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Passive sampling of SO_2 and NO_2 ambient air concentrations in Cairo

October 2000

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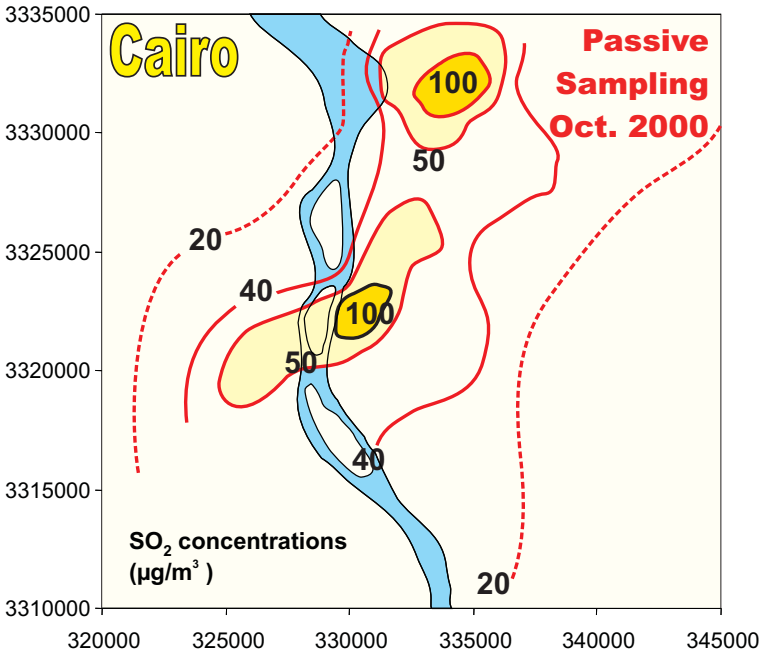

EIMP

Preface

The Environmental Information and Monitoring Programme (EIMP) is funded by Danida and has been running since 1996. The Egyptian Environmental Affairs Agency (EEAA) is the executing agency and COWI (Consulting Engineers and Planners AS) has been the prime contractor. VKI and the Norwegian Institute for Air Research (NILU) are participating as subcontractors for COWI.

NILU has been responsible for the Air Pollution Monitoring component. This component seeks to develop EEAA capacity to obtain and manage information about air pollution in Egypt. It has involved the development of an air pollution monitoring programme included data collection, data transfer, quality assurance procedures and an air pollution database at EEAA. Data are collected using automatic on-line monitors and a variety of sampling equipment. A total of 42 sites covering all Egypt have been selected and has been fully operated since June 1999. An additional twenty sites is selected for using simplified passive samplers of SO_2 and NO_2.

The greater Cairo area has 14 measurement sites for air pollution. These sites are selected for different purposes and are located in different types of microenvironments. It is thus not possible to generate a unified spatial concentration distribution map for Cairo. To enable this kind of mapping a comprehensive network of 50 sites was selected in the greater Cairo area for using inexpensive passive samplers during a sampling period of two weeks in October 2000. The samplers were prepared by NILU and analysed at NILU. Parallels prepared and analysed by the Monitoring Institution at Cairo University (CEHM) were prepared to study the performance of using this kind of passive samplers in Egypt as part of the EIMP/EEAA programme.

Thanks to the field operators at CEHM as well as the EEAA air pollution staff all samplers were located and collected with a loss of only 2 samplers.

Contents

Summary

As part of a screening study of air pollution in Cairo performed in order to evaluate the total concentration distribution over the city, a field study was designed and performed during a period of 2 weeks in October 2000.

About 50 SO_2 and 20 NO_2 passive samplers were located in different parts of the greater Cairo city area. The passive samplers were installed at sites operated by the EIMP air pollution measurement programme, some sites operated by CAIP as well as at new sites.

SO_2 is particularly a problem in the industrial areas near Shoubra ElKheima in the northern part of Cairo, and also in some streets with heavy traffic from diesel buses. High SO_2 concentrations were identified south of the city centre around Fum AlKhalig.

The measured NO_2 concentrations originate mainly from traffic, and the highest concentrations were found in streets and near major roads.

Comparisons of filter preparations and analyses performed at NILU and at CEHM have been reported. The passive sampling data also compared reasonably well with the permanent monitoring and sampling network operated by EIMP/EEAA in Cairo.

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1 Introduction

As part of the Danida financed air pollution monitoring programme for Egypt a screening study was prepared to investigate the concentration distribution of SO_2 and NO_2 in greater Cairo area.

The passive samplers were installed at in field to measure ground level concentrations as a result of emissions from traffic and industry.

2 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 was developed by the Swedish Environmental Research Institute (IVL) and has been used in several cases by NILU. The sampler includes an impregnated filter inside a small plastic tube. To avoid turbulent diffusion inside the sampler, the inlet is covered by a thin porous membrane filter. Gases are transported and collected by molecular diffusion.

The samplers are 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 anticonvection mesh/membrane at the inlet end (as shown in Figure 1).

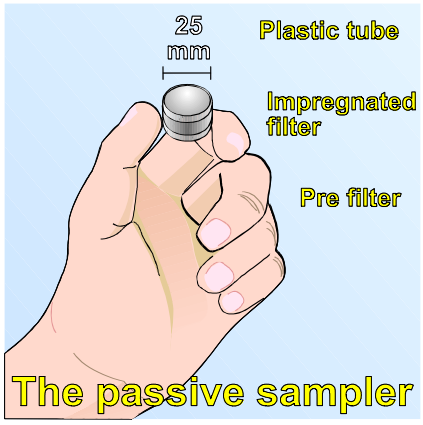

Figure 1: The passive sampler.

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 (~2g), 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 (which can be daily, weekly, monthly, etc.). They are obviously not well suited for monitoring temporal variations over short time intervals, or for detection of individual peak values, or when real time measurements are needed.

2.1 The basic principle

The sampling technique is based on the property of molecular diffusion of gases, hence the term passive (also referred to as diffusive) sampling. The gas molecules diffuse into the sampler where they are quantitatively collected on an impregnated filter or an absorbent material. Thus they achieve a time-integrated (or average) concentration. No electricity, pumps or other supporting equipment are needed.

If the sampling efficiency is sufficiently high, then the sampling rate can be calculated from the cross sectional area perpendicular to the transport direction and the distance that the gas has to diffuse using Fick's first law of diffusion.

To work properly (and quantitatively) it is essential that the transport occurs solely by molecular diffusion and that no gas is lost to the walls of the sampler. Under these conditions then the sampling rate, and thus the concentration range of the sampler, is directly proportional to its cross sectional area and inversely proportional to its length.

Inorganic gases are absorbed by chemical reaction on a filter impregnated with a solution specific to each pollutant measured. The reaction product, which is washed out of the filter prior to analysis, is specific to the particular gas in question. When species do not react sufficiently fast with other chemicals (e.g., organics) they are instead trapped on an absorbent material. Such gases are then desorbed from the adsorbent during analysis.

2.2 Uptake rates and analyses

The uptake rate is only dependent upon the diffusion rate of the gas. The collection rate is 31 *l*/24h for SO_2 and 36 *l*/24h for NO_2. Also NH_3 can be collected at a rate of 59 *l*/24h.

For SO_2 the measuring ranges are approximately 0,1-80 ppb for a sampling period of one month. The corresponding range for NO_2 is 0,02-40 ppb. The passive samplers are assembled and made ready for use at NILU. After exposure the samplers are usually returned to NILU where concentrations of SO_2 are determined as sulphate by ion chromatography. NO_2 and NH_3 is determined by spectrophotometry.

The average concentration at the measurement site over the time period that the sampler is exposed to ambient conditions is determined by chemical analysis of the filter. Analysis consists of removing the impregnated filter and leaching the reaction product, typically using de-ionised water. The leachate is then analysed using an appropriate analytical technique. The highest concentration that can be measured depends on the amount of sorbent on the impregnated filter. This is typically estimated by the stoichiometric amount of the impregnate reduced by a safety factor (typically a factor of 2).

The lower detection limit of the samplers is determined by the use of blanks. As soon as a filter is impregnated it will begin to measure ambient levels. A filter kept in the laboratory will measure laboratory levels, while field blanks will measure the integrated exposure during the transport and storage periods.

The samplers are impregnated shortly before sent to the field, samplers labelled for batch number, a few filters checked immediately, and then filters identified for lab and field blanks. The laboratory blanks are stored in the lab and periodically tested. The field blanks are kept in their containers and accompany the samplers to the field and are returned after the filters are exposed. The field blanks are analysed along with the exposed samples. The concentrations determined from the exposed filters are then corrected using the blanks. The lower detection limit is commonly defined as 2 to 3 times the standard deviation of the blanks. The repeatability of the results is quantified and checked by use of duplicate samples.

3 Sampling sites in Cairo

Passive samplers were used to measure NO_2 and SO_2 concentrations at selected sites in Cairo. The sites were selected from two main criteria:

1. Measure at the same sites as other air quality measurements are performed
2. Measure in different micro environments (streets, near industries, in urban areas, in residential areas)

The sites where air quality measurements were being collected are operated by EEAA. The measurement programme is presented in Table 1. The maps in Appendix A give a picture of the spatial distribution of the sampling sites and residential areas in relation to the main sources, for each city.

Table 1: Selected sites for passive samplers in Cairo, October 2000

			Observer	SO_2	NO_2	Out		In		
	Site no.	Site name				Day	Hr	Day	Hr	Comm
EIMP	AQ-01	El Qualaly.	Omar	1	3	15	1330	28	1330	
		Parallell		88	99					91,89
	AQ-02	El Gemhoroya street	Kamela	7	10	15	1420	28	1510	
	AQ-03	Abbasya	Kamela	5	2	15	1240	28	1510	
		Parrallell		82	83	15		28		84,81
	AQ-04	Nasr City	Mahmoud	4	9	15	1430		1130	
	AQ-05	Maadi EEAA	Heba	22	11	14	1450	28	1053	
	AQ-06	Tabbin	Maher	31		14	1630	28	1000	
	AQ-07	Tabbin south	Maher	2	5	14	1600	28	1045	
	AQ-08	Fum El Khalig	Kamela	9	7	14	1430	28	1650	
	AQ-09	Abu Zabel	Kamela	10	8	15	1030	28	1300	
	AQ-10	Shoubra el Kheima.	Kamela	8	6	15	1110	28	1345	
	AQ-11	Giza, Cairo University.	Tarek	6	4	15	1030	28	1530	
		Parallell		93	97	15		28		94.1
CAIP	6	Maadi/Digla	Ashraf	33		15	900	28	1145	
	12	ElDarb ElAhmer	Basil	38		15	1000	29	800	
	16	Mokotam hills	Omar	19		15	1530	28	1430	
	21	Matarya	Omar	36		15	1140	28	900	
	22	ElWaily	Basil	24	13	15	1100	29	900	
	25	Imbaba	Basil	26	20	15	1420	29	1000	
	27	15th May city	Ashraf	37		15	800	28	800	
	28	Almaza	Omar	34		15	1240	28	950	
	29	Basateen	Omar	16		15	1200	28	1215	
	30	Giza, Sheraton	Ashraf	30	19	14	1400	29	900	
	31	Tahrir Square	Omar	29	12	15	1300	29	730	
	32	Zamalek	Ashraf	20		15	1600	28	830	
	33	Helwan	Ashraf	40		15	830	28	930	
	34	El Massara	Ashraf	28	17	15	1000	28	1100	
	35	Heliopolis	Omar	11		15	1215	28	1020	
	36	Abbasya	Ashraf	39		15	1040	28	930	
New		Shoubra, Ayman	Ayman	12		14	1830	28	1930	
		Shoubra Kh., Kamela	Kamela	18		14	815	27	1930	
		Nasr City, Hesham	Hesham	3	1	14	1900	28	1000	
		Parallell	Hesham	96	98	14		28		
		Roda Isl. Lydia	Lydia	25	16	14	2020	28	725	
		Masr el Adina	Haytham	17		14	1900	28	2200	
		Roxy , Heba	Heba	75	76	14	1815	28	2100	
		NIS	Haytham	32		15	1200	28	1400	
		Helwan , Maher	Maher	35		14	2100	27	830	
		Muh. Farid str.	Mahmoud	21	15	15	1600	28	900	
		Sultan Hassan mosq	Heba	27	18	14	1320	28	1028	
		Islamic museum	Heba	79	78	14	1400	28	1017	
		DarelSalam	Haytham	15		14	2000	28	1300	
		Garden City, Ital. Emb.	Tarek..	14		15	830	29	1215	

4 Measured concentrations

4.1 Passive sampling

A complete list of analyses of SO_2 and NO_2 is presented in Appendix B.

Most of the passive SO_2 and NO_2 samplers were brought to NILU for analysis. The results of the SO_2 analyses are indicated in Figure 2.

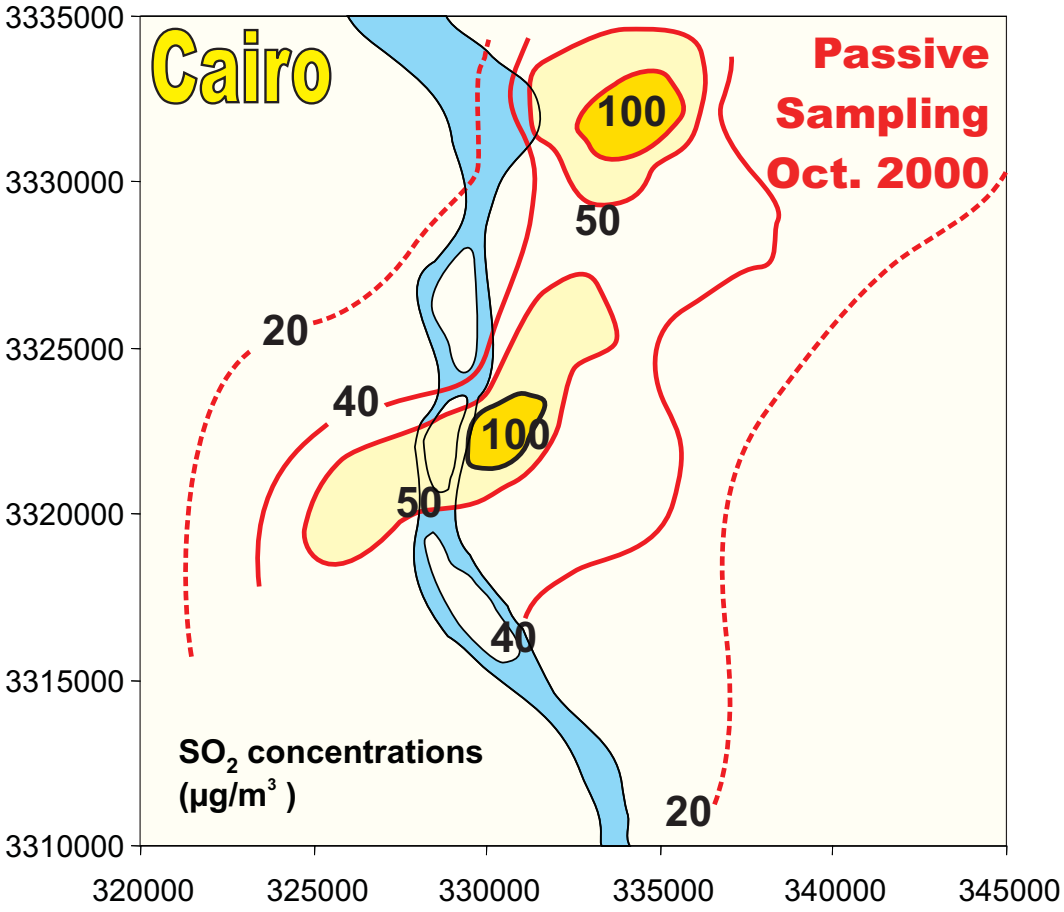

Figure 2: SO_2 concentrations measured by passive samplers in Cairo, 14-28 October 2000.

Two maximum areas were identified in the Cairo area; one downwind from the city centre, with a maximum occurring around FumAlKhalig and at the southern part of KasrElEini street. The other maximum was found in the ShoubraElKheima area, which is the normal situation due to many industrial sources in this area. In these areas the two-week average SO_2 concentrations exceeded 100 µg/m^3, which indicates that also the long-term air quality limit value of 60 µg/m^3 could be violated.

NO_2 concentration, as presented in Figure 3 and in Appendix B, Table B1, varied from from 34 to 79 µg/m^3. The highest concentrations were found near streets at FumAlKhalig, ElGomhoryia Street, Tahrir square and Sultan Hassan Mosque. High concentrations of NO_2 were also measured near the main streets in Nasr

City. The lowest concentrations were outside Cairo at Tabbin South and AbyZabel.

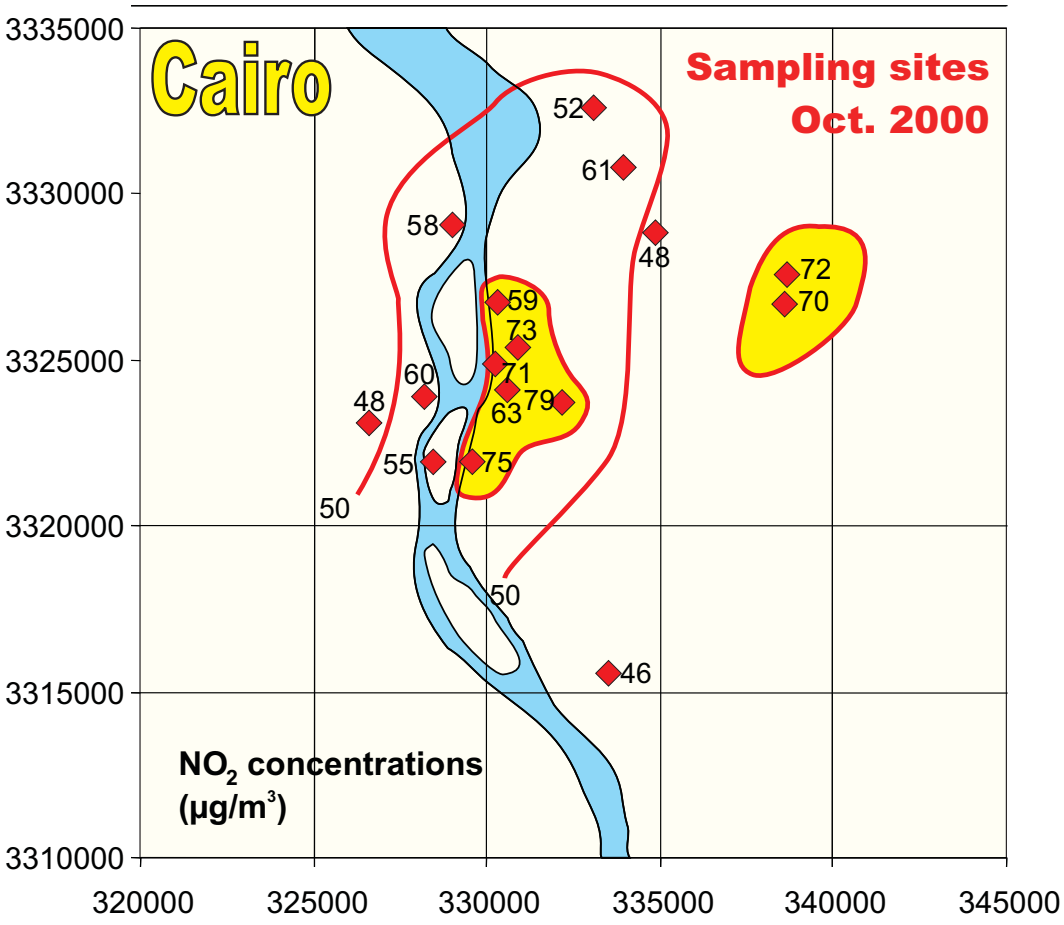

Figure 3: NO_2 concentrations measured by passive samplers in Cairo, 14-28 October 2000.

4.2 Comparisons of analyses

Analyses of passive samplers have been performed both at NILU and at CEHM. Parallel samples have been collected at 4 different sites. The passive sample filters have also been prepared both by NILU and by CEHM.

The results of the parallels are given for SO_2 in Table 2 and for NO_2 in Table 3. Identification number (i.d.) less than 60 are prepared at NILU and analysed at NILU. I.d. numbers higher than 70 are prepared by CEHM. Half of the parallels are analysed by NILU the other half by CEHM.

Table 2: Passive SO_2 samplers operated in parallel at selected sites. Concentrations are given in µg/m³ as an average for the two weeks of sampling.

	NILU		Parallel, NILU		CEHM	
Site	i.d.	conc	i.d.	conc	i.d.	conc.
Quolaly	1	85	88	74	91	97
Abbaseya	5	46	82	43	84	57
Giza CU	6	21	93	26	94	35
NasrCity, Hesham	3	42	96	35	95	82

The analyses of SO_2 are in fair agreement with each other. Filters prepared by NILU and by CEHM, and analysed by NILU varied from between 2 and 13 % from each other. However, parallels analysed at CEHM were higher than the NILU results. The CEHM analyses were 26-32% higher than the NILU analyses, except in one case where the CEHM analyses was more than twice the NILU result.

Table 3: Passive NO_2 samplers operated in parallel at selected sites.

	NILU		Parallel, NILU		CEHM	
Site	i.d.	conc	i.d.	conc	i.d.	conc.
Quolaly	3	59	99	133	89	174
Abbaseya	2	48	83	78	81	120
Giza CU	4	48	97	76	100	63
NasrCity, Hesham	1	72	98	106	92	135

In the case of the passive NO_2 samples it seems as the preparation of the filters at CEHM may be the main problem. The analyses performed on filters prepared at CEHM are consistently 2 to 3 times higher than filters prepared and analysed by NILU.

The typical levels of NO_2 measured by other instruments in Cairo during the period ranged from 40 to 80 µg/m³. This seems to be in accordance with the NILU analyses.

4.3 Measurements from the EIMP network

Measurements collected by the EIMP monitoring network as well as from sequential samplers located in the greater Cairo area are presented in Appendix C. A summary of average concentrations is given in Table 4.

Table 4: Measured ground level daily concentrations, averaged over the sampling period; 14 – 28 October 2000 and for the fourth quarter 2000.

Instrument	Site	14-28 October 2000		Typical 3 month aver.	
		SO_2	NO_2	SO_2	NO_2
Monitors	Shoubra	76,3		67	-
	Quolaly	72,7	80,5	70	86
	Abbasyia	44,4		38	-
	Gomhoryia	36,6	68,1	42	62
	FumAlKhalig	60,5		65	-
	Giza, CU	28,3	44,4		
	Maadi EEAA	17,5	55,7	37	59
	Tabbin	22,0	26,9	25	28
Seq. Samplers	Shoubra		31,2		
	Nasr City	43,8	46,2		
	Tabbin South	51,3			

4.4 Comparisons passive samplers vs. monitors and sequential samplers

The results obtained from the passive sampler programme have been compared to the average concentrations measured by the monitors and the sequential samplers at the same locations and for the same period in Table 5.

Table 5: Analyses of SO_2 and NO_2 performed on the passive samplers as well as on monitors and sequential samplers (SS) during 14 to 28 October 2000.

Site	SO_2		NO_2	
	Passive sampler	Monitors / SS	Passive sampler	Monitors / SS
Shoubra	152	78,9	52	
Quolaly	85	73,8	59	80,5
Abbasyia	46	44,4	48	
Gomhoryia	51	37,7	73	68,1
FumAlKhalig	113	62,0	75	
Giza, CU	21	28,3	48	44,4
Maadi EEAA	22	17,5	46	55,7
Tabbin	18	22,0	-	26,9
Nasr City	38	43,8 SS	70	46,2 SS
Tabbin South	38	51,3 SS	34	

For SO_2 concentrations ranging from 20 to 80 µg/m^3 the passive samplers and the monitors measure the same concentrations within plus-minus 25 % of each other. Considering that the intakes and the sampling periods are not exactly the same this result is satisfactory. For the two most impacted sites (highest concentrations) at Shoubra and at FumAlKhalig the passive sampler results were 80-90% higher than the average concentrations measured by monitors. We measured SO_2 by passive sampler also at one other location in Shoubra, and this was within 10 % of the monitor.

Figure 3 summarises the SO_2 concentration measurements, and confirm the discussion above.

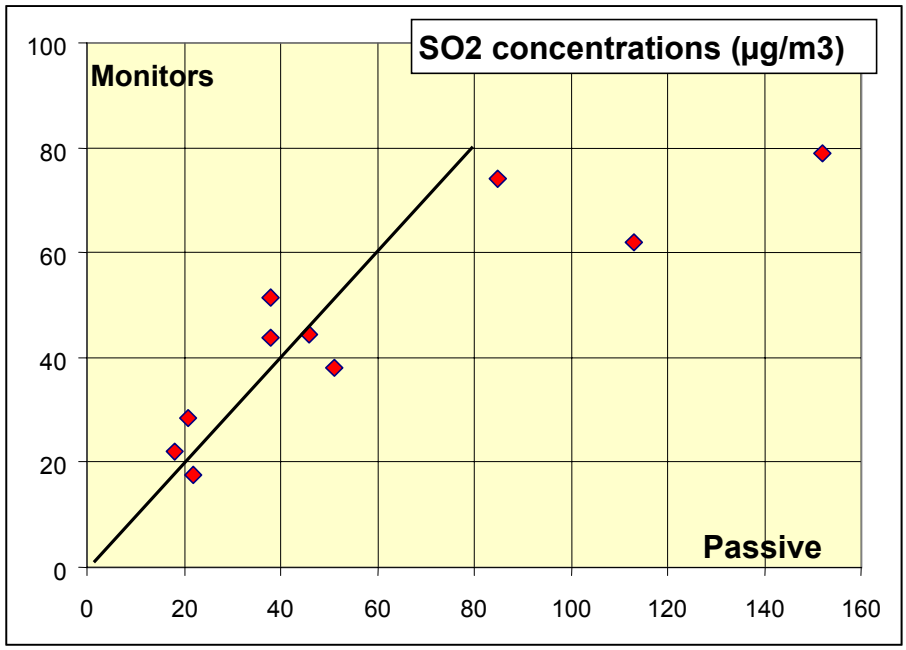

Figure 4: SO_2 concentrations from passive samplers versus SO_2 by monitors based on measurements performed in Cairo from 14 to 28 October 2000.

5 Air quality guidelines

The air quality guidelines for SO_2 and NO_2 from the Egypt Environmental Affairs Agency (EEAA) Law no. 4, and given by the World Health Organisation (WHO) is presented in Table 6.

Table 6: Air quality limit values for SO_2 and NO_2.

Component	Aver. time	Limit value µg/m3	
		EEEA	WHO
SO_2	24 hour	150	125
	Annual	60	50
NO_2	24 hour	150	-
	Annual	-	40-50

6 Discussions and conclusions

The SO_2 concentrations measured in Cairo was averaged over a period of two weeks. To compare the measured levels to the air quality limit values given in Table 6, one has to assume that the concentration distribution in the urban area are close to log-normal distributed. For a measurement period of two weeks we

should compare the levels to about 100 μg/m^3 to discuss possible exceedances of the limit values.

Two areas were identified during this measurement period to have a potential for exceeding the air quality limit values given by Law no. 2 from EEAA. These areas were found around Shoubra ELKheima and at FumAlKhalig.

Most of the city centre areas of Cairo had concentrations exceeding 50 μg/m^3, which is the annual average concentration limit given by World Health Organisation.

The results from the passive sampling programme compared reasonable well with measurements performed by the permanent network of monitors and sequential samplers operated by the EIMP/EEAA programme.

7 References

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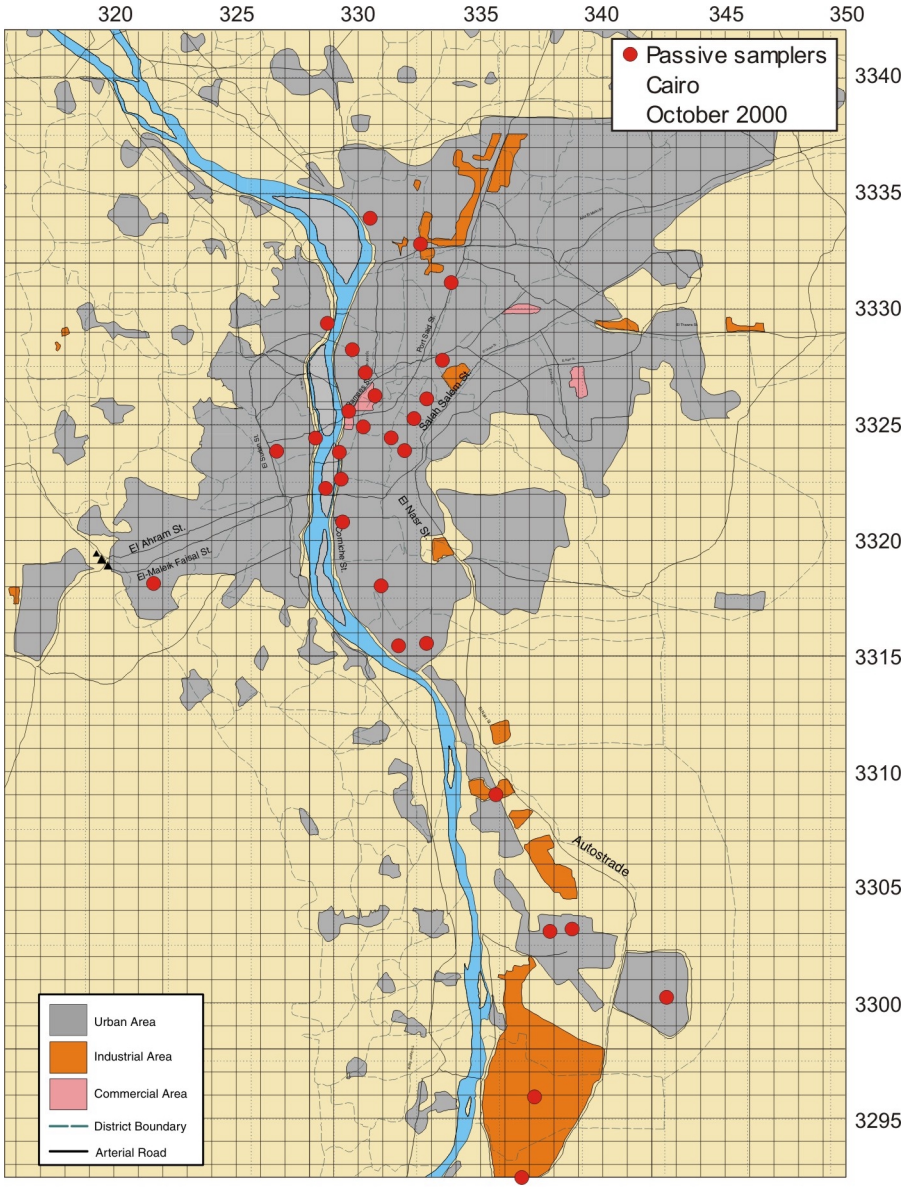
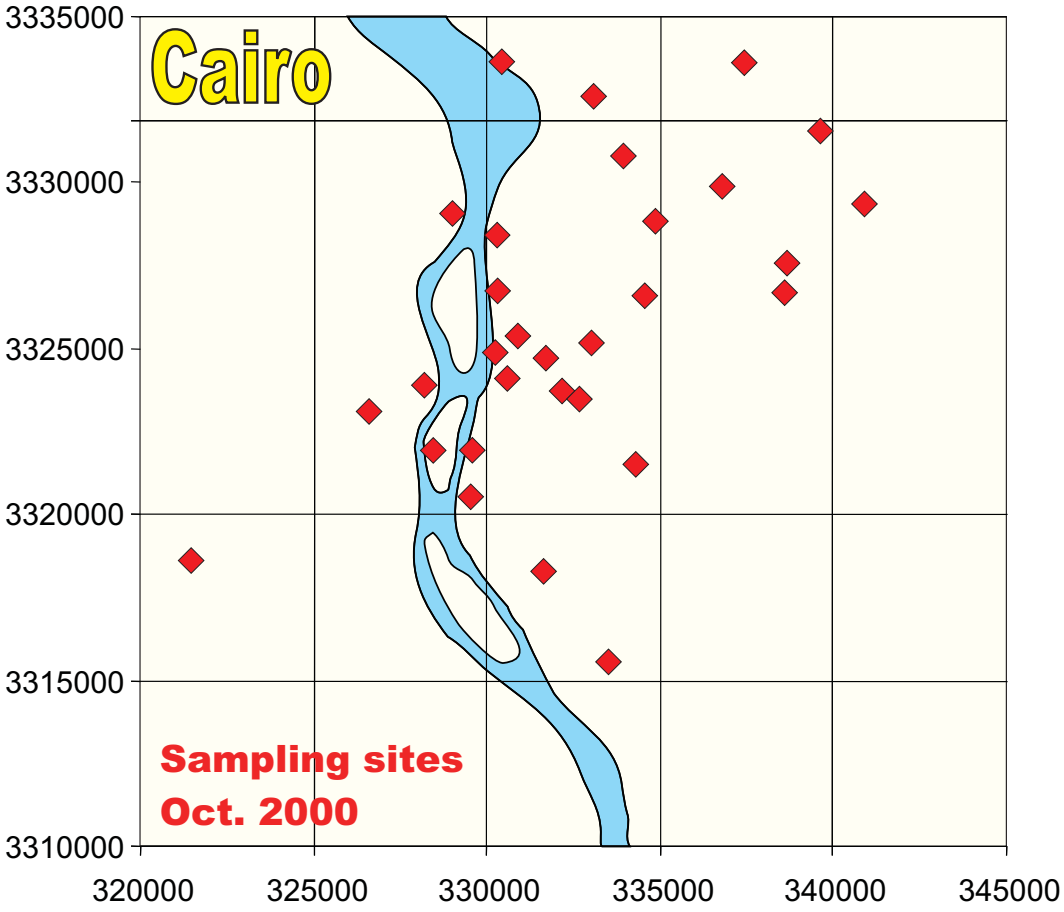
Appendix A

Location of sampling sites



The locations of all passive SO_2 samplers in the greater Cairo area for the measurements carried out from 14 to 28 October 2000.



Locations for passive sampling of SO_2 in the Cairo city area.

Appendix B

Passive sampling results

Table B.1: NO_2 concentrations

Rapport for måling av NO_2-gass i luft med passiv prøvetaker

Målerapport : NILU-U-
Prosjekt nummer :O-96013

Prøveidentifikasjon	Journal nummer	Posisjon	Fra dato	Til dato	Fra kl	Til kl	Antall døgn	NO_2-N µg N/ml	NO_2-N µg N/m^3	NO_2 µg/m^3
Nasr City, Hesham	00-104-1	1	14.10.00	28.10.00	1900	1000	14	2.490	22.1	72
Abbasya	00-104-2	2	15.10.00	28.10.00	1240	1510	13	1.525	14.5	48
El Qualaly.	00-104-3	3	15.10.00	28.10.00	1330	1330	13	1.880	17.9	59
Giza, Cairo University.	00-104-4	4	15.10.00	28.10.00	1030	1530	13	1.540	14.7	48
Tabbin south	00-104-5	5	14.10.00	28.10.00	1600	1045	14	1.180	10.5	34
Shoubra el Kheima.	00-104-6	6	15.10.00	28.10.00	1110	1345	13	1.645	15.7	52
Fum El Khalig	00-104-7	7	14.10.00	28.10.00	1430	1650	14	2.560	22.7	75
Abu Zabel	00-104-8	8	15.10.00	28.10.00	1030	1300	13	1.280	12.2	40
Nasr City	00-104-9	9	15.10.00	28.10.00	1430	1130	13	2.235	21.3	70
El Gemhoroya street	00-104-10	10	15.10.00	28.10.00	1420	1510	13	2.330	22.2	73
Maadi EEAA	00-104-11	11	14.10.00	28.10.00	1450	1053	14	1.590	14.1	46
Tahrir Square	00-104-12	12	15.10.00	29.10.00	1300	730	14	2.435	21.6	71
ElWaily	00-104-13	13	15.10.00	29.10.00	1100	900	14	2.085	18.5	61
Muh. Farid str.	00-104-14	15	15.10.00	28.10.00	1600	900	13	2.020	19.3	63
Roda Isl. Lydia	00-104-15	16	14.10.00	28.10.00	2020	725	14	1.895	16.8	55
El Massara	00-104-16	17	15.10.00	28.10.00	1000	1100	13	1.340	12.8	42
Sultan Hassan mosq	00-104-17	18	14.10.00	28.10.00	1320	1028	14	2.715	24.0	79
Giza, Sheraton	00-104-18	19	14.10.00	29.10.00	1400	900	15	2.200	18.2	60
Imbaba	00-104-19	20	15.10.00	29.10.00	1420	1000	14	2.000	17.7	58

Prøveidentifikasjon	Journal nummer	Posisjon	Fra dato	Til dato	Fra kl	Til kl	Antall døgn	NO_2-N µg N/ml	NO_2-N µg N/m^3	NO_2 µg/m^3
Roxy , Heba	00-104-20	76	14.10.00	28.10.00	1815	2100	14	Mangler		
Islamic museum	00-104-21	78	14.10.00	28.10.00	1400	1017	14	Mangler		
Abbasya Parallell	00-104-22	83	15.10.00	28.10.00	1240	1510	13	2.500	23.8	78
Giza, Cairo University Parallell	00-104-23	97	15.10.00	28.10.00	1030	1530	13	2.425	23.1	76
Nasr City, Hesham Parallell	00-104-24	98	14.10.00	28.10.00	1900	1000	14	3.640	32.2	106
El Qualaly. Parallell	00-104-25	99	15.10.00	28.10.00	1330	1330	13	4.230	40.3	133
Feltblind 1								0.022		
Feltblind 2								0.017		

Table B.2: SO_2 concentrations measured by passive samplers

Rapport for måling av SO_2-gass i luft med passiv prøvetaker

Målerapport : NILU-U-
Prosjekt nummer : O-96013

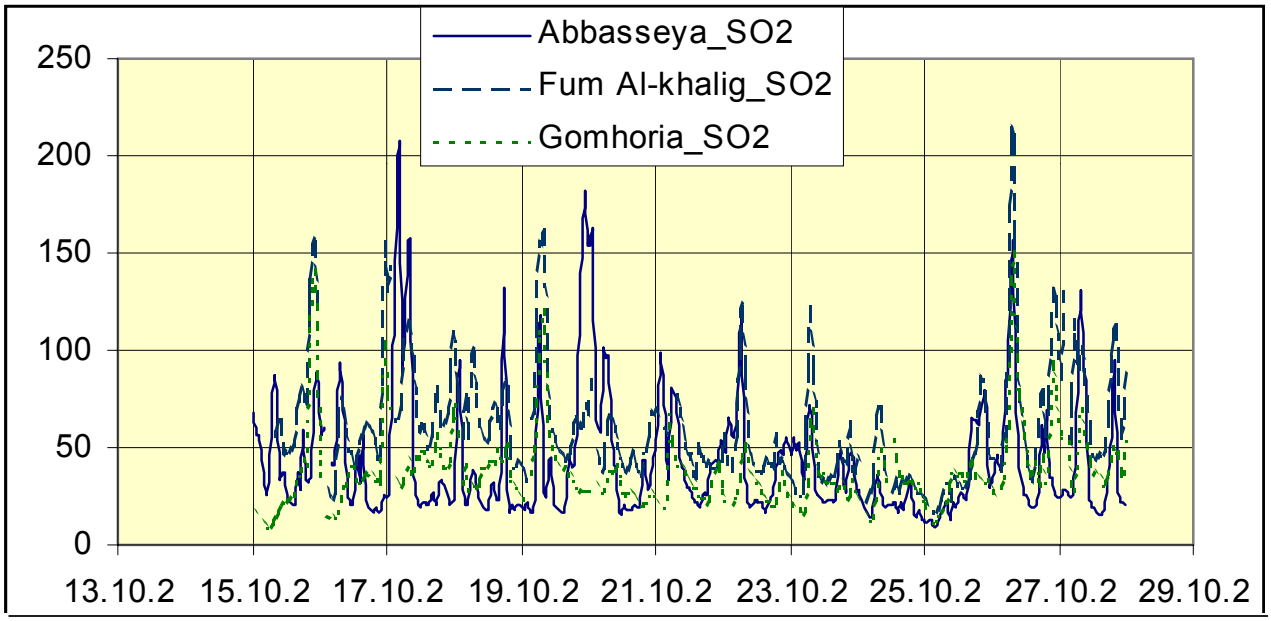
Prøveidentitet	Journal nummer	Posisjon	Fra dato	Til dato	Fra kl	Til kl	Antall døgn	SO_4-S µg S/ml	SO2-S µg S/m^3	SO_2 µg/m^3
El Qualaly.	103-1	1	15.10.00	28.10.00	1330	1330	13	3.8	42.4	85
Tabbin south	103-2	2	14.10.00	28.10.00	1600	1045	14	1.8	18.9	38
Nasr City, Hesham	103-3	3	14.10.00	28.10.00	1900	1000	14	2.1	21.1	42
Nasr City	103-4	4	15.10.00	28.10.00	1430	1130	13	1.7	19.1	38
Abbasya	103-5	5	15.10.00	28.10.00	1240	1510	13	2.1	22.9	46
Giza, Cairo University.	103-6	6	15.10.00	28.10.00	1030	1530	13	1.0	10.7	21
El Gemhoroya street	103-7	7	15.10.00	28.10.00	1420	1510	13	2.3	25.3	51
Shoubra el Kheima.	103-8	8	15.10.00	28.10.00	1110	1345	13	6.8	75.8	152
Fum El Khalig	103-9	9	14.10.00	28.10.00	1430	1650	14	5.5	56.7	113
Abu Zabel	103-10	10	15.10.00	28.10.00	1030	1300	13	3.1	33.9	68
Heliopolis	103-11	11	15.10.00	28.10.00	1215	1020	13	1.8	20.1	40
Shoubra, Ayman	103-12	12	14.10.00	28.10.00	1830	1930	14	1.6	16.4	33
Garden City, Ital. Emb.	103-13	14	15.10.00	29.10.00	830	1215	14	1.3	13.1	26
DarelSalam	103-14	15	14.10.00	28.10.00	2000	1300	14	1.1	10.9	22
Basateen	103-15	16	15.10.00	28.10.00	1200	1215	13	1.4	15.2	30
Masr el Adina	103-16	17	14.10.00	28.10.00	1900	2200	14	0.9	9.6	19
Shoubra Kh., Kamela	103-17	18	14.10.00	27.10.00	815	1930	13	3.8	42.4	85
Mokotam hills	103-18	19	15.10.00	28.10.00	1530	1430	13	0.9	9.4	19
Zamalek	103-19	20	15.10.00	28.10.00	1600	830	13	1.2	13.0	26
Muh. Farid str.	103-20	21	15.10.00	28.10.00	1600	900	13	1.5	17.1	34

Prøveidentitet	Journal nummer	Posisjon	Fra dato	Til dato	Fra kl	Til kl	Antall døgn	SO_4-S µg S/ml	SO2-S µg S/m^3	SO_2 $µg/m^3$
Maadi EEAA	103-21	22	14.10.00	28.10.00	1450	1053	14	1.1	11.0	22
ElWaily	103-22	24	15.10.00	29.10.00	1100	900	14	4.2	43.1	86
Roda Isl. Lydia	103-23	25	14.10.00	28.10.00	2020	725	14	1.1	11.7	23
Imbaba	103-24	26	15.10.00	29.10.00	1420	1000	14	2.3	23.7	47
Sultan Hassan mosq	103-25	27	14.10.00	28.10.00	1320	1028	14	2.3	23.2	46
El Massara	103-26	28	15.10.00	28.10.00	1000	1100	13	1.1	11.9	24
Tahrir Square	103-27	29	15.10.00	29.10.00	1300	730	14	3.1	32.0	64
Giza, Sheraton	103-28	30	14.10.00	29.10.00	1400	900	15	1.6	15.6	31
Tabbin	103-29	31	14.10.00	28.10.00	1630	1000	14	0.9	9.2	18
NIS	103-30	32	15.10.00	28.10.00	1200	1400	13	1.0	11.6	23
Maadi/Digla	103-31	33	15.10.00	28.10.00	900	1145	13	0.9	9.9	20
Almaza	103-32	34	15.10.00	28.10.00	1240	950	13	1.3	13.9	28
Helwan , Maher	103-33	35	14.10.00	27.10.00	2100	830	13	0.7	7.4	15
Matarya	103-34	36	15.10.00	28.10.00	1140	900	13	1.6	17.8	36
15th May city	103-35	37	15.10.00	28.10.00	800	800	13	0.2	1.8	4
ElDarb ElAhmer	103-36	38	15.10.00	29.10.00	1000	800	14	1.6	16.4	33
Abbasya	103-37	39	15.10.00	28.10.00	1040	930	13	1.9	20.7	41
Helwan	103-38	40	15.10.00	28.10.00	830	930	13	1.1	12.6	25
Roxy , Heba	103-39	75	14.10.00	28.10.00	1815	2100	14	1.6	16.6	33
Islamic museum	103-40	79	14.10.00	28.10.00	1400	1017	14	2.2	22.7	45
Abbasya Parallell	103-41	82	15.10.00	28.10.00	1240	1510	13	1.9	21.3	43
El Qualaly Parallell	103-42	88	15.10.00	28.10.00	1330	1330	13	3.3	36.9	74
Giza, Cairo University Parallell	103-43	93	15.10.00	28.10.00	1030	1530	13	1.2	13.1	26
Nasr City, Hesham Parallell	103-44	96	14.10.00	28.10.00	1900	1000	14	1.7	17.3	35

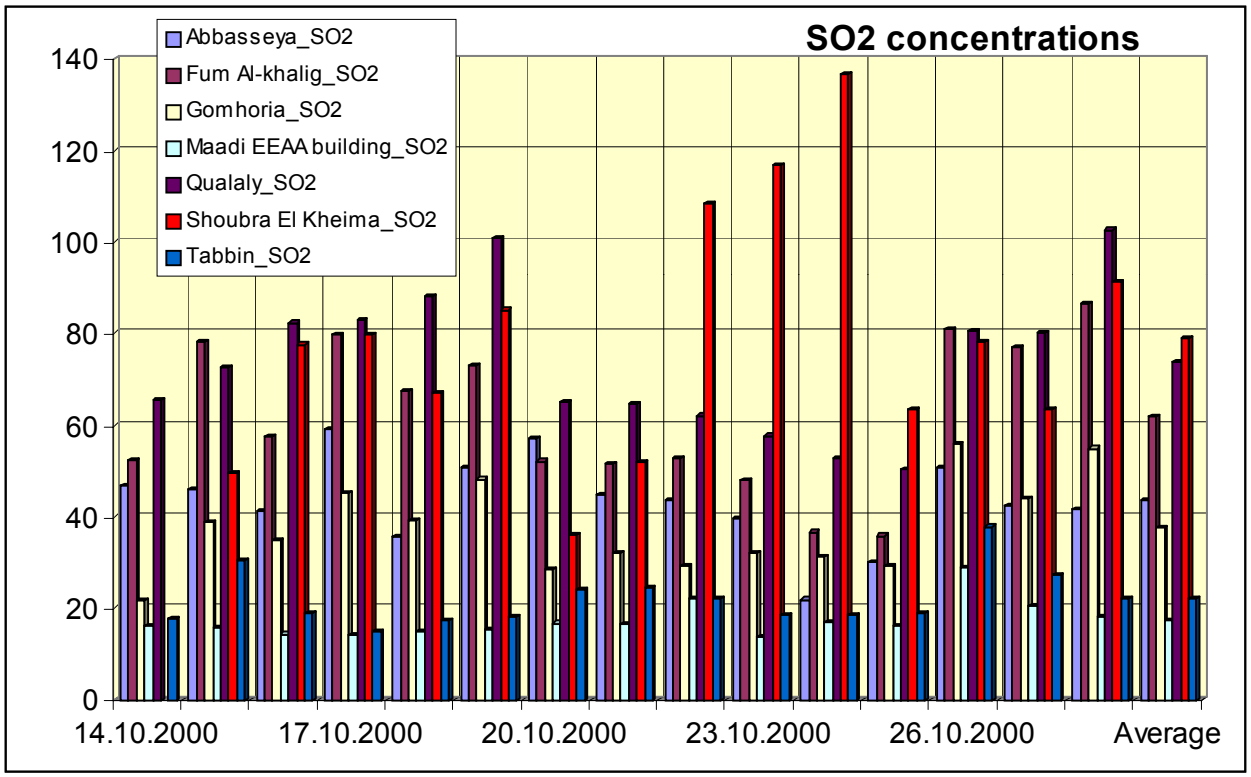
Appendix C

Air Quality data from the EIMP network

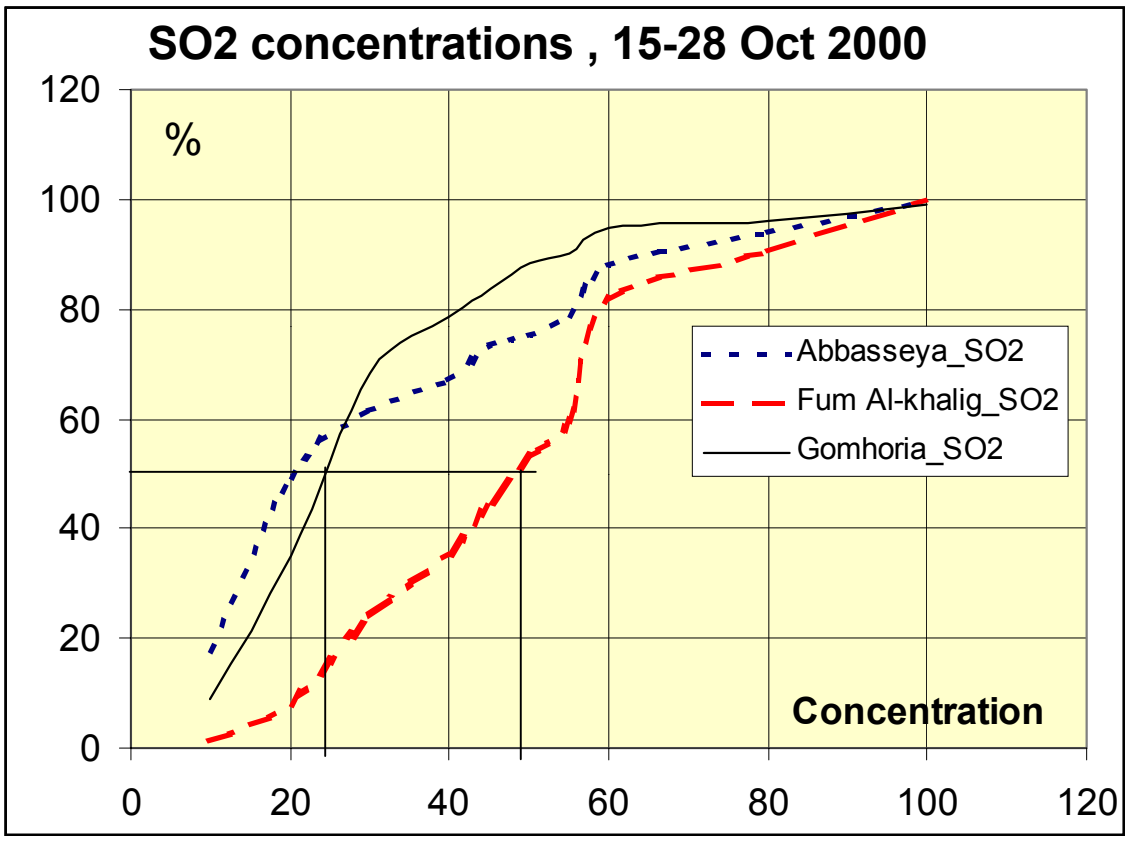
SO2 concentrations measured by monitors during the sampling period



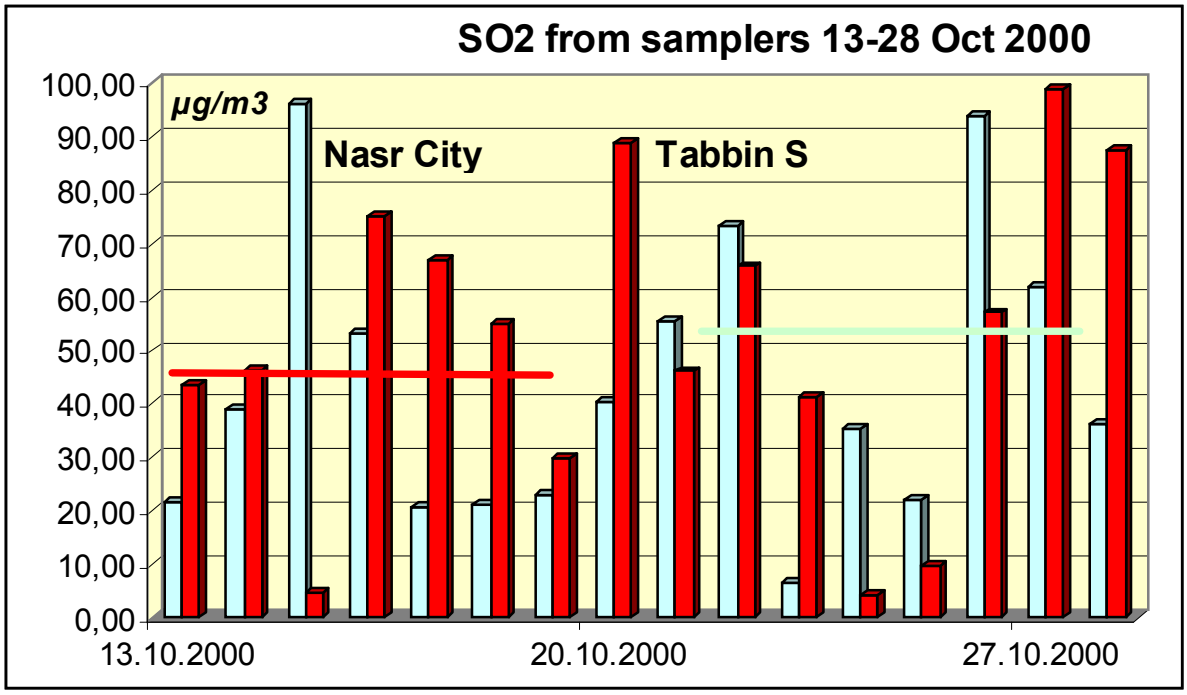
One hour average concentrations from 3 sites in Cairo.

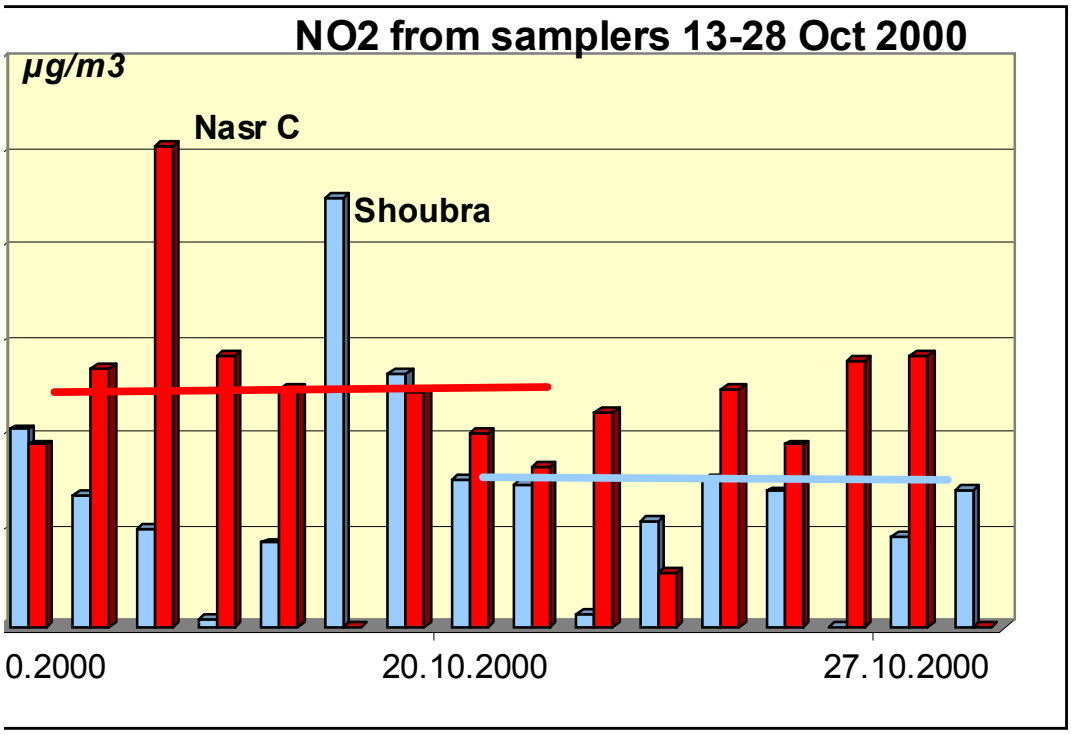


24-hour average concentrations of SO_2 measured by monitors at 7 sites in Cairo.



Cumulative frequency distributions of SO_2 presented for 3 sites in Cairo. The median concentrations differ from the average concentrations for the same periods.


SO2 from samplers 13-28 Oct 2000
µg/m3
Nasr City
Tabbin S
100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
13.10.2000
20.10.2000
27.10.2000


NO2 from samplers 13-28 Oct 2000
µg/m3
Nasr C
Shoubra
0.2000
20.10.2000
27.10.2000

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TITLE	PROJECT LEADER
Passive sampling of SO2 and NO2 ambient air concentrations in Cairo October 2000	Bjarne Sivertsen NILU PROJECT NO. O-96013
AUTHOR(S) Bjarne Sivertsen	CLASSIFICATION * A CONTRACT REF.

REPORT PREPARED FOR
Egypt Environmental Affairs Agency (EEAA), EIMP programme

ABSTRACT
A screening study was undertaken in greater Cairo to check and verify the ambient air pollution monitoring network operated by EIMP/EEAA. The passive samplers were installed in field to measure ground level concentrations in different microenvironments as a result of emissions from traffic and industry. The possibilities for exceeding the EEAA Law no. 4 and the World Health Organisation's (WHO) air quality guidelines for SO_2 were identified in two areas of Cairo. NO_2 concentration limits were high in some selected streets. The passive sampling results compared reasonably well with the permanent network operated by EIMP/EEAA.

NORWEGIAN TITLE
Passiv prøvetaking av SO_2 og NO_2 luftkonsentrasjoner i Kairo. Oktober 2000.

KEYWORDS		
Passive sampling	Cairo, Egypt	Screening study

ABSTRACT (in Norwegian)

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