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Ho Chi Minh City

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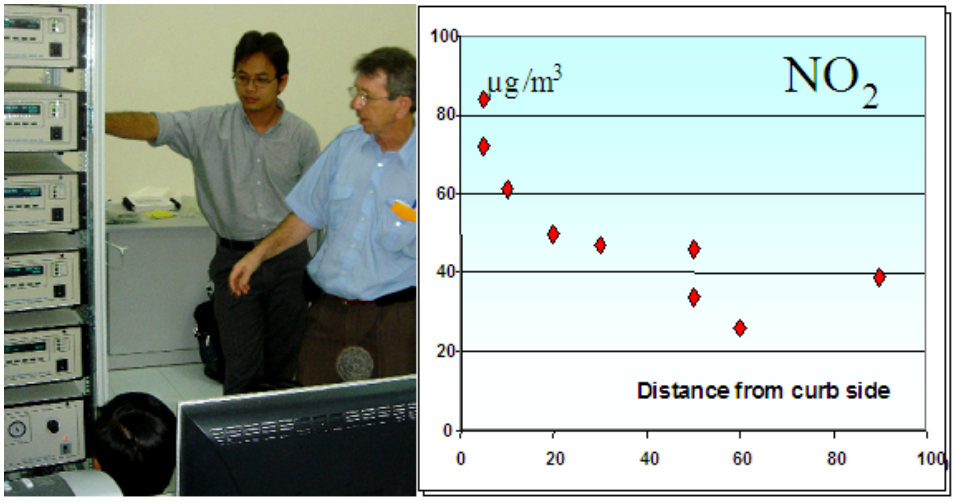
NORWEGIAN AGENCY FOR DEVELOPMENT COOPERATION

Ho Chi Minh City Environmental Improvement Project
Air Quality Monitoring and Reference Laboratory

SR-1
Reference laboratory equipment and air pollution field measurements using passive samplers

Bjarne Sivertsen



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1 Introduction

On 16 November 2004 an extension of the project **H**o Chi Minh City **E**nvironmental **I**mprovement Project **A**ir Quality Monitoring component (HEIA) was signed between DONRE and NILU. The new project is named the Ho Chi Minh City Environmental Improvement Project; Air Quality Monitoring Component, Reference Laboratory and Training (HEIA-R). NORAD shall make payment for supplies and services provided under the new Contract.

This report was prepared after the second Mission of the HEIA-R project, which was undertaken in May 2005. It summarises some of the background for the HEIA-R project, and presents the instrumentation needed to fulfil the objectives of this laboratory.

The report also includes the results of an additional field study that was undertaken during the mission in May. In this study we used passive samplers to study the concentration gradients around major roads and streets in HCMC.

2 The reference laboratory

As part of the maintenance and calibration procedures we identified already during our first missions during the HEIA project that the establishment of a reference, calibration and maintenance laboratory would be needed at HEPA. This laboratory is of crucial importance for keeping up a good quality monitoring system. The objectives were to keep a standard of monitoring, which would meet international requirements.

NILU prepared a proposal to be presented to NORAD for the support of an addition to the original HEIA project. NILU pointed out early that this reference laboratory should be equipped with gas monitors to enable calibrations of gas standards. Expert personnel have to be trained to operate the monitors for calibration reasons. Personnel have to be prepared and trained to carry out systematic calibrations, data controls and audits of the monitoring programme.

The procurement of instruments for the laboratory was finalised at NILU in April 2005. NILU evaluated the content as well as prices and placed a final request at Industriell Måleteknikk in Norway. They also delivered all the instruments for the NORAD financed part of the monitoring system in HCMC. The background for this decision was price, quality, the possibility to check and verify the equipment as well as our good experience with the equipment already delivered in the first phase of the project.

3 Instruments for the laboratory

The complete "Reference Laboratory" should be equipped with gas monitors in addition to the multipoint calibration units, to enable calibrations of gas standards. Expert personnel have to be trained to operate the monitors for calibration reasons. Some experts will also have to be prepared and trained to carry out systematic audits of the monitoring programmes.

The monitors should be placed in a rack in the reference laboratory. The complete set-up includes the following instruments:

NO_x mon.	Equipment:	NO_x monitor, API 200
SO_2 mon.	Equipment:	SO_2 monitor, API 100
O_3 mon.	Equipment:	O_3 monitor, API 400
CO mon.	Equipment:	CO monitor, API 300
Data acq.	Equipment:	Data logger and PC
Zero air	Equipment:	Two point calibration unit, API 701
Calibrator	Equipment	Multipoint calibrator, API 700
Accessories	Equipment:	Accessories

A complete specification as presented during the procurement phase is presented in Appendix A.

NILU will establish the necessary expertise to operate the whole system at DONRE/HEPA. If necessary NILU could be contracted by DONRE to perform Audits once a year in the future.

4 Activities at the reference laboratory

The new Reference laboratory will have to undertake advanced quality assurance and maintenance routines. Once every year the monitors should undergo a dynamic calibration and overhaul at the Reference Laboratory.

The field operations require that trained monitoring experts are visiting the stations every week. Other experts are being trained for using the data retrieval systems and the databases. QA/QC at all levels is an important issue that should be kept alive through regular Auditing of the system.

Regular maintenance of the instruments is usually performed at the station during routine service visits. In addition to the regular maintenance NILU recommends a yearly overhaul where the instrument is examined, cleaned and adjusted more thoroughly. The overhaul will typically take two to three days. Due to limited space at the station and to prevent the overhaul activities from disturbing the other instruments at the station the overhaul should be performed in the laboratory. In addition the overhaul usually requires spare parts, consumables and tools that is easier accessible in the laboratory then at the station. Before and after the yearly overhaul the monitor should undergo a linearity check to document the response after the last measurement period and before the next period respectively.

The yearly linearity check as recommended by CEN and the yearly overhaul as recommended by NILU should be combined and performed at the same time in the laboratory. The linearity check requires a complete dilution/calibration unit. The three-monthly calibration of the monitor requires only two gas concentrations, zero and a fixed span level and should be performed at the station. The two-point calibration requires a zero air generator and a span gas cylinder containing a fixed “outdoor” concentration.

5 Passive sampling of NO_2 and SO_2, May 2003

Concentrations of NO_2 and SO_2 were measured along selected roads and streets in HCMC using passive samplers. The sampling period for most of the samplers were from 4 to 12 May 2005.

5.1 The passive samplers

A sensitive diffusion sampler for sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) in ambient air has been used in several investigations to undertake a screening of the spatial concentration distribution.

The sampler includes an impregnated filter inside a small plastic tube. A thin porous membrane filter to avoid turbulent diffusion inside the sampler covers the inlet. Gases are transported and collected by molecular diffusion.

The samplers are very easy to manufacture. For example, the samplers used by NILU are produced from commercially available 50 mm long polypropylene tubes. The tubes are cut to the desired length and then fitted with a solid cap containing the impregnated filter at one end, and an open cap containing the ant convection mesh/membrane at the inlet end (as shown in Figure 1).

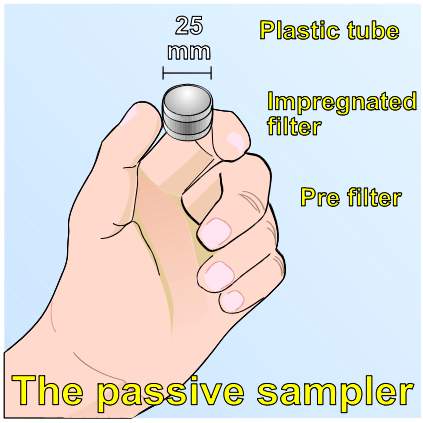

Figure 1: The passive sampler.

All components, except the impregnated filter can be reused. They have many other advantages as well for use in the field. For example they are small, light (~2 g), and require no electricity.

It should be emphasised that they provide time integrated concentrations with continuous time coverage, with the averaging time determined by the period they are exposed to ambient air. For the study in HCMC in May 2005 a sampling time of 7-8-days is used.

5.2 Sampling points

Fifteen sampling points were selected around some of the main roads in HCMC. The main objective was to investigate the pollution gradients from the streets and roads and into the urban background atmosphere.

A simplified sketch in Figure 2 indicates some of the positions of the samplers given by UTM coordinates.

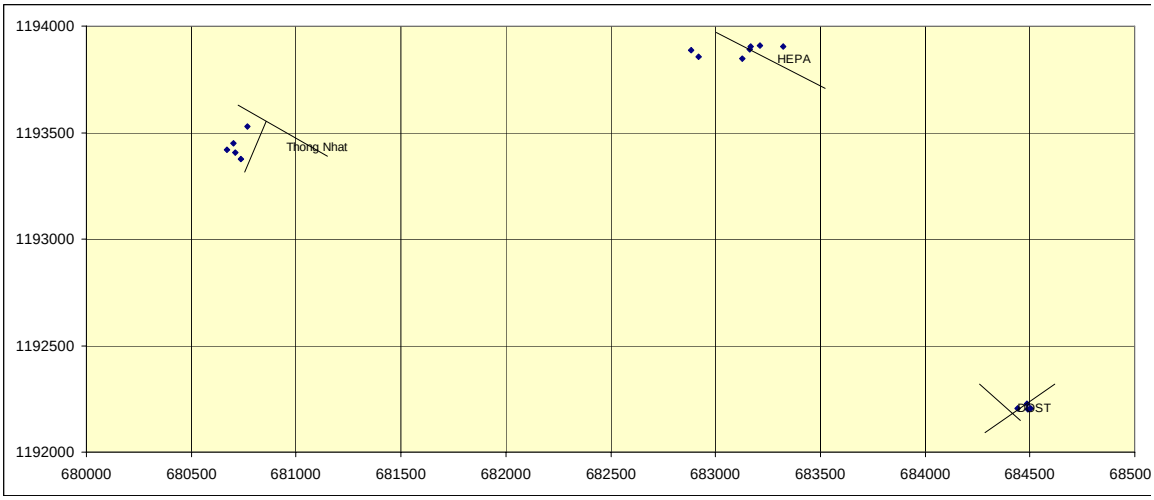

Figure 2: The positions for the 15 samplers used during the May experiments.

We see that the samplers were concentrated around 3 main streets:

- Ly Thuong Kiet Street near the Thongh Nhat hospital station
- Nguyen van Troi street, near Hepa
- Dien Bien Phu Street, near the DOSTE station

In addition we had one sampler set located at Liberty 2 hotel second floor on Ham Nghi Boulevard close to Ben Thanh market

5.3 Results

A summary of the results is presented in the Table below. Concentrations of SO_2 ranged between 16 and 53 µg/m^3 as an average over 8 days of sampling. Similarly the NO_2 concentrations varied from 24 µg/m^3 at the urban background site at Ton Son Hoa to 84 µg/m^3 in Ly Thuong Kiet Street near Thong Nhat hospital.

It is also worth noting that the average concentration at the fifth floor at Liberty 2 hotel near the Binh Thanh marked was as high as 79 µg/m^3 for NO_2 and 39 µg/m^3 for SO_2. These concentrations may be typical for the average exposure in the city centre (District 1) of HCMC.

Passive air pollution sampling

Tel. 9320121 /Mail:aqvie1702@hcm.vnn.vn

Field observations **Observer:_Bjarne Sivertsen & Mr Huy**

Sampling period				Site name	UTM coord.		Sampler concentrations (µg/m^3) and comments		
From:		To:		(Position)			SO_2	NO2	Comments
Date	Hr.	Date	hr.		East	North	(red)	(blue)	
4May05	0920	12May	1320	HEPA balcony	683325	1193905	4	37	
4May05	0925	12May	1145	Street near HEPA	683210	1193910		39	90 m from Nguyen van Troi rd.
4May05		12May	1100	South side road	683163	1193890	47	39	
4May05		12May	1105	60 m from road	683129	1193846		26	
4May05	1015	12May	1115	DOST fence	684491	1192199	40	72	
4May05		12May	1117	DOST shelter	684503	1192205		61	
4May05		12May	1120	DOST building	684487	1192225	16	**47**	30 m from street
4May05		12May	1125	DOST tower	684440	1192205		51	
4May05		12May	1010	TN 50 from street	680735	1193377	25	34	
4May05		12May	0950	Ly Thuong Kiet str	680702	1193449	53	84	
4May05		12May	1000	Ly Thuong Kiet str	680670	1193420		46	50 m west of street
4May05		12May	1030	Tan SonHoa	682920	1193856	18	24	
4May05	1650	12May	1600	Liberty 2 , 5 floor			39	79	
10 May	0930	12May	1330	HEPA gate in street				**48**	5 left of gate in Dinh Ching str
4May05	1130	12May	1045	TonSonHoa fence	682884	1193887		24	100m from Nguyen van Troi rd.

Developed by: Norwegian Institute for Air Research (NILU), POBox 100, N-2007 Kjeller, Norway

A summary of the results is presented in Appendix B.

5.4 Concentrations along the roads

The concentrations of NO_2 decrease significantly with the distance from the road as shown in Figure 3 below.

Along the road and on the sidewalk concentrations of NO_2 ranged between 60 and 85 µg/m^3, beyond 50 m from the road the concentrations levelled at about 40 µg/m^3, which seems to be the typical urban background concentration of NO_2.

The traffic density along some of these main roads is very high. Traffic counting indicated that about 90 % of the vehicles are motorbikes. On some of the roads there are more than 300 000 vehicles passing every day.

The average concentrations measured with passive samplers close to the monitoring stations seem to correspond well to the concentration levels measured by continuous monitoring equipment.

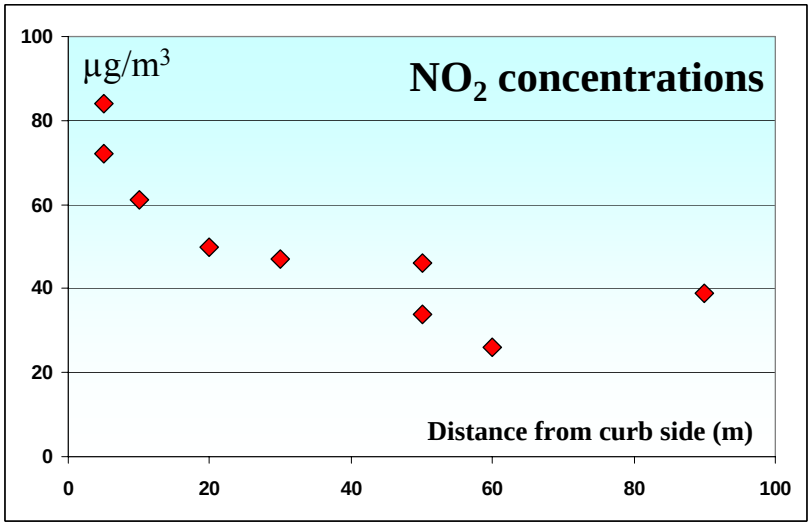

Figure 3: *NO_2 concentrations measured as a function of the distance from major roads.*

Typical average concentrations measured in the urban background atmosphere were around 40 µg/m^3 for NO_2 and between 20 and 30 µg/m^3 for SO_2. The concentration levels near streets and roads were more than twice these levels.

6 References

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Appendix A

Reference laboratory equipment needed

Equipment: NO, NOx, NO_2 ambient air monitor

Quantity of equipment: 1

Purpose
A NO, NOx, NO_2 ambient air monitor is required for measuring NO and NO_2 span gases. The span gas will be supplied to the monitor inlet port at ambient pressure.

Qualification requirements
1. Power requirements: 220 - 240 V.
2. Measurement principle: Chemiluminescence.
3. Measurement range: 1 - 2000 ppb.
4. Permapure drier for drying air to the O_3 generator.
5. The use of silica gel as air drier shall be avoided.
6. Data averaging time: Instantaneous values approx. every 10 seconds.
7. U.S. EPA designated.
8. Rack mountable with rails included.
9. Output values (NO, NO_2, NO_x) via RS232 serial communication port for connecting to the laboratory data acquisition and control system.
10. Complete documentation of RS232 communication commands.
11. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
12. The supplier must have spare sparts in stock for at least five years after delivery of monitor.
13. Operating temperature: +15 °C to +30 °C.

Equipment: SO_2 monitor

Quantity of equipment: 1
Purpose
A SO_2 ambient air monitor is required for measuring SO_2 span gas. The span gas will be supplied to the monitor inlet port at ambient pressure.
Qualification requirements
1. Power requirements: 220 - 240 V.
2. Measurement principle: U.V. fluorescence.
3. Measurement range: 1 - 2000 ppb.
4. The use of silica gel as air drier shall be avoided.
5. Data averaging time: Instantaneous values approx. every 10 seconds.
6. U.S. EPA designated.
7. Rack mountable with rails included.
8. Output values (SO_2) via RS232 serial communication port for connecting to the laboratory data acquisition and control system.
9. Complete documentation of RS232 communication commands.
10. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.

11. Operating temperature: +15 °C to +30 °C.

Equipment: CO monitor

Quantity of equipment: 1
Purpose
A CO ambient air monitor is required for measuring CO span gas. The span gas will be supplied to the monitor inlet port at ambient pressure.

Qualification requirements
1. Power requirements: 220 - 240 V.
2. Measurement principle: Gas filter correlation.
3. Measurement range: 0.1 - 100 ppm.
4. The use of silica gel as air drier shall be avoided.
5. Data averaging time: Instantaneous values approx. every 10 seconds.
6. U.S. EPA designated.
7. Rack mountable with rails included.
8. Output values (CO) via RS232 serial communication port for connecting to the laboratory data acquisition and control system.
9. Complete documentation of RS232 communication commands.
10. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
11. Operating temperature: +15 °C to +30 °C.

Equipment: O_3 monitor

Quantity of equipment: 1
Purpose
An O_3 ambient air monitor is required as the national reference standard for O_3.
Qualification requirements
1. Power requirements: 220 - 240 V.
2. Measurement principle: U.V. absorption.
3. Measurement range: 1 - 1000 ppb.
4. The use of silica gel as air drier shall be avoided.
5. Data averaging time: Instantaneous values approx. every 10 seconds.
6. U.S. EPA designated.
7. Internal O_3 generator.
8. Rack mountable with rails included.
9. Output values (O_3) via RS232 serial communication port for connecting to the laboratory data acquisition and control system.
10. Complete documentation of RS232 communication commands.
11. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
12. Operating temperature: +15 °C to +30 °C.

Equipment: Multigas multipoint calibrator

Quantity of equipment: 1
Purpose
A Multigas multipoint calibrator is required for dynamic calibrations of ambient air monitors.
Qualification requirements
1. Power requirements: 220 - 240 V.
2. Calibration gas input ports: 4.
3. Dilution air flow range: 0 - 5 l/min.
4. Cylinder gass flow range: 0 - 50 ml/min.
5. Certification of calibration of the mass flow controllers.
6. O_3 generator for gas phase titration.
7. Programmable calibration sequence for automatic unattended operation.
8. Output values (measured dilution air and cylinder gas flow rates or output gas concentration) via RS232 serial communication port for connecting to the laboratory data acquisition and control system.
9. Complete control of calibrator (setting flow rates/ output concentrations) via RS232 communication port using the laboratory data acquisition and control system.
10. Complete documentation of RS232 communication commands.
11. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
12. Operating temperature: +15 °C to +30 °C.

Equipment: CO converter
Quantity of equipment: 1
Purpose
A CO converter is required to produce zero air for the dilution of CO gas in the calibrator.
Qualification requirements
1. Power requirements: 220 - 240 V.
2. CO converter capable of delivering zero air free from CO (<0.025 ppm) to the calibrator.
3. The converter must be capable of delivering sufficient air to the calibrator.
4. Operating temperature: +15 °C to +30 °C.

Equipment: Rack for monitors, calibrators, etc.
Purpose
A rack is required for the reference lab ambient air monitors, calibrators, zero air generator and data logger.
Qualification requirements
1. Floor mounted 19-inch relay rack.
2. Minimum rack depth: 30 inches (762 mm).
3. Open on all sides.
4. Number of units in the rack: 5 including data logger.

Equipment: Table for monitors

Purpose

2 nos. solid tables are required for calibration of ambient air monitors.

Qualification requirements

1. Table dimension (approx.), W, D, H: 120 cm, 80 cm, 90 cm.
2. Work load: 150 kg.
3. A solid shelf under the table top.

Equipment: Reference lab repair and maintenance tools kit

Purpose

A complet set of repair and maintenance tools including a toolbox is required for repair and maintenance work in the laboratory.

Equipment: Chair and desk for PC, printer and papers

Purpose

A Chair and desk is required for papers and the reference lab PC and printer.

Qualification requirements

1. Desk dimension (approx.), W, D, H: 120 cm, 80 cm, 90 cm.
2. Swivel-chair.

Equipment: Shelf for manuals

Purpose

A shelf is required for manuals etc.

Qualification requirements

1. Shelf dimension (approx), W, D: 600 cm, 30 cm, split in two equal shelves at a vertical distance of 35 cm.

Equipment: Reference lab air conditioner

Quantity of equipment: 1

Purpose

An air conditioner is required to maintain a stable temperature in the reference lab.

Qualification requirements

1. Power requirements: 220 - 240 V.
2. Temperature set point: +22 °C - +25 °C.
3. Energy dissipation from instruments inside the room (approx.): 8 kW.
4. Condensing water must be removed from the air.
5. Reference lab room air must be ventilated out in order to keep the span gas concentration levels at a minimum.

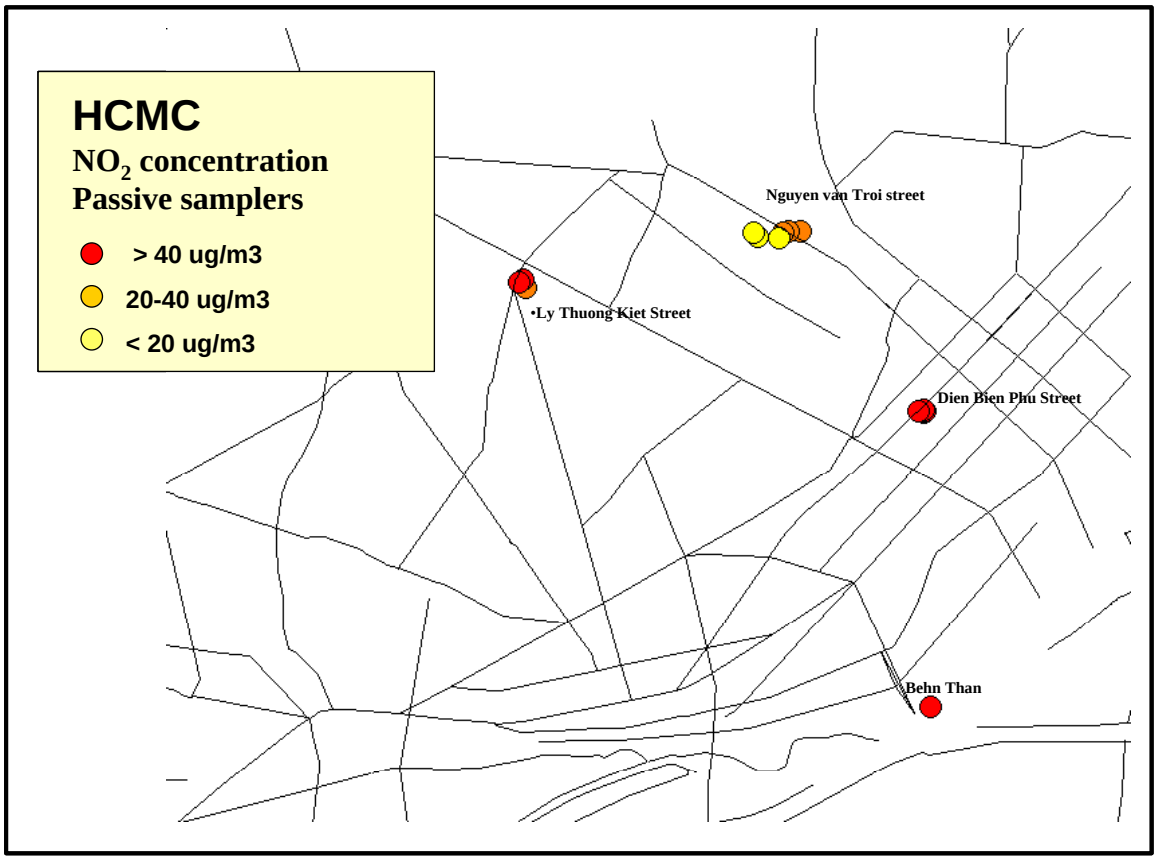
Appendix B

Results from passive sampling of NO_2.

Results from Passive sampling May 2005

The map below summarizes the results from the passive sampling of NO_2 in HCMC undertaken from 4 to 12 May 2005.

Sampling was undertaken at different distances from three streets, and from the fifthe floor of Liberty hotel near Benh Thanh Marked.



Concentrations exceeding 40 and 50 µg/m^3 were only observed near to the main streets,

Norwegian Institute for Air Research (NILU)

P.O. Box 100, N-2027 Kjeller, Norway

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NORAD
Postboks 8034 Dep.
0030 OSLO, Norway

Ho Chi Minh City, Env. Improv. Project Implement Unit
Departement of Natural Resources and Environment (DONRE)
63 Ly Tu Trong Street,
District 1
Ho Chi Minh City

ABSTRACT

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ABSTRACT (in Norwegian)

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- *B Restricted distribution*
- *C Classified (not to be distributed)*