms of chemical stratification
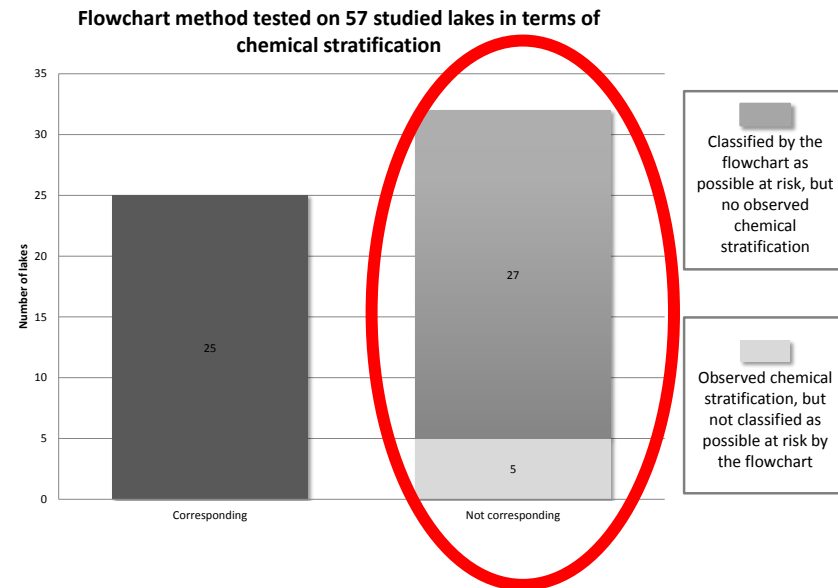
Conclusion

- A flowchart method to identify water resources vulnerable to road salt has been developed and is presented in a GIS
- The method has been tested on 57 studied lakes
  - 25/57 cases corresponded
  - 32/57 cases did not correspond, but 27 of these lakes were classified as possible at risk, but a chemical stratification is not observed
- The method cannot replace water samples, but give an indication of were to find the vulnerable water resources
- The maps provide a useful tool for:
  - Management decision to minimize environmental impacts
  - Road maintenance contrators
- The quality of the data is getting improved, which will lead to improved method and results

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Thank you for your attention!