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Ambient PM; A screening study

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Lecture

AMBIENT PM; A SCREENING STUDY

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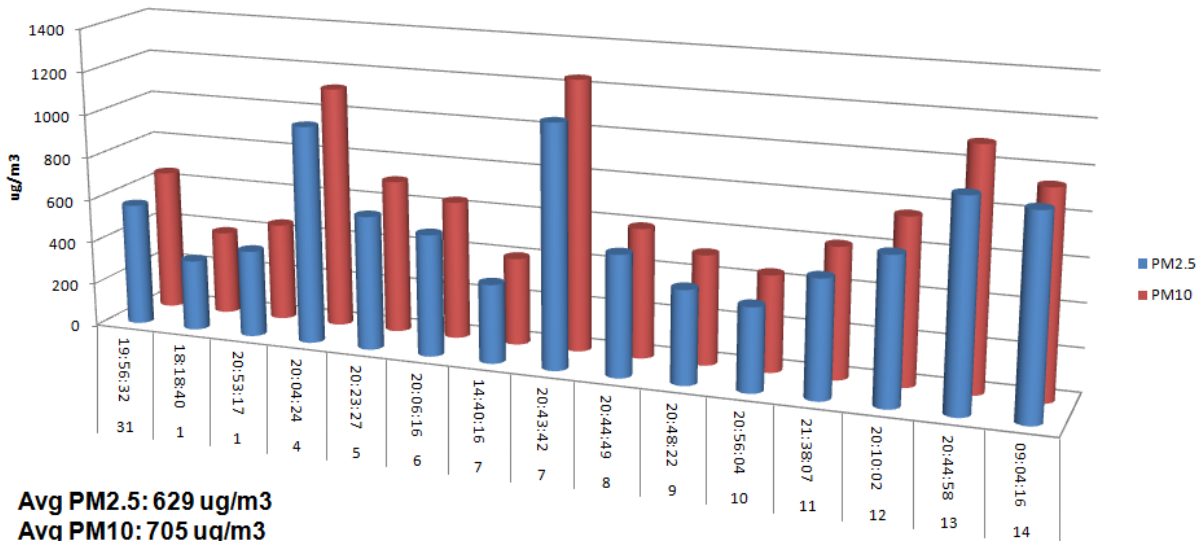

Ambient particle concentrations, a screening study

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In one of the most polluted cities in the World, Dhaka Bangladesh, a screening study was performed in order to investigate the typical levels of suspended particles in the air by using simple handheld instruments. The main objective of the study was to gain an overview of the background concentrations and the spatial distribution of air pollution in Dhaka city area during the most polluted winter season. Continuous measurements have been undertaken from time to time, but limited information about the present situation exists.

The screening study was performed during the winter season which is known to be the most polluted period of the year. Thousands of brick kilns are being operated during this period. These factories emit large amounts of particles and SO2 into the atmosphere. Other possible sources of particulate matter (PM) include re-suspension of road dust from traffic, open air burning of waste, and industrial sources such as cement manufacturing and metal smelting. Regional haze on the plains south of the Himalayas due to sources in India burning dirty coal is also a significant contribution to local PM values on the regional scale. In order to map this regional scale particulate haze over Bangladesh, satellite data were analyzed for Aerosol Optical Depth (AOD). As part of the screening study surface measurements, also SO2, NO2 and ozone was measured using simple passive samplers.

PM sampling procedures

TSI Distract DRX (model 8534) was used to collect particles in the air, such as PM1, PM2.5, PM4, and PM10 simultaneously. For most sites data was collected over 30 minutes at one second increments (data was prepared with 10 second averages). The sampler was calibrated before each sample was taken according to the manufacturers specifications. The sampler was placed at 1m-2m height above ground and run for 30 minutes. The sampler was left alone for the sampling period, with careful attention not to have others walk in the vicinity of the sampler Data was downloaded from the sampler each evening into a developed MS Excel macro to easily display and analyze the raw data. Samples were collected from different types of microenvironments around the city.

PM concentrations

Of the 23 PM_{10} grab samples taken the average 30-minute concentration values ranged from 258 µg/m^3 to 2039 µg/m^3, with an average concentration of 613 µg/m^3 for all sites. The average $PM_{2.5}$ concentration from the 23 grab samples taken was 439 µg/m^3 for all sites. Measurements were also collected at one site over a 24 h period, indicating that the average concentrations of PM in Dhaka frequently exceeded national and international air quality limit values during the winter season.

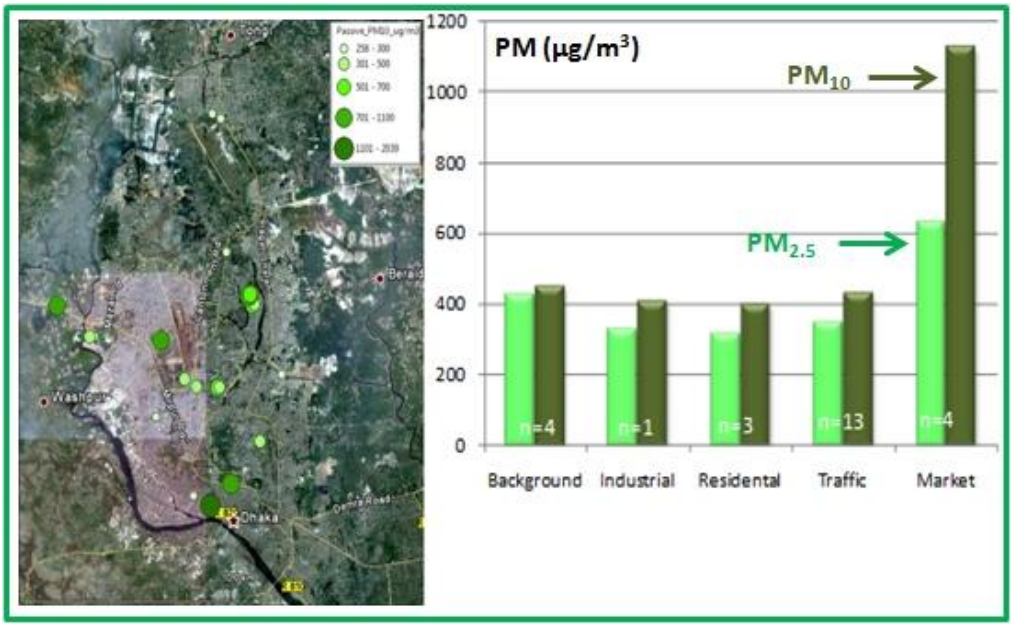


Figure 1: a) Geographical distribution of PM_{10} results.
b) Average PM_{10} and $PM_{2,5}$ concentrations as measured in four different micro environments; background, industrial, residential, traffic and at a busy marked. At the highly polluted marked about 50% of the PM was PM_{10}.

$PM_{2.5}/PM_{10}$ ratios

Simultaneous measurements of $PM_{2.5}$ and PM_{10} made it possible to study the ratio of the size fractions. The $PM_{2.5}/PM_{10}$ ratio of the concentrations for the samples ranges from 0.47 to 0.99, and the average for all sites was 0.8. This indicates that during the winter season PM levels in the atmospheric air are dominated by $PM_{2.5}$ fraction and smaller, and combustion sources are major contributors to the particulate air pollution in Dhaka city. I t also indicated that the regional component of aerosols may play an important role.

Satellite mapping of PM

It has been shown that in addition to local sources of air pollution, PM levels in Dhaka are to some degree also influenced by contribution from more distant pollution sources through long-range transport. It is therefore valuable to utilize satellite data for obtaining a synoptic view of regional spatial patterns of PM beyond the boundaries of Bangladesh.

Satellite data for Aerosol Optical Depth (AOD) were analyzed for the purpose of mapping regional air pollution over Bangladesh, where AOD data is analyzed to obtain a regional-scale spatial overview of PM levels and to investigate to what extent the AOD data can duplicate time series measured on the ground as part of the screening study.

While PM concentrations cannot yet be retrieved directly from satellite data, AOD is an operational product derived for a wide variety of satellite sensors and is closely linked to PM concentrations. This empirical relationship between AOD

and PM has been applied in the past in order to map PM from satellite images. Available AOD data was collected every day during the study period.

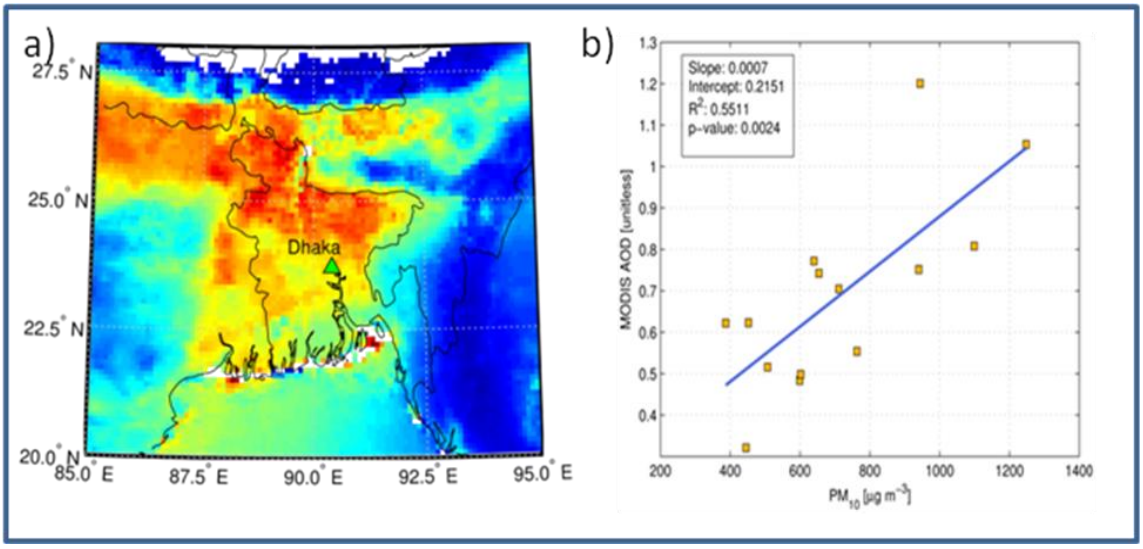


Figure 2: a) Mean MODIS-derived AOD over Bangladesh for the study period between 31 January 2011 and 15 February 2011.
b) In situ observations of PM_{10} plotted against MODIS AOD. AOD was linearly interpolated to provide a matchup at the same time at which the in situ samples were taken. A few in situ samples had to be removed due to contamination by a local fire.

Conclusion

This simple screening study using hand held equipment and passive samplers has shown that Dhaka experiences severe air quality problems in the winter season, and the sheer volume of human exposure to these ambient pollutants is staggering. PM concentrations are exceeding national and international standards.

References

Randall, S., Sivertsen, B., Schneider, P., Thanh, D., Uddin, N., Biswas, S., Saroar, G., Rana, M. (2011) Ambient Air Pollution Screening Study in Dhaka, 31 January - 15 February 2011. Kjeller (NILU OR 28/2011).

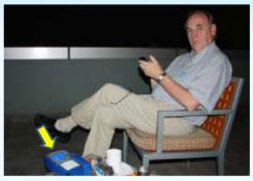
Begum, B.A., Biswas, S.K., Nasiruddin, M. (2010b) Trend and spatial distribution of air particulate matter pollution in Dhaka City. J. Bangladesh Acad. Sci., 34, 33-48.

Appendix A

Presentation

Ambient PM a Screening Study

Dhaka, Bangladesh, February 2011



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Bangladesh/Dhaka Profile

< Location

Bangladesh 145,000km2
Dhaka 200km from coast, Dhaka m.o.h.?

160,000,000 people
>1000/km² *(Norway 13/km²)*

GDP per capita 1,700 USD *(Norway 55,000 USD)*

Dhaka: between 10 mill and 20 mill people

Dry Season: Oct-Mar
Wet Season: April-Sept

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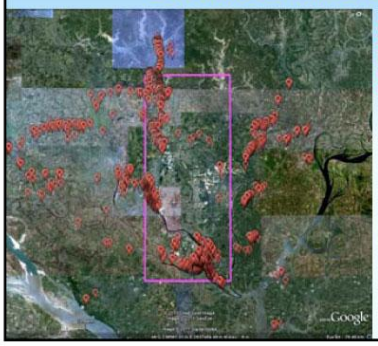
Dhaka Sources



Main Sources:
- Brick kilns, many
- local burning,
- re-suspension on roads,
- local industry
- Regional haze.

Most other sources CNG!:
Vehicles
Power Plants
Large Industries
Residential

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PM sampling

TSI DustTrak was used to collect particles: PM_1, $PM_{2.5}$, PM_4, and PM_{10} simultaneously.

"Semi continuous" sampling
1 sec increments averaged at 10 sec intervals
Primarily over periods of 30 minutes

TSI DustTrak DRX (model 8534)

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PM at 23 Sampling Sites

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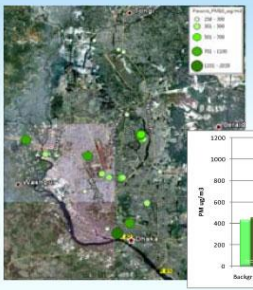
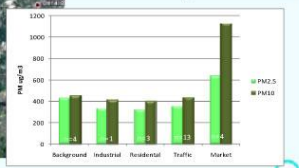
PM results, averages



Average PM_{10} and $PM_{2.5}$ In 4 different micro environments; background, industrial, residential, traffic and at a busy marked.



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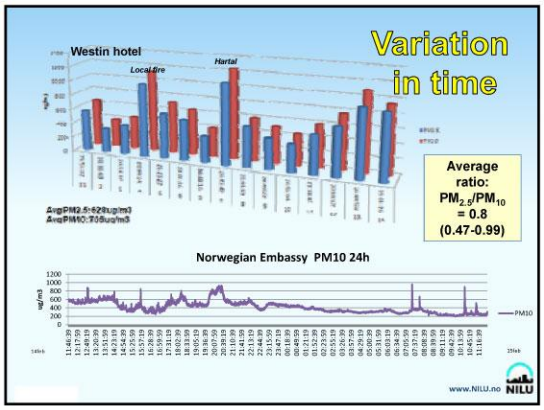
Variation in time
Westin hotel
Local fire
Hartal
Average ratio: PM2.5/PM10 = 0.8 (0.47-0.99)
Norwegian Embassy PM10 24h
PM10
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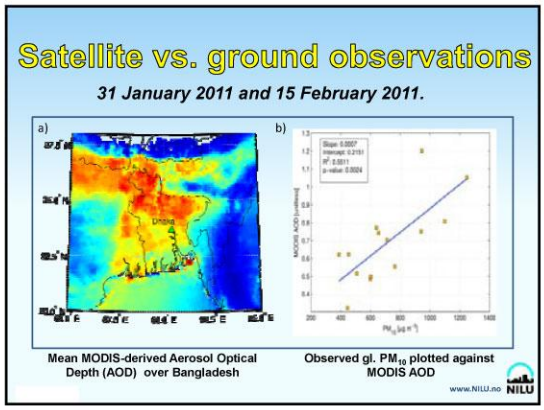
Satellite vs. ground observations
31 January 2011 and 15 February 2011.
a)
b)
Mean MODIS-derived Aerosol Optical Depth (AOD) over Bangladesh
Observed gl. PM10 plotted against MODIS AOD
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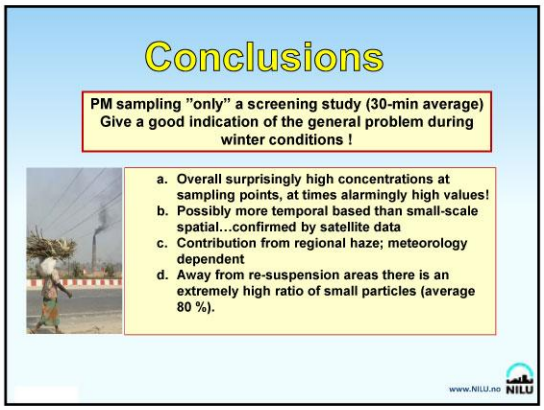
Conclusions
PM sampling "only" a screening study (30-min average) Give a good indication of the general problem during winter conditions !
a. Overall surprisingly high concentrations at sampling points, at times alarmingly high values!
b. Possibly more temporal based than small-scale spatial…confirmed by satellite data
c. Contribution from regional haze; meteorology dependent
d. Away from re-suspension areas there is an extremely high ratio of small particles (average 80 %).
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Thank you !
Questions ???
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