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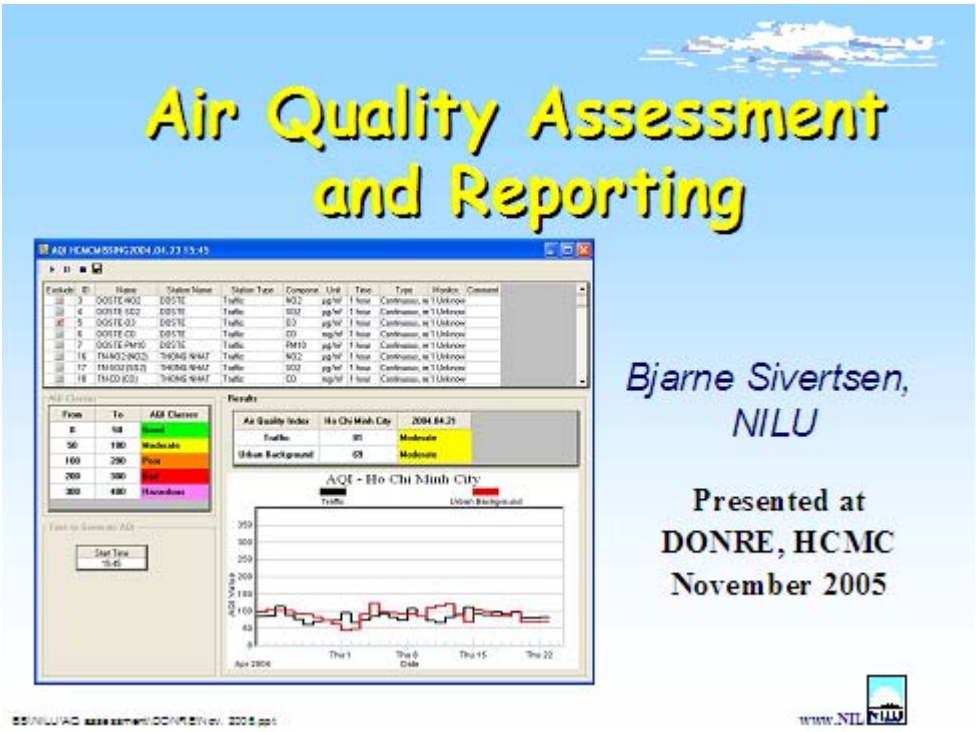
Department of Natural Resources and Environment (DONRE) Ho Chi Minh City

NORAD
DIREKTORAT FOR UTVIKLINGSSAMARBEID
NORWEGIAN AGENCY FOR DEVELOPMENT COOPERATION

Ho Chi Minh City Environmental Improvement Project
Air Quality Monitoring Component

Air Quality Assessment and Reporting in Ho Chi Minh City

Bjarne Sivertsen, NILU



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Air Quality Assessment and Reporting for Ho Chi Minh City

Introduction

This report is based on a presentation prepared for the Seminar: "HCMC Air Quality Monitoring and Management Programme" This was a final seminar held at the end of the Ho Chi Minh City Improvement Project, Air Quality, Monitoring Component, Second part: Reference laboratory and Training. The project has been supported by Norwegian Agency for Development Cooperation (NORAD). The seminar was arranged by DONRE in Ho Chi Minh City (HCMC) on 23 November 2005.

The seminar presented a summary of the air quality monitoring and management programme, which has been developed, based on DANIDA and NORAD funds in Ho Chi Minh City. The presentations were mainly based on the development and training performed by NILU and will include background, monitoring system, calibration laboratory and air quality results.

This report presents the assessment of air quality in HCMC based on measurement data from 9 monitoring stations in the city.

The monitoring programme

The 9 measurement sites using automatic monitors have been established in Ho Chi Minh City (HCMC) supported by Danida (installed in 2000) and by NORAD (installed in 2002).
The Norwegian Institute for Air Research (NILU) has established the database system AirQUIS and ahs undertaken training since 2002.
The stations, site characteristics and locations are given in the Table below.

Table1: Air pollution measurement sites in HCMC, site characteristics and positions.

Stations				Indicators					UTM 84 N	
ID	Code	Name	Charact.	PM10	NO2	SO2	O3	CO	X coordin (m)	Y coordin (m)
1	DO	DOSTE	Traffic		X	X	X	X	684,430	1,192,220
2	HB	Hong Bang	Traffic		X		X	X	681,620	1,189,460
3	TD	Thu duc	Res/Ind		X	X			693,640	1,199,790
4	TS	Tan Son Hoa	Urb Bkg		X	X	X	X	682,830	1,193,930
5	TN	Thong Nhat	Traffic	X	X	X		X	680,690	1,193,530
6	BC	Binh Chanh	Traffic	X	X			X	674,500	1,183,000
7	ZO	Zoo	Urb Bkg	X	X		X		686,420	1,193,370
8	D2	District 2	Res/ind	X	X	X	X		691,160	1,193,510
9	QT	Quang Trung	Urb Bkg	X	X	X	X		677,940	1,200,080

Data are automatically transferred to a central database every night.

The AirQUIS databases and models

The GIS based platform AirQUIS, which include emission inventories, monitor data and dispersion and exposure models has been installed by NILU at HEPA in HCMC. The system will be used for air quality planning purposes and is a management and decision support system.

AirQUIS consists of six components and makes use of an Oracle database. The system has integrated forms and maps, was developed in Visual Basic and Map Object (GIS) and works well on an ordinary NT-server. The different components consist of:

- A manual data entering application,
- An on line monitoring system,
- A module for online data acquisition and quality control,
- A measurement data base for meteorology and air quality,
- A modern emission inventory data base with emission models,
- Numerical models for transport and dispersion of air pollutants,
- A module for exposure estimates and population exposure assessment,
- Statistical treatment and graphical presentation of measurements and modelling results,

All objects described above are integrated in a map and menu oriented user-friendly interface with direct link to the databases for measurements, emissions, modelling results and presentation tools. Advanced import/export wizards allow the user to transfer data easily to and from the AirQUIS system.

NILU prepared the interface between the OPSIS (DANIDA delivered) data retrieval system and AirQUIS. The “old” as well as the new NILU measurement stations have been included on the same AirQUIS platform..

Air pollution dispersion models have also been added to the system in HCMC to enable concentration estimates, evaluation of different source’s relative importance to the total exposure, impact assessment and to perform optimal abatement planning. For this purpose the HEPA experts are in the process of completing an emission inventory for HCMC.

During the last few months NILU has, with the financial support from NORAD, established a reference and calibration laboratory at HEPA. This will assure that calibrations and controls of the data will give quality assured air pollution information for HCMC.

Indicators and limit values

The indicators selected by the monitoring programme for HCMC were:

- Sulphur dioxide (SO_2)
- Nitrogen dioxide (NO_2) and/or NOx (Nitrogen oxides),
- Suspended particles with diameter less than 10 micrometer (PM_{10})

- Ozone (O_3)
- Carbon monoxide (CO)

The measured concentrations have been compared to the limit values or air quality standards given for Vietnam (**TCVN 5937 – 2005).** These standards are presented in Table 2 below, together with the World Health Organisations proposed guideline values.

Table 2: WHO guideline values and the Vietnam air quality standards as proposed in te TCVN 5937-2005.

Pollutant	**Averaging time**	**Guideline and Limit Value**	
		WHO	**Vietnam**
Sulphur dioxide (SO_2)	1 hour 24 hours Year	500 (10 min) 125 50	- 125 50
Nitrogen dioxide (NO_2)	1 hour 24 hours Year	200 - 40	200 40
Ozone (O_3)	1 hour 8 hours 24 hours	200 120	120 - 80
Carbon monoxide (CO)	1 hour 8 hours	30 000 10 000	30 000 10 000
Particles <10 µm (PM_{10})	24 hours Year	 20	150 50
Lead (Pb)	Year	0.5	5 (hourly)

A summary of results

A brief summary of the air quality in HCMC is presented below. Figures and tables can be found in the Appendix.

PM_{10} concentrations

Suspended particulate matter represents the largest problem in HCMC. The annual average PM_{10} limit values are exceeded at all measurement sites.
Daily average concentrations are also exceeded. The daily limit value given for Vietnam is relatively high. Even so we see that the 24-hour average concentrations are exceeded by more than 1 % of the time at the urban background stations.

NO_2 concentrations

Annual average NO_2 concentrations were only exceeded at the roadside stations in HCMC. The measurements performed by passive samplers indicated that the NO_2 concentrations sharply decrease with the distance from the street or road. Only about 50 m away from the street the concentrations are half the level measured at the street.

There is also a clear diurnal variation in NO_2 concentrations with peak values in the morning and late afternoon rush hour. It is also evident that the highly turbulent

daytime boundary layer in HCMC efficiently dilutes the NOx emitted from cars at the surface.

Ozone concentrations

Ozone in the lower part of the atmosphere (in the troposphere) is one of the most wide spread global air pollution problem today. In and around urban areas, relatively large gradients of ozone can be observed. Near strong emission sources of NOx, where there is an abundance of NO, ozone is "scavenged" as it reacts with NO. As a result the ozone concentrations are often low in busy urban centres and higher in suburban and adjacent rural areas.

The highest ozone concentrations measured in the HCMC network is thus found at the regional background stations. Daytime hourly concentrations may easily exceed 200 $\mu g/m^3$ in the dry season. The daytime hourly concentrations inside the city and close to roads seldom exceeded 120 $\mu g/m^3$. The limit value of 120 $\mu g/m^3$ was exceeded about 4 % of the time from 1 January to 1 September 2005 at the sites District 2 and Zoo station.

CO concentrations

CO concentrations measured near roads and streets also show a clear diurnal variation with maxima during rush hours. The highest average CO concentration at BinhChanh, located near one of the main roads running out of HCMC, was 12.6 mg/m^3 in October 2005.
The eight hour average limit values were exceeded during a few days in 2004.

SO_2 concentrations

SO_2 is not a major air pollution problem in HCMC. None of the limit values have been exceeded for SO_2. Typical annual average concentrations are between 20 an 30 $\mu g/m^3$.

Air Quality Index (AQI) generated daily

Daily values of the Air Quality Index (AQI) has been established in AirQUIS based on the present and proposed air quality standards for Vietnam (TCVN 5937 – 1995 and TCVN 5937 – 2005).

The generated AQI values are being transferred every day to the information board near Binh Thanh marked in the city centre of HCMC.

The AQI estimated for the preceding day has also been prepared to present on an Internet page for HEPA. A test site was developed by NILU based on the measurement programme. This site was based on the AirOnline development at NILU and was shown to HEPA in September 2004.

The final evaluation of the automatic AQI generator in AirQUIS has been tested and evaluated and is now being presented on the HEPA web page:
www.hepa.gov.vn

References

Sivertsen, B., Thanh, T.N. and Ødegaard, R. (2003) Ho Chi Minh City Environmental Improvement Project. Air Quality Monitoring Component. Mission 3, November 2003, Status Report (QR6), AirQUIS installed and trained. Kjeller (NILU OR 84/2003).

Sivertsen, B. and Thanh, T.N. (2004) Ho Chi Minh City Environmental Improvement Project. Air Quality Monitoring Component. Mission 4, November 2003, Status Report (QR7-9), Data assessment and training. Kjeller (NILU OR 51/2004).

Sivertsen, B., Thanh, T.N., Le, K.V. and Vo, D.T. (2004) The air quality monitoring and management system for HCMC, Vietnam, Presented at the Better Air Quality Conference, Agra, India, December 2004.
URL: http://www.cleanairnet.org/baq2004/1527/article-59135.html

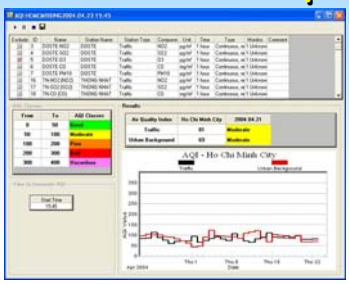
Sivertsen, B., Thanh, T.N., Le, K.V. and Vo, D.T. (2005) The air quality monitoring and management system for HCMC, Vietnam. Kjeller (NILU OR 1/2005).

WHO (2000) Air quality guidelines for Europe, second edition. Copenhagen, WHO, Regional Office for Europe (WHO Regional Publications, European Series, No. 91).
http://www.euro.who.int/document/e71922.pdf

Appendix

Air Quality Assessment
Presentation of the results from air quality measurements in Ho Chi Minh City

Air Quality Assessment and Reporting



Bjarne Sivertsen, NILU

Presented at DONRE, HCMC November 2005

The air quality in HCMC

Based on the selected air quality indicators:

PROJECT CLEAN AIR

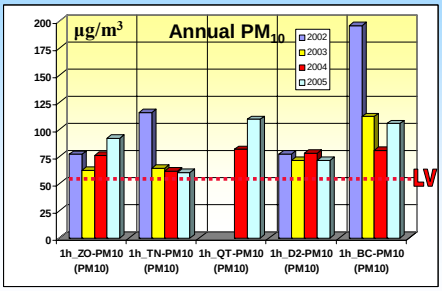
- SO_2 (Sulphur dioxide)
- NO_2 (Nitrogen dioxide)
- PM_{10} (Particles with aerodynamic diameter < 10 micrometer)
- O_3 (Ozone)
- CO (Carbon monoxide)

AQ Guidelines and standards

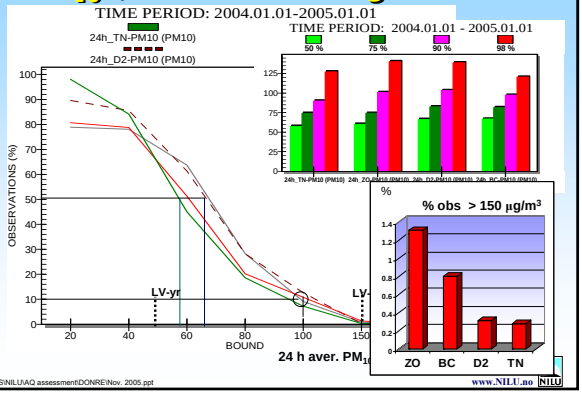
Pollutant	Averaging Time	WHO (µg/m^3)	TCVN-2005 (µg/m^3)
SO_2	Annual Avg.	50	50
	24 Hours	125	125
	1 Hour	500 (10min)	-
CO	8 Hours	10 000	10 000
	1 Hour	30 000	30 000
NO_2	Annual Avg.	40	40
	24 Hours	-	-
	1 Hour	200	200
O_3	8 Hours	120	*80 (24 h)*
	1 Hour	-	120
PM10	Annual Avg.	20	50
	24 Hours	50	150
Pb	Annual	0.5	

LV

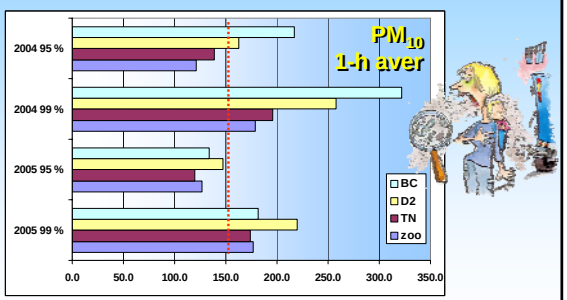
PM_{10} , annual average concentrations



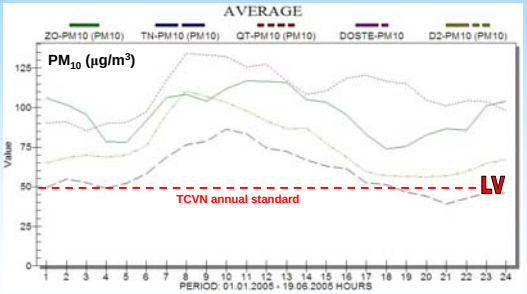
PM_{10} , 24 hour average



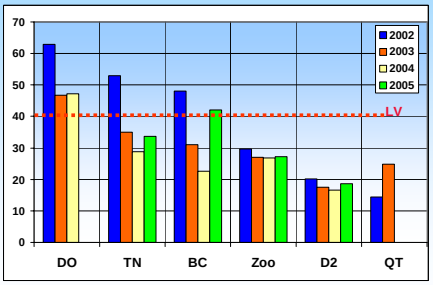
PM_{10} : one hour average



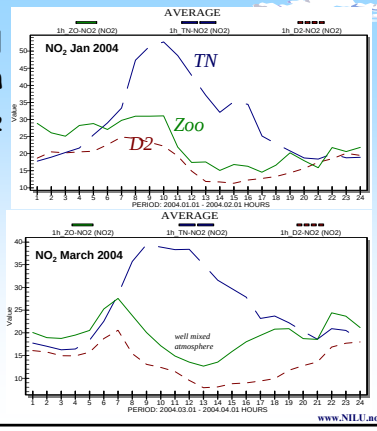
Average diurnal variation PM_{10}



NO_2 , annual average concentrations

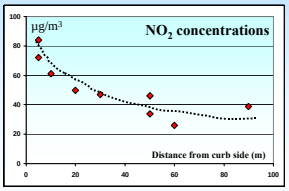


Diurnal variation of NO_2

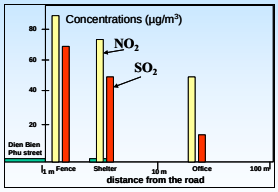


Concentrations fall with Distance from the street

results of passive sampling campaigns



Nguyen van Troi str.

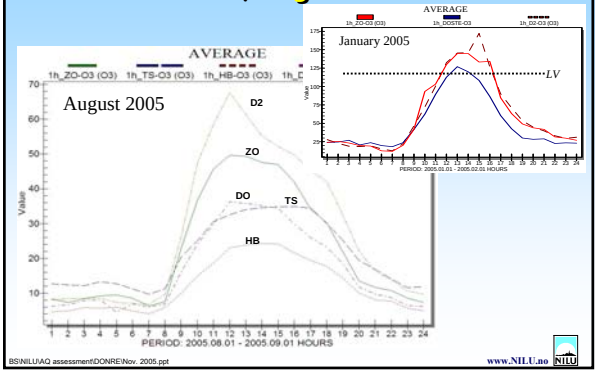


Dien Bien Phu str.

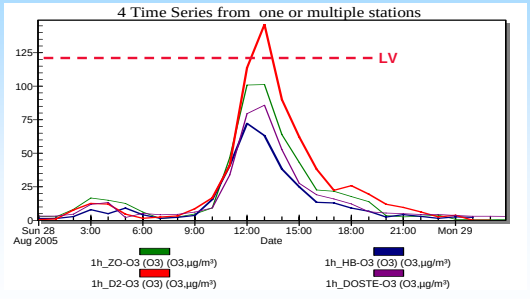
Ozone

-highest in the dry season

Average diurnal variation of Ozone, August 2005

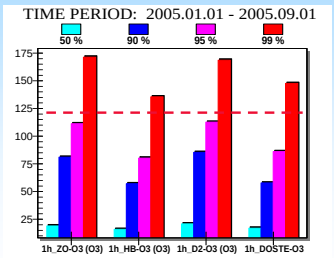


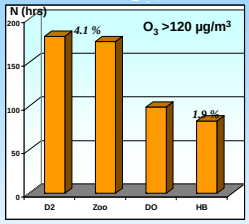
Hourly ozone 28 August 2005 (µg/m³)



Ozone above limit values

Between 1 and 5 % O_3 above 120 µg/m³

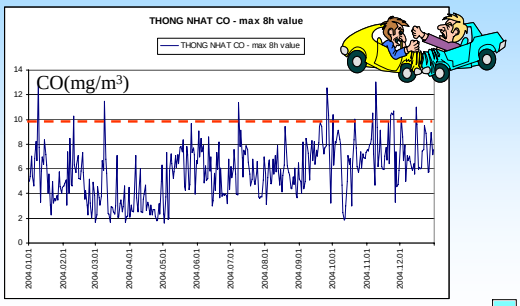




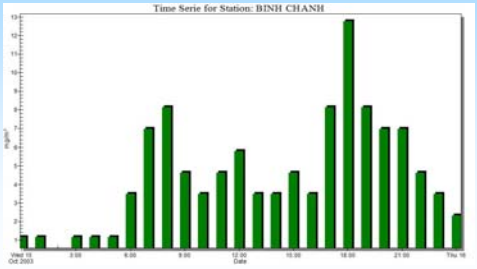
Hours with ozone concentrations above LV: 120 µg/m³

CO concentrations

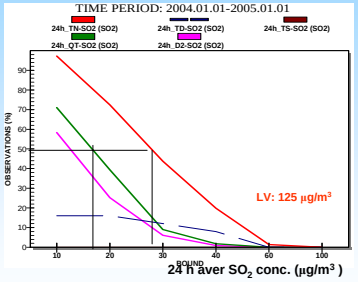
Daily max 8-h average 2004

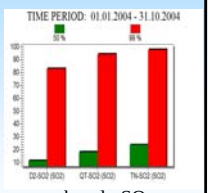


Diurnal variation CO at Binh Chanh



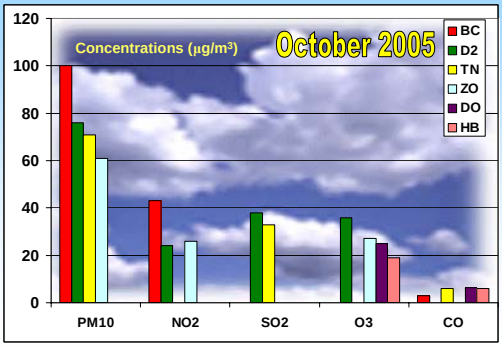
SO_2 : no problem in HCMC





hourly SO_2

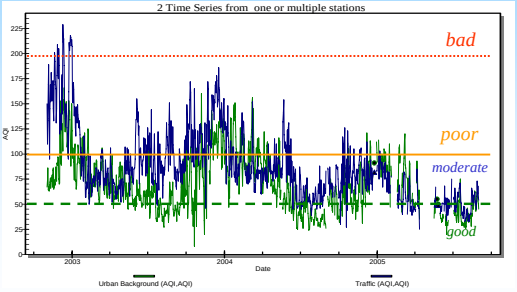
Air Quality HCMC, Oct. 2005



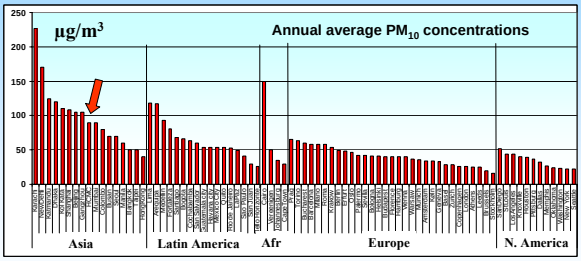
Air Quality Index (AQI)

- ✓ Generated automatically every day
- ✓ Displayed on board at Benh Thanh
- ✓ Presented daily on Internet

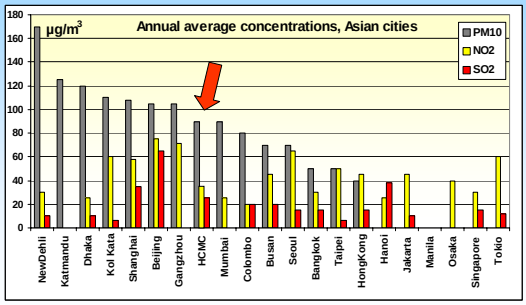
Daily AQI values, 2002 - 2005



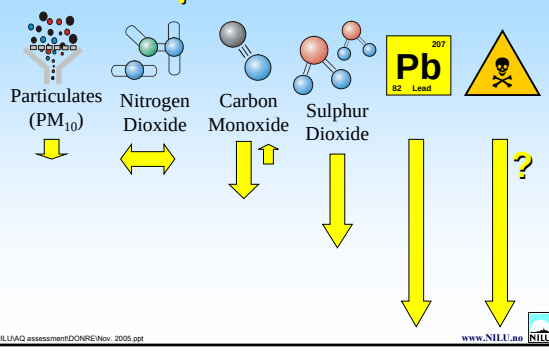
HCMC compared to the World



HCMC compared to Asian cities



Hopeful Trends



Summary

- ✓ Main problem; suspended particles
- ✓ High ozone on dry hot days
- ✓ NO_2 exceeding limit values (annual)
- ✓ Very high exposure in streets and roads
- ✓ AQI seldom at bad and hazardeous level
- ✓ Need for future EIA and planning
- ✓ Should develop abatement action plan
- ✓ Study on Air Quality and Health impact

Thank you !

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