Successfully mitigating PM_{10} in Stockholm city

Congestion tax, studded tyre bans, dust bindning with CMA, road cleaning and speed regulation

Max Elmgren, Michael Norman, Sanna Silvergren, & Christer Johansson
SLB-analys, Environment and Health Administration, Stockholm

Contact Information:
SLB-Analys
Fleminggatan 4, Stockholm, Sweden
Phone: +46 (0)8-508 28 930
Email: max@slb.nu

All streets in Stockholm city has met the air quality regulations for PM_{10} since 2014, PM_{10} in Stockholm city is successfully mitigated.

High concentrations of PM_{10} in Stockholm are usually witnessed in late winter to early spring when roads are and accumulated road dust from the winter season becomes available for re-suspension. Road dust in Stockholm is generated by the wear and tear of studded winter tyres and partly from traction sand which is commonly used on sidewalks and bicycle lanes during winter. Traction sand is rarely used on vehicle lanes. [2].

Sources
1. Road dust generated by studded winter tyres
2. Long range transport & natural background
3. Break and tyre particles from traffic
4. Tailpipe exhaust particles
5. Combustion particles from heating and energy

Abatements
1. Decrease the amount of studded tyres
2. Stop road dust from re-suspending

1 Congestion tax

2007 congestion tax was introduced. Initial decrease in traffic and rejuvenation of the vehicle fleet since environmental friendly vehicles were exempt from paying the tax. In 2016 a motorway pass was included in the congestion tax and the former exempt on environmental friendly vehicles was removed. PM_{10}-concentrations on weekdays in Stockholm decreased with 13% [1]

2 Studded tyre bans

In 2010 the most polluted street in Stockholm at that time, Hornsgatan, introduced a ban on studded winter tyres. The studded tyre percentage decreased as well as total traffic leading to a decrease of PM_{10} with almost 20% [4]. In 2016 two more streets introduced studded tyre bans. The share of studded winter tyres continues to decrease and has since before the ban 2010 dropped from around 70% to around 25% 2017.

3 Dustbinding with CMA

2011 Stockholm city started dust binding city streets in order to keep them wet for longer periods, thus inhibiting re-suspension of road dust. A hygroscopic salt solution consisting of calcium magnesium acetate (CMA) is applied at night when traffic is low. From 2013 dust binding includes 35 city streets, it is applied more 40 times every season (Okt-Apr) [2]. The effect of dust binding is a decrease with 20-40% on daily average PM_{10}-concentrations. The effect is much lower the second day but still present [3].

4 Extensive street cleaning

Since 2014 a street cleaning with powerful vacuum has been conducted on 35 inner city streets in Stockholm. The vacuum cleaner undoubtedly removes great amounts of PM_{10} from the streets, but the effect of removing it shows little to no effect on the daily average PM_{10}-concentrations. It does however make the city looks cleaner. It is possible that the vacuum cleaner has a long term effect on PM_{10} which is hard to measure since several mitigation actions are at work simultaneously. [2]

5 Speed regulations

Speed is known to be linearly linked to the amount of particles emitted from traffic [5], which would mean a reduction in speed would decrease the PM_{10}-concentrations. In 2014 the speed limit on Hornsgatan was changed from 50 km/h to 30 km/h. The change in actual speed was 45 km/h - 43 km/h. This decrease had very limited effect on PM_{10}.

Conclusions

- Congestion tax decreased the concentrations of PM_{10} city streets on weekdays with between 15-20%. The effect on yearly average was around 3-4%.

- Studded tyre bans decreased the use of studded tyres from 70% to 30%. 20% less PM_{10} was emitted yearly.

- Dust binding with CMA conducted on 35 city streets in Stockholm decreased the number of days exceeding the daily limit value for PM_{10}, from over 50 days to below 20.

- Road cleaning with strong vacuum on 35 city streets reduces the amount of dust on the road, but it has limited effect on daily average PM_{10}-concentrations.

- Speed regulation on Hornsgatan did not have any significant effect on PM_{10}-concentrations since the regulation was not followed, the actual speed reduction was 2 km/h.

Results

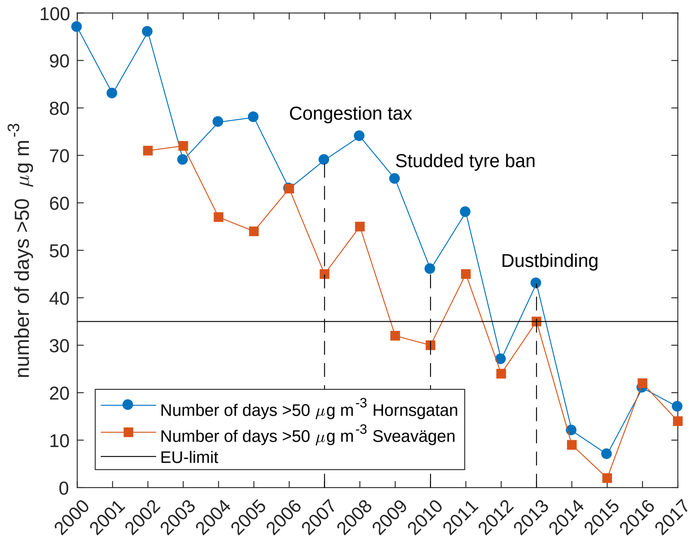

Figure 1: Number of days exceeding the limit value for daily average PM_{10}-concentrations per year for two city streets in Stockholm from 2000 to 2017

Figure 1 shows the steady decline of exceedances of the daily limit value for PM_{10} in Stockholm since the beginning of this century. Nearly 100 days in 2000, to well below the maximum allowed 35 days limit the last four years. Depending on meteorology number of exceedances can vary a lot from year to year, a mild and wet winter will reduce the build-up of road dust and thus decrease the number of exceedances. In the graph the dashed lines show the year a certain abatement method was introduced.

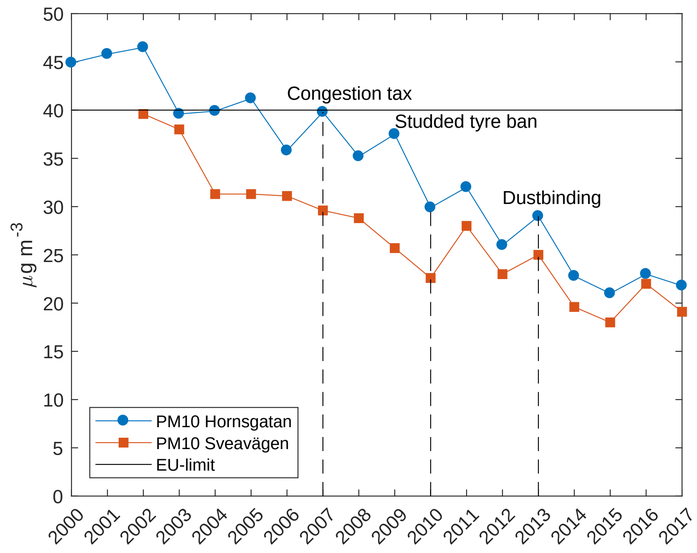

Figure 2: Yearly average PM_{10}-concentrations for two city streets in Stockholm from 2000 to 2017

Figure 2 shows the yearly average PM_{10}-concentrations from 2000 to 2017. In the graph the dashed lines show the year a certain abatement method was introduced. In early 2000's the yearly limit value for PM_{10} was exceeded, after implementing the mitigation plans, the average has drastically decreased.

Important endnote
A contributing factor to the success in mitigating PM_{10} in Stockholm, has been a steady decline in long range transport of particles from other European countries

Future improvements

Stockholm aims to meet Sweden's environmental goals for air quality by 2030, which are stricter than the EU-regulations. This means that PM_{10}-concentrations need to decrease even further. In the project OPTIDRIFT the aim is to streamline winter maintenance to reduce unnecessary costs and work but also to improve the methods being used by using models and predictions.

References

[1] Lars Burman and Christer Johansson. *Trängselskattens inverkan på utsläpp och luftkvalitet*. SLB-analys SLB 8:2009, 2009.

[2] Mats Gustafsson, Göran Blomqvist, Sara Janhäll, Michael Norman, Christer Johansson, Ida Järlskog, Joacim Lundberg, and Sanna Silvergren. *Driftåtgärder mot PM10 i Stockholm: utvärdering av vintersäsongen 2015–2016*. Statens väg-och transportforskningsinstitut, 2017.

[3] Mats Gustafsson, Göran Blomqvist, Per Jonsson, and Martin Ferm. *Effekter av dammbindning av belagda vägar*. Statens väg-och transportforskningsinstitut, 2010.

[4] Christer Johansson, Michael Norman, and Lars Burman. *Vad dubbdäcksförbudet på Hornsgatan har betytt för luftkvaliteten*. SLB 2:2011, 2011.

[5] SLB-analys. *Miljöanpassad hastighet på Norrtäljevägen - utvärderingsrapport 2009*. SLB 7:2009, 2009.

Acknowledgements

This work have been made possible by VINNOVA within the OPTIDRIFT project.