NILU: OR 79/2003

NILU: OR 79/2003
REFERENCE: O-96013
DATE: NOVEMBER 2003
ISBN: 82-425-1515-8

DANIDA

EIMP Phasing-out Phase, 2003-2004

End of Mission Report, Air Quality Monitoring, Mission 03, October 2003

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Environmental Information and Monitoring Programme

Norwegian Institute for Air Research

List of Abbreviations:

ASU	:	Ain Shams University
CAIP	:	Cairo Air Improvement Programme
CCC	:	Central Cairo Centre (EEAA)
CD	:	Central Department (EEAA)
CEHM	:	Centre for Environmental Hazard Mitigation
Danida	:	Danish International Development Assistance
DKK	:	Danish Currency Unit
EEIS	:	Egyptian Environmental Information System
EIA	:	Environmental Impact Assessment
EIMP	:	Environmental Information and Monitoring Programme
ESPS	:	Environmental Sector Programme Support
GD	:	General Directorate (EEAA)
GIS	:	Geographical Information System
GOE	:	Government of Egypt
IGSR	:	Institute for Graduate Studies and Research (Alexandria)
NILU	:	Norwegian Institute for Air Research
NIS	:	National Institute for Standardisation
NO_2	:	Nitrogen dioxide
PM_{10}	:	Particles with diameter less than 10 micrometer
RDE	:	Royal Danish Embassy
SO_2	:	Sulphur dioxide
QA / QC	:	Quality Assurance / Quality Control
TA	:	Technical Assistance
ToR	:	Terms of Reference

Table of Contents

1 Introduction

The EIMP project was launched in 1996 with the Egyptian Environmental Affairs Agency (EEAA) as the implementing agency for an environmental information and monitoring programme covering institutional support, coastal waters, air pollution, point sources emissions and the development of reference laboratories for improvement of the quality of monitoring data.

The EIMP project is funded by Danida and headed by COWI. NILU was as sub-consultant to COWI responsible for the design, installations, training and operations of the national air quality monitoring system for Egypt, to be operated by experts in EEAA. The design, installations and training of the monitoring network were completed covering 42 sites all over Egypt in July 2000.

The EIMP Phasing-out Phase has been formulated to consolidate EIMP achievements, while gradually integrating the EIMP activities and staff into the existing EEAA administrative and organisational structure.

The objective is to produce relevant data reports on ambient air quality as well as input to EEAA's State of the Environment reports in the form of reliable monitoring data in order to provide a sound basis for EEAA policy and decision-making. During the Phasing out Phase we will also prepare and maintain newsletters, internet web-site(s) and other relevant data dissemination media in order to ensure that EIMP data be made available to a larger segment of society and thus be used for developing a demand among the wider public for implementation of appropriate environmental policies and regulations

The third Mission during the EIMP Phasing out Phase Air Quality component was undertaken during 4 October to 29 October 2003. Responsible for the Mission was Bjarne Sivertsen. Rolf Dreiem was responsible for station and instrument audits, repair, maintenance and monitoring system training.

A schedule for the Mission is presented in Appendix A.2. People met during the mission are presented in Appendix A.1. References to previous presentations and summary reports were presented in Mission report 01 (Sivertsen, 2003).

2 The Monitoring programme, 2003

The following research institutions are contracted to undertake the air quality monitoring work:

- Institute for Graduate Studies and Research (IGSR), Alexandria,
- Cairo University, Centre for Environmental Hazard Mitigation (CEHM), Cairo,
- National Institute of Standardisation (NIS), Cairo.
- Ain Shams University (ASU), Cairo,

Meetings were held with the monitoring institutions at Cairo University, CEHM, and with Alexandria University, IGSR to update the status of the monitoring programme.

A maintenance and support programme was prepared for Rolf Dreiem. He checked the most critical components of the programme during his short visit to Egypt. The schedule and results of his work is presented in Appendix B.1.

2.1 CEHM monitoring status

The objective of the meeting was to go through the air quality monitoring programme with all operators present. A summary of the meeting included a status report and some action to be undertaken is presented in Appendix B.2.

Site status, instrument status and failures as well as the operations of the programme was discussed. Several sites had to be re-visited by Rolf. There were also still questions about the low SO_2 concentrations measured by sequential samplers.

2.2 IGSR monitoring status

A meeting with the staff at IGSR was held in Alexandria on 18 Octobewr 2003. The air quality monitoring programme in Alexandria and in the Delta was discussed, as presented in Appendix B.3.

Rolf Dreiem participated in the meeting, and a schedule for visits to the most “critical” sites was prepared. The Shouhada station was inspected even if the SO_2 and NOx monitors were to be sent to CEHM for calibration. New calibration gases were installed at this site.

Another important site in the EEAA system is Kafr Zayat. This station was in bad condition and relevant maintenance and operations did not seem to have been adequately taken care of.

Several minor errors at sites such as at IGSR and Gheat El Inab was checked and repaired. We have a feeling that the operators are just visiting and collecting and hardly performing all duties according to the Standard Operations Procedures. On-the-job training was undertaken during the site visits.

Some of the proposals for changes to the monitoring programme in Alexandria were discussed again. Dr Shallaby will visit the possible sites and report on mail to B. Sivertsen.

2.3 Sequential samplers

The SO_2 concentrations measured by the sequential samplers have been reported very low, especially in areas with high dust concentrations (e.g. cement factories in Helwan). Several studies have been undertaken to find out whether SO_2 is disappearing in the atmosphere (transferred to sulphate) or deposited and reacted in the intake or in the instrument filter systems.

Further documentation of the SO_2 to sulphate concentrations is presented in Appendix C1.

Dirt (typically dust), which deposits in the inlet tubing, inlet manifold or internal tubing of the sequential sampler may absorb SO_2. The absorbed SO_2 will not reach the filter causing lower SO_2/sulphate results in the subsequent analysis. This effect was observed in a SO_2 monitor at Cairo University where dust deposits were found in the inlet filter holder. After cleaning the filter holder the instrument response to SO_2 was doubled.

The inlet tubing, inlet manifold and internal tubing of the sequential sampler should be inspected for dust deposits and cleaned. We will after the latest information request this procedure to be undertaken every 3 month!

2.4 VOC sampling

A few samples of VOC have been collected and analysed. The result of the analyses have been presented and discussed in a memo dated 11 May 2003.

The steel canisters have been assigned for semi instantaneous sampling. Three samples with 30-minute intervals will be collected at the following sites.
Gomhoreya street
Tabbin South
Shoubra ElKheima

Also sites in the Delta will have to receive canisters. Samples will be collected at El-Max and in Damietta.

2.5 Lead analyses

Lead analyses on filters from the PM_{10} samplers as well as from TSP samplers are part of the EIMP programme. The first results of analyses was reported during Mission 2, (see Memo Appendix B5, Mission 02 report).

Another set of filters based on PM_{10} and TSP samples was selected as given in Appendix B7 of Mission report 02. These filters had not been analysed yet.

2.6 Meteorological data

Problems measuring temperatures, wind direction (WD) and wind speeds (WS) were identified during the first 2 missions in the Phase out programme. Much of these problems have now been solved through maintenance and repair. Some sensors have been changed and the setting of accepted temperature variations have improved these data.

Most of the meteorological data reported during this Mission seemed to be correct.

2.7 Upgraded calibration system

The travelling standards that were ordered in April have now arrived at CEHM. The Monitoring laboratory is underway calibrating and preparing these new calibration gases for field use.

CEHM installed with support from Rolf the first cylinders at Tabbin and at FumAl-Khalig. Cylinders were also introduced to the IGSR staff for installations in Alexandria and the Delta.

The field calibration system would thus be completely upgraded in the beginning of November 2003. After starting to use Working Standard Gases to make a span check every week the 145 Calibrator is only used to make zero air. These zero air generators have to be upgraded to give correct zero values. (See Appendix B5).

Another problem identified during the installation of new calibration gases, was the fact that EEAA had only purcgased 14 regulators. There is an urgent need for 16 more regulators to enable smooth and safe operations of the calibration procedures. This was also discussed with the Refrence Laboratory representative. (See Appendix B6)

2.8 New sites

A new location was selected for monitoring in Suez in May 2003 (See Appendix B.8, Mission report 02)). Permissions have not been given to install the station at the police station. However, there is no money from EEAA to perform this change. CEHM, who is undertaking the new installation, is waiting for the economical support. Payment from EEAA had not even been forwarded for the last months of work already performed by the Monitoring Institutions.
Danida had approved two new sites for installations in Beni Suef. A site visit and site studies were undertaken on 21 October 2003. A proposal for installations included a rough cost estimated is presented in Appendix B4.

The air quality network will consist of two main stations in the city of Beni Suef. One will have to include meteorological data to enable discussions of sources and impacts. This design will enable air quality information in real-time.

The main stations will mainly contain automatic monitoring equipment located at permanent measurement sites. Two permanent sites have been selected. Meteorological measurement will be undertaken along a 10 m mast at the station located at the roof of the Governerate building. The area is open and representative for the general airflow in the area.

In addition to the permanent monitoring sites, a few passive sampling sites will be assigned. About 4-5 sites will be prepared for permanent integrated sampling using passive samplers in areas where impact is assumed and where people live. In the dustiest areas also PM_{10} measurements will be undertaken with simple AirMetrics samplers.

Other sites have also been evaluated as part of the new updated national monitoring programme for EEAA. Several proposals have been discussed for the measurements in Alex and the Delta region. Dr Elsayed Shallaby inspected several possibilities but final decisions for changes have not been approved by EEAA.

3 Reference Laboratory

3.1 QA/QC and Audit programme

Audits from NIS have been undertaken as a routine programme. These audits seem to work adequately. However, it will also be important to include inspections of the intake systems, and check that cleaning and maintenance has been properly followed up by the Monitoring Institutions.

3.2 SO_2 – sulphate in sequential samplers

The SO_2 concentrations reported by the sequential samplers in Egypt have been very low, and seem to have been reduced during the last months. The problem was also reported in a memo dated 3 June 2003.

One possibility for measuring too low SO_2 concentrations with the impregnated filter method is an inefficient absorption of SO_2 on that filter. The absorption of SO_2 needs some water to be efficient, and a completely dry filter may be inefficient. This may happen if the humidity of the air is "lost" when the air is heated from its outside temperature.

In Egypt we do not believe that this should be the problem. However, the addition of glycerol to the impregnation solution may minimise this problem. The efficiency of the impregnated filter could be controlled by placing a 0.3% H2O2-absorption solution behind the filter holder and analyse the exposed solution for SO_4 by ion chromatography.

More documentation on this problem is presented in Appendix C1. Another conclusion drawn from the investigations performed in field is that the inlet tubing, inlet manifold and internal tubing of the sequential sampler should be inspected for dust deposits and cleaned. We will after the latest information request this procedure to be undertaken every 3 month!

The procedures will have to be checked during the audits performed by NIS.

4 Reports

4.1 Daily reports

Daily reports of the air quality in Cairo are available at the Minister office. The reports are presenting one-hour average daily maximum concentrations of SO_2, NO_2, PM_{10}, CO and Ozone.

As part of the daily reporting in October 2003, the maximum concentrations recorded at Abbasseya relative to those recorded at Quolaly and Fum Al-Khalig were questioned. An investigation started to find out the differences. A strange "episode" on 9 to 10 October initiated the investigation. (For more information see Appendix D1).

Typical ranges of hourly maximum concentrations measured during Mission 03 are presented in the following Table.

	Max. 1 hour aver. concentrations From 6 to 24 Oct. 2003 ($\mu g/m^3$)			
Site	***SO_2***	***NO_2***	***PM_{10}***	***Ozone***
Abbaseya	28 - 169	Na	163 – 677	44 - 133
Quolaly	70 - 176	69 – 123	93 – 188	Na
Fum AlKhalig	57 - 122	66 – 113	78 – 242	Na
Maadi EEAA	23 - 401	52 – 121	Na	Na
Tabbin	31 - 41	23 - 47	54 - 344	Na

4.2 Monthly reports

A data summary report issued every month in Arabic language presents the air pollution concentrations based on preliminary data. Short versions of the reports for June 2003 are presented in Appendix D.2.

In addition to the normal exceeding of PM_{10} and TSP concentration limit values the SO_2 annual limit of 60 $\mu g/m^3$ was found in at Kolaly and Kom Ombo in June 2003.

The one-hour average SO_2 concentration limits were exceeded at Shoubra and in Assyut during June 2003.

4.3 Reporting episodes

Air pollution episodes occur over Cairo caused by meteorological conditions and by the presence of dust storms. During Mission 03 there were no typical stagnant episodes recorded, even if concentrations during some days with low wind conditions were close to the limit values. Except for PM_{10} the limit values given by Law no. 4 of Egypt were not exceeded.

A very different type of air pollution "episodes" occurred over Cairo on 9 to 11 October . This was reflected in very high PM_{10} concentrations measured at Abbasseya and at Tabbin. Also SO_2 concentrations were relatively high at Maadi and at Quolaly.

The situation is presented in more details in Appendix D1.

4.4 Quarterly reports

Quarterly reports were presented by CEHM for April to June 2003. The report follows the set up designed already in 1999. We have several times proofread and discussed the contents and conclusions in length with the responsible authors. The report filed for second quarter 2003 looks satisfactory.

Due to computer problems at IGSR the quarterly report from Alex and the Delta have not been presented yet. The first quarter report has been presented in draft and commented by EEAA, but a final version has not been made available yet.

4.5 Papers and publications

A paper was prepared and presented at the international conference "Environment 2003" at the Fair Grounds in Cairo from 30 September to 3 October 2003. The paper titled "Baseline of Air Pollution from 2000 to 2002 was based on the evaluation of the state of air pollution in Egypt prepared during Mission 02. (Appendix H1, Mission report 02).

The paper as presented during the conference is shown in Appendix D3.

5 A national air quality network

As Output 2.3 of the EIMP Phasing-out Phase a plan for a future complete national ambient air quality monitoring network was to be established.

EEAA has expressed a need for a comprehensive assessment of the overall requirements for establishing a complete national air quality monitoring network. The regularly occurring air pollution “episodes” in Cairo has further accentuated this need. In the Inception report it was stated that the activities will include:

- Assessment of current EIMP and CAIP air quality monitoring networks.
- Establishment of EEAA objectives for a complete national air quality monitoring network.

These matters were discussed and presented during Mission 1 and Mission 2. The case was tried followed up during Mission 3, but none of the EEAA representatives found time and possibilities to discuss in details how to proceed.

5.1 EEAA objectives for a national air quality network

An overall objective of the air quality measurement programme is to obtain a better understanding of the urban and residential air pollution as a prerequisite for finding effective solutions to air quality problems and for sustainable development in the urban environment. A preliminary draft indicating the typical objectives has been presented in Appendix E.1 of Mission 02 report. (Sivertsen and Dreiem, 2003).

5.2 Updating the network

Several changes, improvements and additions have been prepared and effectuated during the Phasing-out Phase. New monitoring sites, improvements at existing sites as well as new procedures for field calibrations have been introduced. (See Ch. 2.7 – 2.8.

6 Air pollution management

6.1 An integrated system for air quality management

Other needs currently identified by the EEAA relates to information vis-à-vis
i) decision makers, and
ii) media and the general public.

To meet these requirements the application and use of the air quality data collected by the EIMP as well as for the CAIP programme has been discussed in several meetings at EEAA. It is desired to develop one common GIS based database, which integrate measurements, emission data and models for assessment and planning into one system.

The best approach to meet the needs identified by EEAA will be to start preparing the tools for performing an air quality management planning system to prepare an extensive assessment study and to prepare a master plan for air quality in Cairo. The tools for such planning including optimal abatement strategy planning are available.

More detailed presentations of possibilities and tools available were presented in Mission report 02. In the discussions during Mission 3 it was stated from EEAA representatives that the funds for these developments are not available, and that the actual development will have to be postponed.

7 Training needs assessment

Needs for further training by all personnel participating in the air quality monitoring programme for Egypt has been identified. To upgrade the personnel on the background and operations of the programme the training programmes will consist of:

- Seminars
- Workshops
- On-the-job training

Seminars and workshops have been prepared. A seminar was already scheduled to be organised at CEHM Cairo University on 22 October 2003, but other pressing matters such as siting studies for new monitoring stations in Beni Suef lead us to postpone the seminar again.

7.1 Seminar

The planned seminar will update all participants in the air quality monitoring programme in understanding the measurements and the results obtained from the measurements. We will also present data to demonstrate errors and malfunctions that have to be identified and corrected by the QA/QC system

We will have to set a day for this seminar well in advance before the next Mission to ensure that participants and experts are all available.

7.2 On-the-job training

The programme for on-the-job training is being followed up. This applies to training of EEAA personnel in reporting and understanding data as well as hands-on training for instrument operators.

Training during Mission 3 related to the operations and maintenance of instruments. Part of this training included the use of travelling standard gases for improving the Quality assurance procedures.

Instrument repair and maintenance was checked and verified and several instruments were prepared fro return to the field during these training sessions. The CEHM and IGSR operators participated in field inspections and repair.

8 Administrative work

Several meetings were held during Mission 3. During the Mission we were also used as consultants to the Environmental Impact Assessment developed for the new airports in Cairo and in Sharm El-Sheikh. EEAA was requested in June 2003 by the Ministry of Civil Aviation to undertake an Environmental Impact Assessment (EIA) related to air pollution emitted from the different sources at a new air terminal at the Cairo Airport.

In a meeting with the Minister of Civil Aviation on 4 June 2003 representatives from EEAA and NILU were briefly informed about the plans for the new Terminal. NILU has undertaken the work during the summer and presented a report in September 2003.

8.1 Update monitoring programme

A meeting with Mohamed Fathi and representatives from Beni Suef was arranged to discuss future air quality measurements in the Beni Suef area. It was indicated that Danida had accepted to support the establishment of two stations in this air pollution exposed area.

The design of a monitoring system for Beni Suef was presented after a visit to the area on 21 October 2003. See Appendix B4.

8.2 Future database

In earlier meetings with Dr Mowaheb it has been mentioned that a new database for EEAA was required. A short meeting with Dr Mowaheb during Mission 3 indicated that the funds for upgrading the air quality database have not been made available for EEAA.
The results of the meetings during Mission 2 resulted in a proposal included cost estimates for a complete GIS based database to be established at EEAA. See Chapter 6.1 of Mission report 2, (Sivertsen and Dreiem, 2003).

8.3 Other meetings

Mission 3 ended 30 October 2003. A final meeting summarised the Mission and it was agreed that the next Mission would be in February 2004 and include a seminar on air pollution measurements and results.

9 References

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Appendix A

People and schedules

A.1 People we met and colleagues (October 2003)

EIMP office,3 EEAA Building, 30 Helwan Str.Maadi, Cairo (behind Sofitel hotel) ,
Tel. 202 525 6474 ext. 7223, Fax: 202 525 6467, E-mail: eimp@intouch.com
Staff: Ahmed AlSeoud (EEAA. *tel: 0123102068, 5721289), aahmed_hm@yahoo.com*
Air: B Sivertsen (Task Manager), tel. 351 1615, Dreiem, **Ahmed Abou Elseoud (AAE), Ashraf Saleh Ibrahim(ASI), , Khaled Hamdy (KH), Ayman El-Maazawy (AEM), Mohamed Awad Shendy(MAS), Al Shabrawy Mahmoud (SMI), Hossam El Shakhs (HS), Mohamed Kassem (MK), (In Germany: Haytham Ahmed (HAA**(p: 320 2078)**), Mai Ezz El din Ahmed (MEA)**
CEHM / Cairo Univ, t el 571 9688, Fax; 571 9687: Dr Sharkawi, Dr. Mortallah, (Dr. Yehia Abd El Hady) Dr Tarek El Arabi (Project Manager) mob: *0123484050*,
Staff:Ashraf Saleh (data retrieval), Dr. Essam Abdel Hallin (data retrieval), Mahir Sayed Hafez (Tabbin), Ahmed Sayd (Qualaly, Gemhoroya), Yassin Fathi (Giza CU, Fumm al Kahlig), Kamela (Mon.lab., Shoubra), Ahmed Sulamen (Chem lab head), Ameni Taher (Chem. Anal.).
IGSR Alex Univ, tel:03422 7688, lab: 03 422 5007, Proj. tel: 424 1485, Fax 203 421 5792 , Dr M El-Raey tel: 0*123109051 (elraey@cns.sisnet.net)*, Dr. El Sayed Shallaby, Shawkat K. Guirguis (QA) (*aplab@igsrnet.net*), Dr Zekry Ghatass, Ashraf A Zahran, Mohamed Rashad Hossam A Said, Heba Said,
Data Management: Jacob Andersen, Hossam ElShakhs, Ayman El-Maazawy, Mohamed Shendy
Coastal Water: Arne Jensen, Erling, Ole, Al Shabrawi Mahmoud
Reference Lab: Ulla Lund, (Street 13 Maadi) tel: 012 312 0951, Mai EzzEldin Ahmed (counterpart), Fleming Boysen,
EEAA,Dr. Mohamed Said Khalid (Chairman), Dr Mawaheb, Mrs Hoda Hanaffi (head of GIS),
Dr Mahmoud Nasrallah
Meterological Authority (EMA): Dr. Ahmed Adel Faris (Deputy Chairman), Dr. Mohamed M. Eissa (Dir. Gen. Information), Dr. Rabiee El Fouly (Dir Gen. Research), Dr. M.A. Abbas (Dir Gen for Instruments and Laboratories),
Sofitel Hotel: Maadi, Tel: 526 06011, Fax: 202 526 1133
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Danmark: 12 Hassan Sabri, Zamalek, John Carstensen 378 2040
COWI: 00 45 45 97 22 11
Danida: Jørgen Simonsen, 21 Road 86/Mustafa Kamel, P: 358 6167, Mob: 012 214 1759
USAID - CAIP: Jim Howes, Monir Labib, Jennifer Baker (Training) , Kirk Stopenhagen
Mrs Ekhlas Gamal ElDin, Hani, Said, Mike Smith
CTS: Amr ElSoueini, tel: 378 2908, Fax: 350 4977, *Mobile: 012 216 6670*, Ali Hamed
EMC Bill Hayes, Steve Gersh (Vice President), Fax:805 544 1824, (sgersh@emcslo.com)
Mohammed Nasar (AQ) , tel 351 5174, Canal Street 3, Maadi
Giza Pyramids: Dr. Hawas, Ahmed El Hagar, **Sakkara**: Mohammed Hagras, Hamdi Amin
Saddam driver: 012297 189, **Ahmed drive**r: 010 113 7410
BS: Flat: no.4 103 Street, Mahmoud Taha, mob: 012 341 3899, priv. 5255743, leil. 3.etg. 5255743

Appendix A.2: Time schedule
Air Quality Monitoring - Work Plan -October 2003

Day	**Hr.**	**Task**	**Assignment**	Comment	person
Sat. 4 Oct			Arrival EEAA, Meeting with Ahmed Upgrade office		 AAE
Sun. 5 Oct	1300		Discuss time schedules – get data Meeting CEHM, monitoring programme		 BS, ASI
Mon. 6 Oct			**Day off**		
Tuesd. 7 Oct	1230		Info meeting Sharm El Sheik airport Passive samplers, QA tests	Reporting CEHM status	
Wednesd 8 Oct	 1700		Reporting status EIMP Meeting Engin. Consul Group (ECG)		ASI, BS
Thursd. 9 Oc					
Friday 10 Oct			day off		
Sat. 11 Oct			Rolf arriving in Cairo Summary status monitoring system		 BS, RD
Sun. 12 Oct			Rolf to CEHM Prepare sites in Beni Suef	Update calibration	Yassin
Mon. 13 Oct			Prepare seminar Rolf at sites in Cairo		
Tuesd. 14 Oct			To Sharm El-Sheikh, Airport study Tabbin site upgraded		BS,ASI RD
Wednesd 15 Oct			Sharm El Sheikh airport measurements Visits to Fuma Al-Khalig and Quolaly	 PM_{10} monitors etc	BS,ASI RD
Thursd. 16 Oct			Reporting Airport EIA		
Friday 17 Oct					
Sat. 18 Oct	0830 1000 1800		Air Quality data EIMP Memo on limit values and PM_{10} measurements Rolf to CEHM and sites Public Hearing Cairo Airport		BS BS RD BS, AAE
Sun. 19 Oct	am 1300		EIMP reporting Data fro m Sharm El Sheikh	 Reporting	 BS
Mon. 20 Oct	1030 1400		Meeting IGSR- Sayed Shallaby & staff Rolf to EL Shouhada station +	Annual report IGSR	BS, ASI RD
Tuesd. 21 Oct	0900		Site study Beni Suef Rolf to Alex + Delta	Find locations for new AQ measurements	BS, ASI RD

Day	Hr.	Task	Assignment	Comment	person
Wednesd 22 Oct	0830		Plan for AQ programme Beni Suef Discuss tasks with Tarek Final Mission 3 Rolf in Alex, to different sites		BS RD
Thursd. 23 Oct					
Friday 24 Oct	0430		Bjarne leave Cairo at 0430		
Sat. 25 Oct			Work notes Alex and Delta		RD
Sun. 26 Oct			At CEHM, maintenance, training, repair	NO_x monitor	RD
Mond 27 Oct			Training at CEHM	Repair, spare parts	RD
Tuesd 28 Oct			CEHM and storage	Update spare part list	RD
Wednes. 29 Oct			Rolf last day at EIMP		

EIMP staff

Ahmed Abu ElSeoud (AAE)
Ashraf Saleh (ASI)
Mai Ahmed (MEA
Shabrawi Mahmoud (SMI),
Ayman El-Maazawy (AEM),
Mohamed Kasim (MK)
Mohamed Shindy (MS)
Khalid Hamdi (KH)
Hossam ElShakhs (HMS)

Expat:
Bjarne Sivertsen (BS)
Rolf Dreiem (RD),

Appendix B

Status measurement programme

Appendix B.1: Memo from R. Dreiem

Work Notes October 2003

11 Oct. 2003 Travelling from Norway to Cairo.

12 Oct. 2003 Arrival EEAA. Upgrade office. Made preparation for my first trip to Yassin at CEHM.
I had a look at raw data and calibration file of zero checkpoints at some of the stations.
No attention is taken to Zero check on the monitors. All data is corrected later in the data treatment. By doing it this way the zero level will be based on guesswork. All raw data have to be corrected by the "real zero" obtained by Zero Air Generator.
El Kolaly PM_{10} air intake was taken to CEHM and cleaned. All PM_{10} air intakes have to be cleaned at intervals (3 months) to assure correct PM_{10} cut off. Strange ozone and SO_2 results from Aswan is due to missing connection of air intake or the fan on air intake is not working.

13 Oct. 2003 Office work. Making a work plan for the next days.
Met Yassin at CEHM. Inspected calibration sheets of different NO cylinders. Looks OK comparing to certificate from manufactory.
Prepared NO and SO_2 gas cylinders inclusive regulators and flowmeters to Tabbin and Fum El Khalig.

14 Oct. 2003 To Tabbin by car from CEHM and met Maher at Station
Made a zero check on SO_2 and NOx. NOx is working but SO_2 is 12 ppb. SO_2 gives a reading of 5 ppb on external charcoal scrubber. This indicates a check of 145 Calibrator at CEHM.
We did a span check with working standard gas cylinder and the instruments are performing well. Air intakes were cleaned.
Maadi air intake was out of function and was repaired. Some people had removed Teflon tubing from supporting air intake tube and funnel.
At Fum El Khalig station zero and span were done the same way as at Tabbin. The old permeation tubes, which were not working, had been left in the 145 Calibrator.
This will "poison" the 145 while not running. I removed these tubes and left them at the station.
The Zero check on the NOx monitor is –8 ppb on both channels. Span is 30 % too low.
This monitor needs calibration as soon as possible.

15 Oct. 2003 CEHM in the morning. Repairing CO monitor. Old IR Source has too low intensity and was replaced by a new one. CO monitor is working fine. One NOx monitor has low main flow and high ozone flow. Did not solve the problem. Has to be investigated another day.

Made plans for Saturday and Sunday.
On Saturday Maher and I went to Abbassyia to investigate a zero-span problem on an ozone-monitor. Sunday is the time for training at CEHM. The subject is new ball bearings on Met One wind speed sensor.

18 Oct. 2003 One-hour office work before leaving to Abbassyia.
At Abbassyia the tape were broken on PM_{10} monitor. Routine maintenance made PM_{10} monitor work again. SO_2 and Ozone did not work daily automatic zero-span.
SO_2 monitor had a shortcut on terminal connector-SO_2 monitor. Ozone monitor had a broken signal wire. After repair both monitors is doing automatic zero-span every night as programmed.

19 Oct. 2003 Made copy of Work Notes to BS.
Went to storage with Ashraf and Maher. We picked up some spare parts for samplers and monitors.
Went to CEHM and trained staff in changing ball bearings on a wind speed sensor. The staff (Maher) did not have a feeler gauge. This is an important tool to make WS correct. Maher said he could easily get one from the local market. This tool is used in cars, adjusting ignition time on engine.
Yassin had some problems in making a proper zero calibration on his CO-monitors. CO-converter is not working well due to loss of heat on one of the converters inside the instrument. Yassin have another CO-converter at CEHM. He is going to use this instead of the one with loss of heat.

20 Oct. 2003 Went to Alexandria by car. Participated in a meeting with Dr El Sayed.
Shallaby and his staff.
Took a Taxi to El Shohada Square Station together with Mohamed Rashad. We had cylinders of working gas containing SO_2 and NO. As at CEHM there is only one regulator for every station. I trained M. Rashad in making weekly zero-span check, fill inn the forms and handling the gas cylinders and regulator correct. We tested zero on SO_2 monitor with a spare scrubber. Zero was 5-6 ppb and this is just above the limit. Zero was then corrected to 0.

21 Oct. 2001 Went visiting four stations in the Delta area by car.
First stop was at ***Kafr Dawar***. Air intake from SO_2 sampler was put in the car to make a proper cleaning at IGSR.

Next stop was ***Kafr El Zayat***.

- The station is in a bad condition. All scrubbers on Zero Air generator (145) need new charcoal and purafil. Old charcoal and purafil is a problem at most of the 145 Thermo Calibrator to have a correct zero every week.
- The NO_x monitor had been 5 months delayed in calibration at CEHM and the SO_2 monitor had a bad pump. The pump

needs maintenance at CEHM.

- The PM_{10} monitor is not working after last maintenance by CEHM. The monitor has to be brought back to CEHM for repair. New backup batteries are also needed.

Next stop was at ***Tanta***. Air intake from SO_2 sampler was taken down and brought to IGSR for proper cleaning.

Last stop was in ***El Mahalla***. The SO_2 monitor is performing well. Zero is 4.1 ppb and ambient air is 4.4 ppb. Smoke from Power Plant is 90 degree off. The air is very clean at the station.
PM_{10} monitor is performing well.
Went back to Alexandria late in the evening.

22 Oct. 2003 Gheat El-Inab station. NIS did not manage to test airflow on audit.
The chart recorder was taken to CTS in 1998 and was never returned.
The tube to the recorder has an open end and no pressure is measured on manometer. The open end is now plugged and next time NIS visit the station flow measurement is working.
WS at IGSR need new ball bearings and set-up factors must be as in Station Manager and the manual.
IGSR NOx: Pump is not working. Repair at CEHM.
SO_2 and CO air inlet tubes was mixed up. This was the reason for zero on SO_2 was the same on calibrator and ambient air.
Charcoal must be replaced as on all other stations (145 Calibrator).
Zero on SO_2 is working well with external charcoal.
Blower on air intake is not working at all. Have to be repaired or replaced.
Went back to Cairo by train in the evening.

25 Oct. 2003 Office work. Making work notes from Alexandria Delta travel.

26 Oct. 2003 Went to CEHM. Made a count of spare part and consumables. We found charcoal and purafil but Yassin need more to make 145 Calibrator at all stations work well. Have to go to storage to search for more cans of charcoal and purafil later.
Repair NO_x monitor. Monitor had high flow on ozonator. The flow sensor did not work properly and had to be replaced by a new one.

27 Oct. 2003 Went to storage with Maher. Picked up items from yesterdays list.
In search of items from the list we found many spare parts Maher did not know was in the storage at all. The part we knew was needed at CEHM was left on a table to be picked up later.
Went to CEHM and made a request form to release this spare parts.
Trained Yassin and Maher in how to make proper maintenance of the PM_{10} monitor pumps. The storage has many maintenance kits for these pumps. Maintenance schedule is every 12 months.

28 Oct. 2003	To CEHM. Met Yassin and made plans how to make the measurement at the stations work better in the future. The storage is not working well. Inventory list is not complete and some major items are not listed. It is important to update the spare part list. A 100% accurate list is an important tool to CEHM staff. In this way CEHM staff is able to have maintenance kit and spare parts as needed.
29 Oct. 2003	Office work. Last working day at EIMP.

Appendix B.2: CEHM-meeting

EIMP

Environmental Information
and Monitoring Programme
EEAA - Danida - COWI
30 Misr-Helwan Str. Maadi, Cairo, Egypt
Tel: 202 525 6442, Fax: 202 525 6467

Meeting

Date: 5 October 2003
Present: Dr.Tarek and the crew from CEHM, Ashraf EIMP and Bjarne S
Referent: Bjarne Sivertsen

EIMP Air Quality Measurement Programme Status

	Site	Area type	Comments and Status	Action	Who
1	El-Kolaly	Urban centre	NO_2 data missing 1 to 4 Sep. Station working okay!	Check NO_2 monitor	RD Yassin?
2	El-Gom horiya.	Street canyon	CO data missing in September, spare part not working All monitors used at exhibition 28 Sep-5 Oct.	Install all instruments next week	Yassin +?
3	Abbassey ia	Residential.	Monitors working fine. PM_{10} in repair till 23 Sep. Now working with spare from Assyut	Repair PM_{10}	Yassin
4	Nasr City	Roadside/ Res	Station working okay	SO_2 also by passive sampl	
5	El-Maadi (EEAA)	Residential	Data missing 25-27 Sep. Power failure, computer hanging	Check SO_2 monitor and intake	RD Maher
6	Tabbin	Industrial	SO_2 zero line at 35 $\mu g/m^3$? Temp recorder	Check SO_2 monitor Lead analyses	RD Tarek
7	Tabbin south	Industrial	TSP pump burned SO_2 and BS high from 6 June!!	TSP repair this week	Maher
8	Fum Al-Khalig	Road /urban	Station down on 4 Oct. Working now, No CO data last days Computer was full	Computer emptied at 21:00 4 Oct.	Maher
9	Abu Zabel	Industry/Re s	Okay		
10	Shoubra El-Kheima	Industrial	Okay		

	Site	Area type	Comments and Status	Action	Who
12	Kaha	Regional Background	Everyting working now NO_2, PM_{10}, T repaired 22 Sep		
13	6 October	Res/ industrial	Low SO_2, use passive	Change site position	BS, Ashraf, Adel?
14	10 Ramadan	Residential	SO_2 low, use passive samplers		
	Canal area				
15	Suez	Res/urban	SO_2 and NO_2 show strange patterns New site has been appointed	Check monitors Move to new site!	RD Ashraf Tarek!
16	Port Said	Residential	Okay Shelter for PM_{10} changed		
17	Ismailia	Residential	Okay		
	Upper Egypt				
18	El Fayum	Urban	Okay		
19	El Minya	Urban/Res	Okay		
20	Assyut I	Res/Urban.	PM_{10} out of order, no data Wind direction not working	PM_{10} to be repaired on site	RD, Yassin, Maher
21	Assyut II	Residential	Okay		
22	Naga Hammadi	Industrial/res	Okay		
23	Luxor	Urban/res	Okay		
24	Edfu	Urban.	Okay		
25	Kom Ombo	Industrial	Working, use passive samplers also for SO_2	Passive sampling	Mahmoud
26	Aswan	Urban/res.	Computer at CEHM 5-17 Sep No data in October Fax modem hanging, data in computer	Check temperature Verify data	Maher, Mahmoud
	Sinai Area				
27	Ras Mohamed	Background	Varying ozone data quality. Data received , but some of ppb not transferred to $\mu g/m^3$ Audit to site next week !	Ozone monitor returned to day	

Other Matters

Spare parts and consumables

New order placed at NILU Products. Ordered from CTS on 10 Sep 2003. ot received from CTS. Deficiency in pre filters.

Passive sampling

SO_2 Passive Sampling will be continued at some of the stations using SO_2 sequential samplers :

- Nasr City,
- Tabbin South,
- 6 October,

- Ramadan, and
- Kom Ombo)

to compare the analysis results.

New and modified sites
A new location was selected for Suez Station in May 2003. No change has been undertaken. The site have to be moved as soon as possible. Permissions have to be requested.

VOC sampling and analyses
A few samples of VOC have been collected and analysed. The result of the analyses have been presented and discussed in a memo dated 11 May 2003.

The steel canisters have been assigned for semi instantaneous sampling. Three samples with 30-minute intervals will be collected at the following sites.

- Gomhoreya street
- Tabbin South
- Shoubra ElKheima

Also sites in the Delta will have to receive canisters. Samples will be collected at El-Max and in Damietta.

SO_2 and sulphate tested on impregnated filters
Five filters prepared for the proficiency test of the European Monitoring and Evaluation Programme (EMEP) were given to the laboratory at CEHM. The result show that the analyses of SO_2 performed by the CEHM laboratory was acceptable.

Sulphate and SO_2 on impregnated filters selected at Nasr City and Tabbin South have been investigated by NILU. The results are presented in a Memo of 5 October 2003. The fraction of SO_4-S on these filters was surprisingly high. Is there a sulphate problem in Egypt?

EIMP Passive sampling programme

Updated Oct 1999

			Quarterly samples									
	Site name	**Area type**	**Jan**	**April**	**July**	**Oct**	**monthly**	**Passive**		**Other**		
	Cairo											
3	Meteorological Inst	Residential.	x	x	x	x		NO2		SO2	M	
7	Tabbin south	Industrial					x	NO2		SO2		df
9	Abu Zabel	Industry/res					x	NO2	SO2			
12	Gizapyramid	Monument					x	NO2	SO2			
	Sakkara	Monument	x	x	x	x		NO2	SO2			
	Tahrir Sq.Am.Un.	Urban					x	NO2	SO2		A	
	Shoubra (Kamela)	Residential	x	x	x	x		NO2	SO2			
	Helwan (Maher)	Residential	x	x	x	x		NO2	SO2			
	Nasr City (Tarek)	Residential	x	x	x	x		NO2	SO2			
	Heliopolis (Tarek)	Residential	x	x	x	x		NO2	SO2			
	AinShams (Ahmed)	Residential	x	x	x	x		NO2	SO2			
	Canal area											
	Suez industrial	industrial/res.					x	NO2	SO2			df
16	Port Said	Residential					x	NO2	SO2		A	
17	Ismailia	urban/resid					x	NO2	SO2		A	
	Upper Egypt											
18	El Fayum	urban					x	NO2	SO2		A	df
19	El Minya	Res./ Industrial					x	NO2	SO2		A	df
21	Assyut 2	residential/urban					x	NO2	SO2		A	df
22	Naga Hammadi	industrial/res					x	NO2	SO2		A	df
	Luxor, Karnak	monument	x	x	x	x		NO2	SO2			
	Luxor, Temple	monument	x	x	x	x		NO2	SO2			
24	Edfu	Industry/urban.					x	NO2	SO2		A	df
25	Kom Ombo	industrial					x	NO2		SO2	A	p
26	Aswan	urban/residential.					x	NO2		SO2	A	df
	Sinai Area											
	Sharm ElSheik	city, tourist	x	x	x	x		NO2	SO2			
27	Ras Mohamed	background					x	NO2	SO2		O3	df
	Alexandria											
33	IGSR, Background	Urban regional					x	NO2	SO2		O3	M
	AlAzafra (Shallaby)	Residential	x	x	x	x		NO2	SO2			
	Roman theatre	Monument	x	x	x	x		NO2	SO2			
	Delta Area											
40	Kafr Dawar	industrial					x	NO2		SO2	A	df
34	Damanhur	industrial/res					x	NO2	SO2		A	df
	Kafr el Zayet south	industrial					x	NO2	SO2		A	df
36	Tanta	urban					x	NO2		SO2	A	
39	Domyat	resid					x	NO2		SO2	A	df

A = AIRmetrics PM10 sampler
df = dust fall collector

In addition Passive sampling will be undertaken every quarter around the AbuQuir factories.

Appendix B.3: IGSR-meeting

**Environmental Information
and Monitoring Programme
Phasing out Phase
EEAA - Danida - COWI
30 Misr-Helwan Str. Maadi, Cairo, Egypt
Tel: 202 525 6442, Fax: 202 525 6467**

Meeting

Date: **18 October 2003**
Present: **Dr. Elsayed Shallaby and the IGSR team (see below), Ashraf Saleh, Rolf Dreiem, Bjarne Sivertsen**

Meeting with IGSR – monitoring programme
EIMP Air Quality Project
Summary of status of the measurements by IGSR

Introduction

The objective of the meeting was to go through the air quality monitoring programme with the IGSR team and to design the site visits to be undertaken by Rolf Dreiem.

The IGSR team responsible for the measurements in Alexandria and in the Delta are:
DrElsayed A.Shalaby
DrShawkat Guirguis
DrZekry Ghatass
DrMohamed Rashad
DrAshraf Zahran
EngHossam Said Ahmed
Eng Heba Said
Eng.Morad Khamis

A summary concerning the status of the IGSR air quality monitoring programme is prepared and presented in the following Table.

EIMP Monitoring and Sampling Program Status, IGSR

I.D	Alexandria Sites	Area type	Param	Stat	Responsible	Comments
28	Abu Qir	Industrial	SO_2(PS) NO_2 (PS) NO_2 (SS) NH_3	Ok Ok Ok Ok	M.Rashad	Seq sampler need calibration?.
29	El-Max Petrogas	Industrial	SO_2 (SS) NO_2 (SS) PM_{10} (HV) DF	Ok Ok OK Ok	M. Rashad	Hivol out of operation, change of pump
30	IGSR, Alex	Urban	NOx (M) SO_2 (M) PM_{10} (M) CO (M) SO_2 (PS) NO_2 (PS)	--- - Ok ? - --- Ok	Heba Said.	Calibrator sent to be checked SO_2 sent to CEHM for repair Zero of NOx need checks
.	El-Asafra-	Residential	SO_2 SS PM_{10} (AM) SO_2 (PS	Ok Ok Ok	M.Rashad	Low SO_2 Instruments to be used at new site?
32	Gheat El-Inab	Residential	SO_2 (SS) NO_2 (SS) PM_{10} (HVS)	Ok Ok Ok	M. Rashad	PM_{10} HV low concentrations, have to be checked, error in flow
33	Alexandria regional	Regional	Met Ozone (M)	------ Ok	Heba Said	Ozone working Met station need complete over haul, New sensors for wind speed?
41	El Nahda	Industrial Semi urban	PM_{10} (HV) DF	--- Ok	M. Rashad	Measurements here will be terminated.
42	El-Shohada Square Station	Traffic	SO_2 (M) NO_2 (M) PM_{10} (AM) SO_2 (PS) NO_2 (PS)	Ok Ok Ok Ok Ok	M.Rashad	SO_2 and NOx will be sent to CEHM for calibration Zero line off by 20 Rolf visit the station today, install calibration gases.
34	Damanhour	Urban	PM_{10} (AM) SO_2 (PS) NO_2 (PS)	--- Ok Ok	H. Ahmed	The station has been out of operations for 7 months due to rebuilding of bus station
35	Kafr El Zayat Kafr Elnasrya	Industrial/res.	SO_2 (M) NO_x (M) PM_{10} (M) DF SO_2 (PS) NO_2 (PS	 ---- no Ok no no	H. S.A	SO_2 gives low flow alarm PM_{10} working Rolf will check the quality of the site, install calibration gas Passive sampling undertaken
36	Tanta	Urban	SO_2 (SS) PS (N) PM_{10} (AM)	Ok -- Ok	H. S.A	Ok, low SO_2
37	El-Mahalla	Industr/res.	SO_2 (M) PM_{10} (M) DF	Ok - Ok	H. S.A	Strange data at SO_2 monitor Zero check close to background = 4 ppb
38	El-Mansura	Industr/res.	Met NOx (M) SO_2 (M) DF	Ok --- Ok Ok	Ashraf Zahran	NOx sent to CEHM for repair one year ago (why?) Met station need complete check. Bring in Maher.
39	Damietta	Urban/resid	SO_2 (SS) PM_{10} (HV) NO_2 (PS) DF	Ok Ok Ok Ok	Ashraf Zahran	PM_{10} hivol need check (Hossam) SO_2 low, prefilter will be analysed for sulphate
40	Kafr Dawar	Urban/industry	SO_2 (SS) PM_{10} (AM) SO_2 (PS) NO_2 (PS) DF	OK Ok Ok Ok Ok	H. Ahmed	No comments

Appendix B.4: New monitoring stations for Beni Suef

NILU: Project plan
REFERENCE: P-818
DATE: October 2003

Air Quality Monitoring Plan for Beni Suef

Bjarne Sivertsen

Ministry of State for Environmental Affairs

Norwegian Institute for Air Research

Contents

Air Quality Monitoring Plan for Beni Suef

1 Introduction

As part of the further development of a national network for air quality monitoring and assessment in Egypt, EEAA has been supported to establish two monitoring stations in Beni Suef. EIMP/NILU was asked to undertake the siting study and present a proposal for the air quality monitoring system for Beni Suef. The siting study was undertaken during a one day visit to Beni Suef on 21 October 2003.

The detailed design of the monitoring system and location of sites are described in Chapter 6.

2 General concepts of air quality monitoring

The air quality monitoring station represents the crucial element in the air quality surveillance and management system. An air quality monitoring programme may consist of all types of equipment; from simple passive samplers, via active samplers of different makes and sequential samplers to the most advanced on-line monitoring systems using open path measurement techniques.

The system designed for Beni Suef will include the combination of on-line measurements and passive sampling.

3 Objectives

An important objective for the Beni Suef quality monitoring platform is to enable on-line data and information transfer with direct quality control of the collected data. The monitoring programme has to be in-line with the already existing EIMP/EEAA air quality monitoring programme. The design and components of the measurements in Beni Suef will be an integrated part of a national air quality monitoring system for Egypt under EEAA.

A general objective for the air quality measurement programme is to adequately characterise air pollution for the area of interest, with a minimum expenditure of time and money. As for the EIMP programme the main aim in the design is to assess the impact of air pollution to the public health.

The air quality measurement station should meet the following requirements:

1. Produce real time air quality data for areas impacted by air pollution
2. Identify the most important sources to air pollution, industries, road traffic, energy sources, storage areas and regional impacts,
3. Assess health impact on the population from air pollution
4. Evaluate whether national and international standards and limits are violated
5. Support information to the public

6. Undertake immediate actions to reduce ambient impacts
7. Evaluate consequences of development and trends

To meet these requirements on-line monitoring as well as sampling will be needed. Future possibilities for the development of modelling capabilities should be considered.

4 Air quality measurements

As part of the design for an ambient air quality monitoring station several decisions will have to be taken, The definition of the air pollution problem together with an analysis of available personnel, budget and equipment usually represent the basis for decision on the following questions:

- What are the sources to be monitored?
- Which compounds or indicators should be monitored?
- What kind of equipment should be used?
- What should be the sampling (averaging) time and frequency?
- Where should meteorological data be collected?
- What kind of effects are to be evaluated using the data?
- What is the best way to obtain the data (configuration of sensors and stations)?
- How shall the data be communicated, processed and used?

4.1 The monitoring network design

The air quality network will consist of two main stations in the city of Beni Suef. One will have to include meteorological data to enable discussions of sources and impacts. This design will enable air quality information in real-time.

The main stations will mainly contain automatic monitoring equipment located at permanent measurement sites. Two permanent sites have been selected as seen in Chapter 6.

Meteorological measurement will be undertaken along a 10 m mast at the station located at the roof of the Governerate building. The area is open and representative for the general airflow in the area.

In addition to the permanent monitoring sites, a few passive sampling sites will be assigned. About 4-5 sites will be prepared for permanent integrated sampling using passive samplers in areas where impact is assumed and where people live. In the most dusty areas also PM_{10} measurements will be undertaken with simple AirMetrics samplers.

4.2 Compounds and indicators

The compounds and indicators to be selected for the permanent air quality monitoring stations should be specific for the typical compound emitted from the different sources in the different areas.

The main core of the on-line air quality monitoring programme will be based on the permanently located measurement sites. The compound selected should be possible to measure with reasonable accuracy. It should be adequately documented and linked to possible health impact, building deterioration, impacts related to the specific activity in question (normal release, accidental release, specific pollutants or potential damages in the near surroundings of the releases.

The most commonly selected air quality indicators for urban, traffic and industrial air pollution are:

- nitrogen dioxide (NO_2),
- sulphur dioxide (SO_2),
- carbon monoxide (CO),
- particles with aerodynamic diameter less than 10 μm (or 2,5 μm), PM_{10} ($PM_{2,5}$),
- ozone.

The compounds listed above are referred to as the priority pollutants by the US EPA. They are also given in the Air Quality Daughter Directives of the European Union with specific limit values for the protection of health and the environment. The first three are also given in the World Bank limit values for ambient air pollution. The World Health Organisation guideline values also includes the above indicators as well as others. Selected air quality standards have been given by Law no. 4 of Egypt for NO_2, SO_2, CO, PM_{10}, TSP, black smoke and ozone.

For some of the activities linked to urban traffic inside the streets of the city we will suggest to include volatile hydrocarbons (VOC) measured as:

- Benzene, Toluene and Xylene (BTEX) or as

VOCs will participate in the production of photochemical smog, normally measured by ozone as an indicator.

The selection of which indicator to include in each of the shelters will be decided based on the sources impacting the site.

4.3 The automatic monitoring station

Automatic air quality monitors will be located inside an air conditioned shelter at the permanently located automatic air quality measurement stations.

4.3.1 Shelter

The shelter will include necessary power requirements (220 - 240 V) and an option for stabilization of the electric power supply. It will have a minimum number of electric circuits: 3, each protected with switch breakers. The shelter will be fully air conditioned to meet a requested indoor temperature of 25 to max 30 °C, preferably stable within ± 1 °C. It may be necessary to use split unit air condition. Rack for monitors will be installed and equipment for securing calibration gas cylinders to the shelter wall inside the shelter.

The shelter should be steel plated, painted white, with a door lock and no windows. It should be isolated sufficiently to maintain the requested indoor temperature when located in Egypt.

Excess air from the air intake manifold and monitors must be ventilated outside the shelter.

The air quality instruments inside the shelter will be based on available automatic monitors. In this option we have only used fully automatic equipment, so that all information collected at this station may be available on-line at a central database or via Internet solutions to the different companies interested.

4.3.2 Automatic monitors available

Methods and instruments for measuring air pollutants continuously must be carefully selected, evaluated and standardised. Several factors must be considered:

* *Specific*, i.e. respond to the pollutant of interest in the presence of other substances,
* *sensitive* and range from the lowest to the highest concentration expected,
* *stable*, i.e. remain unaltered during the sampling interval between sampling and analysis,
* *precise, accurate* and representative for the true pollutant concentration in the atmosphere where the sample is obtained,
* adequate for the *sampling time* required,
* *reliable and feasible* relative to man power resources, maintenance cost and needs,
* zero drift and calibration (at least for a few days to ensure reliable data),
* response time short enough to record accurately rapid changes in pollution concentration,
* ambient temperature and humidity shall not influence the concentration measurements,
* maintenance time and cost should allow instruments to operate continuously over long periods with minimum downtime,
* data output should be considered in relation to computer capacity or reading and processing.

The most commonly used methods for automatic monitoring of some of the major air quality indicators are discussed in the following. An example of monitors available is presented in Appendix A.

Most of the measurement methods presented below are considered the international reference methods:

Sulphur dioxide (SO_2)

SO_2 should be measured from the fluorescent signal generated by exciting SO_2 with UV light.

Nitrogen oxides (NO and NO_2)

The principle of chemiluminescent reactions between NO and O_3 will be used for measuring NO_x. NO and total NO_x is being measured.

Ozone (O_3)

An ultraviolet absorption analyser is being used for measuring the ambient concentrations of ozone. The concentration of ozone is determined by the attenuation of 254 nm UV light along a single fixed path cell.

Suspended particles; TSP, PM_{10} and $PM_{2.5}$

Gravimetric methods including a true micro weighing technology has been used to measure ambient concentrations of suspended particulate matter. For automatic monitoring an instrument named "Tapered Element Oscillating Microbalance (TEOM)" has been most frequently used. Using a choice of sampling inlets, the hardware can be configured to measure TSP, PM_{10} or $PM_{2,5}$.

Measurement on filter tape using the principles of beta attenuation for estimating 30 minute or one hour average concentrations of PM_{10} or PM2,5 have been operated with an air flow of about 18 l/min.

Carbon monoxide (CO)

The CO analyser often used in urban air pollution studies is a non-dispersive infrared photometer that uses gas filter correlation technology to measure low concentrations of CO accurately and reliable by use of state-of-the-art optical and electronic technology.

Hydrocarbons and VOC

Hydrocarbons (NMHC, Methane and THC) should be measured using a flame ionisation detector (FID). Experience from measurements performed by the EIMP programme have proven that here may be problems in the continuous power supplies. Short power breaks may interrupt these continuous measurements, and they will have to be started manually.

In the EIMP programme we have thus concentrated on using manual sampling in steel canisters. Another preferred method, which could be an optional indicator in Beni Suef, would be to use the modern BTEX monitors, as it then will be possible to compare the levels with international standards.

4.4 Data transfer systems

All data from the instruments mentioned above may be collected by a data logger and transferred directly to a database for processing, control and presentations.

There are many different options existing on the market for efficient data communication from monitors to a database. The various conditions at the locations decide the best solutions. Several factors such as availability of telephone networks, quality and speed of the network, the amount of data to be transferred, the frequency of transfer, satellite options etc.

Automatic Data Acquisition Systems (ADACS) are available from a number of companies and instrument providers. The NILU developed AirQUIS system will provide all necessary software and hardware system for data quality assurance, data presentations and reporting.

4.5 Samplers

4.5.1 Particles on filters enables analyses of elements

For sampling of PM_{10} and $PM_{2,5}$ there are a number of samplers available, which may enable suspended particle measurements to be undertaken at sites where continuous measurements are not needed.

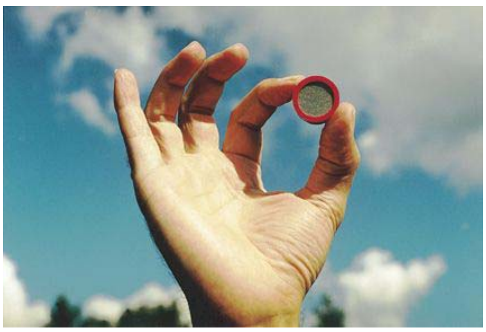
Suspended particles in the atmosphere is a major problem in Egypt when compared to national and international limit values. The reason being most often wind blown dust from the desert areas and general human activities such as open air waste burning and small enterprises using bad quality fuels. The levels of this dust may be interesting to identify at some measurement sites without installing expensive automatic monitors.

All the sampler type measurements will require that a laboratory will be established to undertake the chemical and physical analyses of the samples. This is a challenge that may have to be discussed with EEAA. There are laboratories in Cairo that performed such analyses on a daily basis already.

4.5.2 Passive and hand-held simple samplers

In addition to the permanent network of air quality monitors we will propose to use some simple inexpensive sampling using passive samplers.

Simple samplers for surveillance of time integrated SO_2 and NO_2 concentration distributions has been developed. The samplers are inexpensive in use, simple to handle and have a good overall precision and accuracy. They have been used in traffic studies, industrial areas, in urban areas and for studies of indoor/outdoor exposures. Investigations using passive samplers have been undertaken to develop spatial concentration distribution.



One of the internationally recognised 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.

Other passive diffusion samplers have also been tested at a number of sites where volatile organic compounds (VOC's) are the principal.

It will be recommended that such sampler results are co-ordinated and compared to automatic data from the permanent network. It may thus be advisable to handle such sampling from the shelters already available in field.

4.5.3 A chemical laboratory

The chemical analysis of PM, SO_2 and NO_2 have to performed in a laboratory. All these analyses are being undertaken by EEAA assigned laboratories in Cairo.

Particulate matter have to be analysed gravimetric by high sensitive scales in climate controlled rooms. The chemical analysis of SO_2 and NO_2 in extracts from impregnated filters are performed with ion chromatography.

5 Quality Assurance/Quality Control system (QA/QC)

Quality assurance/quality control (QA/QC) procedures, developed to handle the ambient air quality monitoring programme, contain several levels of controls.

In field operations will be established:

- Station Manuals including Standard Operating Procedures (SOP) for instrument installations, maintenance, controls etc.,
- zero span checks and calibration routines.

At the data centre or at an assigned Monitoring Laboratory data are controlled following quality assurance routines as described i.e. in ISO 17025 from the International Standardisation Organisation;

- at daily retrieval (e.g. using the AirQUIS system),
- through simple statistical and graphical evaluations to check validity and representativeness of data,
- as part of the reporting of data.

The quality control procedures give the data credibility. The data become reliable, which is essential when using the data for reporting, controls and planning. To be used with confidence for scientific and environmental management purposes the data must also be comparable and compatible.

5.1 Instrument calibration procedures

Monitors will be taken once a year to the Monitoring Laboratory for calibration. The technical tools will be supported by quality control descriptions, manuals and reporting procedures. Historical logbooks will have to be established for each instrument. Standard Operational Procedures and Manuals will be developed.

Specifications for instrument calibration and descriptions of measurement procedures (SOP; Standard Operation Procedures) will be developed.

5.2 Establish Standard Operational Procedures as part of QA/QC

Standard Operating Procedures (SOP) will be developed as an important part of the QA/QC system. All SOPs and forms for the operation of the monitoring stations will be presented as part of the Station Manuals.

All procedures to be undertaken at the sites will be collected in a Station Manual. At the Monitoring Laboratory a historical log for each of the stations will be established. The historical log for all instruments at the stations are to be found in this logbook.

5.3 Design QA / QC procedures at Monitoring Laboratory

Good descriptions of day by day routines, including data quality controls, are essential for generating representative results. The QA/QC programme will be prepared for all types of data retrieval methods. The main tool for undertaking these tasks for on-line monitoring data at the Monitoring Laboratory could be based on systems such as the AirQUIS database, which may be delivered as part of the data retrieval system.

Every day data will be checked, corrected and edited. Power failures, calibration values and instrument malfunctions will be taken into account and data are being corrected. These corrections are part of the application of the AirQUIS system.

5.4 Quality controls and calibration routines as part of the on-the-job training

The total QA/QC system will need institutional building through the development of an on-the-job training programme, which will include field installations, calibrations and operations.

The only way of obtaining good quality air pollution data is to assure that the daily field checks and calibrations and the daily data controls at the data retrieval point is undertaken properly. The use of history logbooks for the recording of events at all stations including maintenance and calibrations will be part of the on-the-job training.

For monitors the procedure for zero and span controls, flow controls and various checklists is given in the Station Manuals and the SOPs. Manuals and checklists will have to be followed at every visit and all detailed information has to be stored in the historical logbook forms. These forms will be developed, presented, used and repeated during the training in field.

6 Future programme for Beni Suef

The designed air quality monitoring programme proposed below has been based on meetings and site visits undertaken in Beni Suef on 21 October 2003. Engineer Medhat Awad, Mohamed Fathy and Ashraf Saleh participated in meetings and field studies.

The ambient air quality monitoring system will include:

- 2 complete measurement stations housed inside shelters
- 1 Automatic Weather Station (AWS) located at one of the shelters
- 1 simple PM_{10} samplers (AirMetrics)
- 4 sampling points for passive sampling

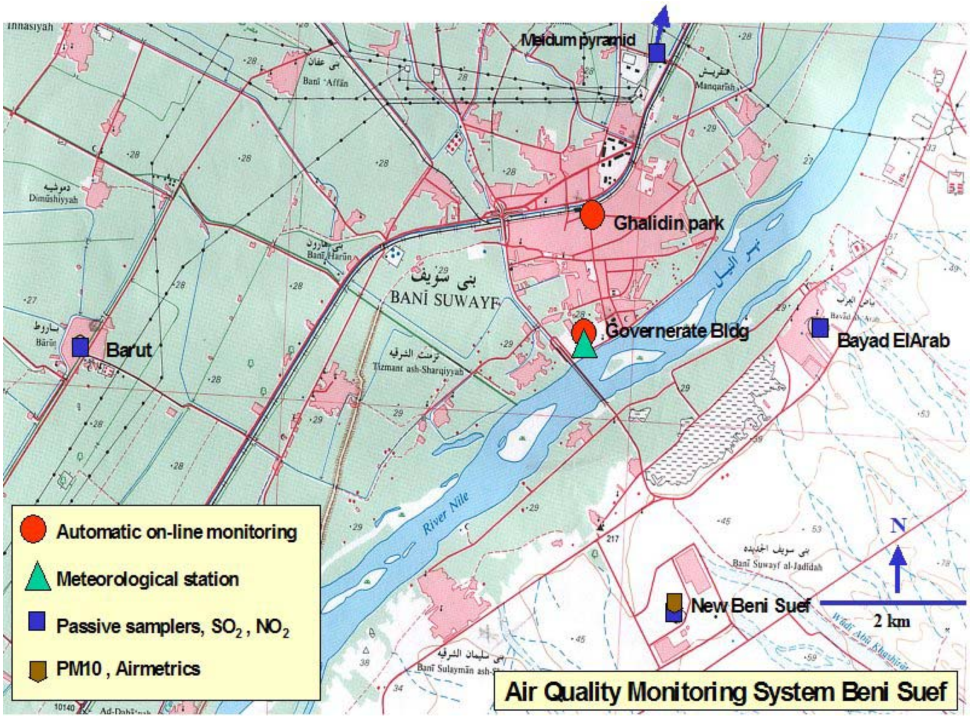


Figure 1: The air quality monitoring network proposed for Beni Suef.

6.1 The sites

6.1.1 Governmental Building

The main station in Beni Suef will be located at the roof of the Governmental Building in the southern part of the city. The area may be impacted by the general emissions from the urban activities as it is located downwind in the prevailing wind direction from the city.

The shelter will be lifted to the roof of the building about 12 m above the surface (see front page photo). The air quality indicators to be measured here are:

- Nitrogen dioxide (NO_2-NO_x)
- Sulphur dioxide (SO_2)
- Ozone (O_3)
- Suspended particulate matter (PM_{10})

The station will also be equipped with a complete automatic Weather Stations (AWS). (See Chapter 6.2.2).

Electricity and telephone connections will be provided and data will be transferred in real-time to a central database in Cairo. The data will be available for EEAA on a daily basis. It may also be possible to provide a data dissemination system via Internet, so that any qualified expert may access the data.

6.1.2 City centre, Ghalidin Park

The second automatic monitoring station will be placed at Ghalidin Park in the city centre of Beni Suef, not far from the railway station. The area is characterised by high traffic and urban activities. The park is surrounded by streets. Measurements here will serve the assessment of air quality and indicate the impact to people living and working in the city centre

The shelter will preferably be placed on the ground in the small park. An alternative location is to place it on the roof of the security building of the police station. The following parameters/indicators will be measured here:

- Nitrogen dioxide (NO_2-NO_x)
- Sulphur dioxide (SO_2)
- Carbon monoxide (CO)
- PM_{10}
- BTEX

Electricity and telephone connections will have to be provided. Data will be transferred in real-time to a central database in Cairo. The data will be available for EEAA on a daily basis.

6.1.3 New Beni Suef

At the building belonging to the Agent for the Development of Beni Suef we will locate one AirMetrics PM_{10} sampler and passive samplers.

PM_{10} measurements will be undertaken as 24-hour averages every 6 day. This will require weekly change of filters at the sire.

Passive samples of SO_2 and NO_2 will be collected once a month.

6.1.4 Bayad El Arab

Passive samples of SO_2 and NO_2 will be collected at the Local Unit building every month. If concentrations prove to be considerable the frequency of sampling may be reconsidered.

6.1.5 Barut

The town of Barut has experienced complaints due to air pollution. Especially odours have been the problem.

We suggest to measure SO_2 and NO_2 as indicators for pollution at one site in the town, preferably downwind from any sources. Samples will be collected on a monthly basis.

6.1.6 Maidum pyramid

To complete a national sampling programme that the EIMP programme conducted at a number of pyramids and temples in Egypt, it is proposed that 2 or 3 monthly samples of SO_2 and NO_2 are collected at the Maidum Pyramid north of Beni Suef.

6.2 Instrumentation

6.2.1 The real-time monitoring station

The two ambient air-monitoring stations should be fixed stations permanently located in the airport area. They should include the following instruments:

- Sulphur dioxide (SO_2): Pulsed UV fluorescence, TEI Model 43 C
- Nitrogen dioxide (NO_2-NO_x) Chemiluminescence, TEI Model 42 C
- CO Gas filter correlation/infrared abs.TEI 48 C
- Ozone (O_3) UV photometry, TEI Model 49 C
- PM_{10} /PM2,5 mon. Eberline TEI Particulate monitor
- Dataloggers NILU type data logger and ADACS
- Benzene-Toluene-Xylene BTEX monitor

In addition the stations will need:

- Air intake Air intake with manifold
- Data acq. Shelter ADACS system
- Z/S unit Equipment: Two point calibration unit
- Accessories Various equipment
- Shelter Shelter/ Container with complete air condition system
- Ozone calibrator TEI 49 CPS calibrator
- Zero air generator
- Calibration gases (SO2, NO, CO)
- Multipoint calibrator TEI 146

CO and BTEX will only be measured at Ghaladin park, ozone only at Governmental building.

6.2.2 Meteorological station

An Automatic Weather Station should be installed at the shelter located away from the Terminal Building. The specifications for this AWS are:

- Power requirements: 220 - 240 V.
- Ultrasonic wind speed and wind direction anemometer
- Relative humidity sensor.
- Temperature sensor at two levels.
- Net radiation sensor
- 10 m tower for sensors, telescopic or foldable with equipment for erecting the tower.
- Necessary equipment for mounting the sensors to the tower.

- Output signals for connecting to the shelter data acquisition and control system.
- Operating temperature: -5 °C to +60 °C.

The meteorological data equipment should be based on “MetOne” Automatic weather station, as this is already installed in the EEAA network in Egypt.

6.2.3 PM_{10} sampling

The additional site for PM_{10} measurements should also be fixed in space and include:

PM_{10}	AirMetric suspended particulate sampler
SO_2, NO_2	NILU/IVL type Passive samplers

6.2.4 Passive sampling

Four sites should be equipped with passive samplers. These data will provide a spatial distribution of time integrated (typical one week to one month) concentrations of SO_2 and NO_2. The results may thus be used to indicated the possible impact in areas where monitors are not being used. We propose to make these sites permanent with a fixed stand for undertaking samples every month.

6.3 Training

As part of installations and the development of a Quality Assurance programme a training programme will be designed to meet the necessary needs to operate the system.

Training will consist of hands-on training in instrument operations, maintenance and service as well as the daily and weekly operations of the measurements.

A workshop will be prepared to be held in Beni Suef for data users and operators aimed to establish a basic knowledge and understanding of air quality data and air pollution assessment.

7 A rough cost estimate

A rough cost estimate for the equipment included data retrieval systems, QA/QC and a GIS based database have been presented in the following. The costs are not binding as we have based the estimate on the available prices for a specific set of instruments and database.

7.1 Instruments

A complete set of instruments for two on-line monitoring stations, one simple sampling stations for PM_{10} , SO_2 nd NO_2 as well as 4 sites for passive sampling have been roughly estimated, and presented in the following table:

Governmental building

Ambient monitors	TEI models	Estimated price
		US$
SO_2 Pulsed UV fluorescence	Model 43 C	9
NO/NO_x Chemiluminescence	Model 42 C	12
Ozone UV photometry	Model 49 C	8
Zero air generator		4
Multipoint calibrator		10
Ozone calibrator		8
Air Intake and racks		6
PM 10 monitor betagauge		21
Shelter w. Aircon (local)		4
Automatic Weather station (AWS)		12
Met. Mast		8
Datalogger 2		9
Total site 1		**111**

City centre

Ambient monitors	TEI models	Estimated price
		US$
SO_2 Pulsed UV fluorescence	Model' 43 C	9
NO/NO_x Chemiluminescence	Model 42 C	12
CO Gas filter correlation/infrared abs.	Model 48 C	14
Zero air generator		4
Multipoint calibrator		11
PM 10 monitor Betagauge		21
BTEX (optional)		17
Air Intake and racks		6
Shelter w. Aircon (local)		4
Datalogger		4
Total site 2		**102**
Sampling sites	**Models**	
PM10 sampling	AirMetrics	0,6
Passive samplers (one year)	NILU/IVL	0,7
		1,3

The total price for instrument and equipment has thus been estimated at **214 300 US$.**

This includes monitors, calibrators, shelters, racks and intake structures and data loggers for all equipment in the shelters.

7.2 Data retrieval and database

An up-to-date data retrieval system will have to be established. The Automatic Data Acquisition System (ADACS) developed and applied by NILU world wide would serve the monitoring system perfectly, and can be easily integrated in the existing EIMP/EEAA network.

The ADACS system is linked to the GIS based database AirQUIS, which may be used to prepare, present and report data. The database include all necessary statistics and has a report generator, which will be tailor made to the needs of EEAA.

A cost estimate have been based on the GIS based AirQUIS database given as a special offer to EEAA. NILU has agreed to reduce the prices compared to the normal list prices.

A summary of these prices has been prepared for EEAA on a specific request.

The total cost for the Air Quality Measurement Module including the basic Kernel and the GIS system is given in the following:
The basic measurement module7800 US$
Hardware and computers 5750 US$
Installation and training6930 US$

Total cost for the AirQUIS measurement module installed and trained = 20 480 US $

If requested the annual cost for maintenance and support will be 2500 US$

If the emission inventory module and the modelling modules may be added to the basic GIS based kernel. These costs may be given additional to the measurement module presented above.

7.3 Spare parts and consumables

The delivery shall include accessory and spare parts kit for 3 years' operation, according to supplier's experience. Budget for accessories and spare parts has been roughly estimated based on experience. The supplier must have spare parts in stock for at least five years after delivery of the instrumentation.

Warranty of a minimum of 1 year for overall equipment is required. The warranty period shall be specified.

A rough estimate indicated that for spare parts and consumables for 3 year of monitor operations the project will have to set aside a fixed sum of about **30 000 US$**. In addition the consumption of calibration gases are estimated at 10 000 US$ per year, which amounts to another **30 000 US$** for 3 years.

7.4 Installations, QA/QC developments

The installation costs will strongly depend on who, how and where this is being performed.

NILU can offer a turn key development where all instruments are prepared, tested and installed ready made in shelters with all racks, intake, air condition systems, hardware and software, data loggers, data retrieval systems, benches etc. and shipped for easy installations at the sites in Beni Suef.

NILU will in this case develop the necessary QA/QC systems and perform training of operators.

Another possibility is to install by local expertise in Cairo. The following cost estimate is based on the use of local experts as far as possible. The experience developed through the EIMP programme will be utilised in the preparations and installations.

The installation support from expatriate experts is estimated in the following as part of the training programme. The additional costs for installations will thus be related to the use of local experts. We will suggest that **5000 US$** is allocated to all these operations locally..

7.5 Training

Expatriate experts will be used in addition to perform training of EEAA, monitor laboratory experts and local experts in Beni Suef.

Training includes:

- Hands-on training in instrument operations, calibrations and maintenance,
- Work shop and on the job training in QA/QC
- Seminar and workshops on “understanding air pollution”

These training sessions will be undertaken by international experts from NILU.
The total cost for these tasks, lasting in Egypt from one to two weeks are:

28 000 US$

7.6 Monitoring operations

Annual costs related to the operation of the measurement programme in Beni Suef will be an additional budget related to the EIMP/EEAA programme already operated by CEHM at Cairo University and EEAA.

The estimated costs for operation of the programme in Beni Suef has been based on the existing EIMP programme and includes field calibrations, instrument operations and maintenance, data retrieval, daily data check, sample collection in field, laboratory analyses and data reporting. The monitoring operations by CEHM was estimated at an annual cost of **4 500US$**.

7.7 Total costs

The total cost for the establishment of the air quality monitoring programme in Beni Suef as plnned and presented in this report is:

	US$
Instruments and equipment	214000
Spare parts and consumables	60000
Data retrieval and database	20480
Training	28000
Three year of operations	13500
Total first year	**335980**

The investments, installations, training as well as the first three years of operations have been estimated at a total cost of:

336 000 US$.

Contingency and additional data collections, upgrading of databases, service and support from experts as well as malfunctions and major repairs have not been taken into account. However, we believe that an investment of 336 000 US$ should be adequate to design, install and operate the necessary air quality network for Beni Suef for a period of three years.

Appendix B.5: The 145 Calibrator

Environmental Information
and Monitoring Programme
Phasing out Phase
EEAA - Danida - COWI
30 Misr-Helwan Str. Maadi, Cairo, Egypt
Tel: 202 525 6442, Fax: 202 525 6467

Memo

Date: 29 Oct. 2003
To: Bjarne Sivertsen
Copy: AAS, TEA, May, Ashraf, Yassin
From: Rolf Dreiem

The 145 Calibrator

After starting to use Working Standard Gases to make a span check every week the 145 Calibrator is only used to make **zero air.**

After visiting some of the monitoring stations in Cairo and Alexandria the following comments and conclusions can be drawn:

- All 145 calibrators do not scrub air well.
- When using the 145 zero air calibrator the zero value is too high. As a result all measurements from the monitors will be over estimated.
- To solve this problem the operators at the monitoring Institutes (CEHM and IGSR) must renew charcoal and purafil scrubbers at **all 145 Calibrators.**

To find out whether the zero air is working well a charcoal cylinder can be installed directly on a SO_2 monitor. If this gives a difference in zero readings charcoal and purafil must be renewed.

Charcoal and purafil can be purchased in Cairo at any chemical suppliers. This may bring the price down compared to the price asked by the monitor suppliers.

Appendix B.6:Working standard regulators

EIMP

Environmental Information
and Monitoring Programme
Phasing out Phase
EEAA - Danida - COWI
30 Misr-Helwan Str. Maadi, Cairo, Egypt
Tel: 202 525 6442, Fax: 202 525 6467

Memo

Date: 28 October 2003
To: Ahmed Abou Elseoud (AAE)
Copy: Tarek, Ashraf,
From: Rolf Dreiem

Working Standard Regulators

In October 2003 CEHM and IGSR stated to use working standard gas cylinders. To use the cylinders in a proper way gas regulators must be used to get correct pressure and gas flow out of the cylinders.
14 REGULATORS is bought together with gas cylinders.
16 REGULATORS is needed to calibrate at the stations.
12 monitoring stations is measuring NO_x and SO_2.
4 monitoring stations is measuring SO_2.
All together the need is
16 REGULATORS to calibrate all monitoring stations every week.

In order to have atmospheric pressure in the sample line to instruments the working gas system **must** contain the following items:

1. Gas Cylinder
2. Regulator
3. Regulator outlet valve
4. Fitting regulator outlet valve (in and out).
5. PlasticT-piece
6. Mini flow meter

<u>Items from 3 to 6 listed above are missing.</u>
Items 3 and 4 from regulator supplier.
Items 5 and 6 from local market.

Conclusion:
It is most important to by all missing part listed above if implementation of new calibration system is going to be a success.

Appendix C
SO_4 versus SO_2 measured on impregnated filters

Appendix C1: SO_4 versus SO_2 measured on impregnated filters

Environmental Information
and Monitoring Programme
Phasing out Phase
EEAA - Danida - COWI
30 Misr-Helwan Str. Maadi, Cairo, Egypt
Tel: 202 525 6442, Fax: 202 525 6467

Memo

Date: 5 October 2003
To: EIMP, Ahmed Abou Elseoud (AAE), Tarek ElAraby
Copy: Ashraf Saleh (ASI)**,**
From: Bjarne Sivertsen (BS)

SO_4 versus SO_2 measured on impregnated filters

Introduction

The SO_2 concentrations reported by the sequential samplers in Egypt have been very low, and seem to have been reduced during the last months as seen from the monthly average concentrations measured at Nasr City. This was reported in a memo dated 3 June 2003. (Appendix C1, Mission 02 report, NILU OR 41/2003))

In another memo of 3 June 2003 (Appendix B4, Mission report 02) it was shown that the ratio of the SO_2-concentrations measured with passive to sequential samplers on the average was 6.57. The ratios vary in general between 1 and 30, and there seem to be no systematic difference.

The SO_2 concentrations reported by sequential samplers were lowest in areas with high dust concentrations (cement factories in Helwan) and in areas with high ammonia and dust concentrations (Delta and Alex). The analyses carried out by the ion chromatographs at CEHM seem to be under control.

Based on these unsolved problems, filters were collected and brought to NILU for analyses. Results from these analyses from Tabbin South and Nasr city are presented below.

SO_4 and SO_2 measured by sequential samplers

One week of 24-h average samples of SO_4 on particle filters and SO_2 on impregnated filters using the NILU sequential samplers were collected from the measurement sites at Tabbin South and Nasr City.

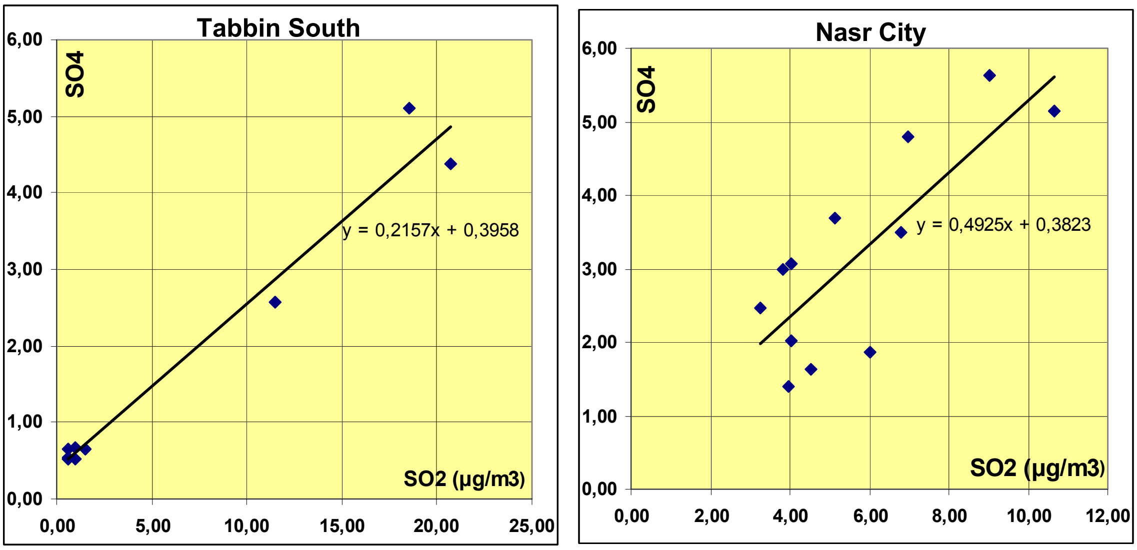


Figure 1: Concentrations of SO_4 -S and SO_2 measured on impregnated filters by sequential samplers at Tabbin South and Nasr City, 24 May to 5 June 2003.

The daily average concentrations were collected from 24 may to 5 June 2003. The results show a systematic difference between the two sites. (No SO_4 from passive samplers)

At Tabbin South, which is highly impacted by industrial sources, SO_4 concentrations were about 22 % of the SO_2 concentrations. At Nasr City, which is a dusty urban site, influenced by traffic, the SO_4 concentrations were more than 50% of the SO_2 concentrations.

In the following a discussion of possible reasons for low SO_2 concentrations has been presented. The need for proper cleaning of the intake system has been indicated before. Other options mentioned below should also be taken into account.

Intake dust problems

Dirt (typically dust) deposits in the inlet tubing, inlet manifold or internal tubing of the sequential sampler may absorb SO_2. The absorbed SO_2 will not reach the filter causing lower SO_2/sulphate results in the subsequent analysis. This effect was observed in a SO_2 monitor at Cairo University where dust deposits were found in the inlet filter holder. After cleaning the filter holder the instrument response to SO_2 was doubled.

The inlet tubing, inlet manifold and internal tubing of the sequential sampler should be inspected for dust deposits and cleaned if necessary.

The system should be cleaned at least once a year, probably more often. A proper cleaning frequency will have to be established based on local experience.

Why low SO_2 concentrations

The reason for measuring too low SO_2 values from the use of impregnated filters at the NILU sequential samplers may be the following:

1. If SO_2, an acid gas, reacts in the atmosphere with alkaline dust e.g. CaO or Ca CO3, it will end up as CaSO4. Depending on the size of such particles, it may end up in the aerosol filter in the filter holder. If nearly all SO_2 in the air react like this, and enter the filter, the sum of SO_4 there and SO_2 on the impregnated filter should be equivalent with the original SO_2 in the air.
2. There may be some reasons why the particles do not reach the filter:
   a) They may be bigger (heavier) than the cut off size for the air intake of the sampler. The cut off size of the intake funnel will depend on the wind velocity.
   b) They may settle in the intake tube. Try to analyse the washing-solution from a cleaning of a used intake tube for SO_4
3. If the emitted SO_2 still enters the intake system as SO_2 it may react with alkaline dust already deposited in the intake tube (see above).
4. SO_2 may also react on alkaline particles already sampled by the pre filter, but again it will be found as SO_4 when the pre filter is analysed.
5. The last possibility to measure too low SO_2 concentrations with the impregnated filter method is an inefficient absorption of SO_2 on that filter. The absorption of SO_2 needs some water to be efficient, and a completely dry filter may be inefficient. This may happen if the humidity of the air is "lost" when the air is heated from its outside temperature. This is why the impregnated filter method originally is used with the filter holder directly in the intake funnel in the ambient air. The addition of glycerol to the impregnation solution is meant to minimise this problem.

The efficiency of the impregnated filter could be controlled by placing a 0.3% H2O2-absorption solution behind the filter holder and analyse the exposed solution for SO_4 by ion chromatography.

Is the sulphur problem in Egypt a SO_4 problem?

There are reasons to believe that there are fast reactions of SO_2 to SO_4 at both sites and most efficient at Nasr City. Whether the reactions of SO_2 to SO_4 are really taking place in the atmosphere or in the instruments (on the filter) is not clear at present. If these concentrations of SO_4, on the other hand, occur in the atmosphere, they may represent a health hazard to the people breathing these concentrations if they occur in the fine particle fraction.

Further studies may reveal that the sulphur problem in Egypt is NOT linked to SO_2 but to the concentrations of sulphate.

Appendix D

What happened 10-12 October 2003

Appendix D1: What happened on 10 – 12 October 2003

Environmental Information
and Monitoring Programme
Phasing out Phase
EEAA - Danida - COWI
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Tel: 202 525 6442, Fax: 202 525 6467

Memo

Date: 15 October 2003
To: EIMP, Ahmed Abu ElSeoud (AAE)
Copy: Ashraf, Tarek
From: Bjarne Sivertsen (BS)

What happened on 10-12 October 2003

1. Introduction

Different types of air pollution "episodes" occur over Cairo. On 9 to 11 October we observed dirty air over Cairo. This was reflected in very high PM_{10} concentrations measured at Abbaseya and at Tabbin. Also SO_2 concentrations were relatively high at Maadi and at Quolaly.

This memo presents a situation during 9 to 10 October 2003, which questioned the quality of the continuous PM_{10} measurements. This memo try to identify whether the PM_{10} measurements at 4 different sites in Cairo where real and very different, or whether there were any possible errors in any of the measurements.

2. PM_{10} concentrations

Concentrations of PM_{10} were measured at 4 sites. Figure 1 show the measured hourly concentrations at Abbasseya, FumEl-Khalig, Quolaly and Tabbin.

Around midnight between 9 and 10 October the concentrations at Abbasseya and Tabbin reached more than 1200 $\mu g/m^3$. At Fum Al-Khalig and Quolaly, which are located in the city centre of Cairo, the concentrations prevailed relatively low at around 200 $\mu g/m^3$. The variations of PM_{10} concentrations over the day varied much more at Abbasseya than at the other sites.

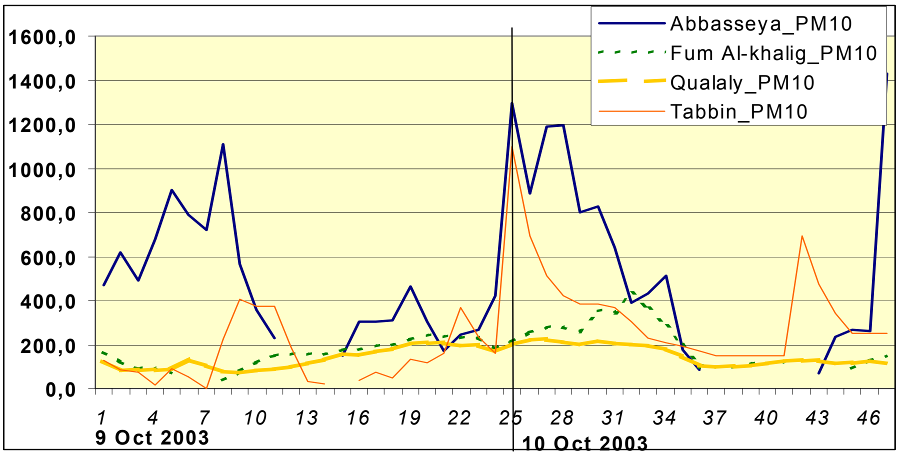
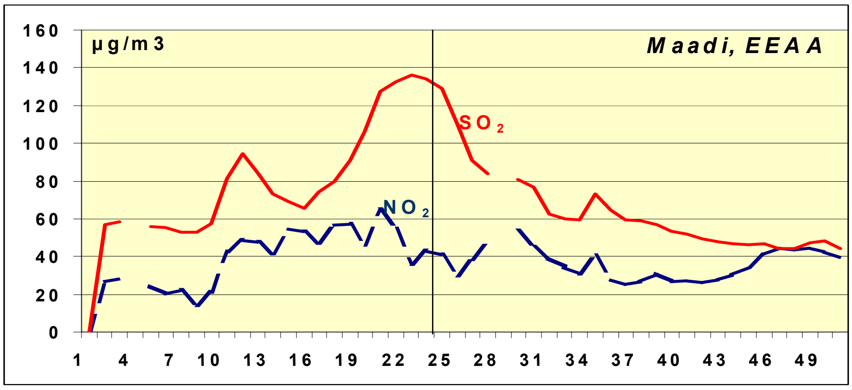


Figure 1: Concentrations of PM_{10} measured at 4 sites in Cairo 9 – 10 October 2003..

How could the concentrations observed at the urban background station at Abbasseya be much higher than inside the polluted city centre of Cairo? What were the sources and where did this pollution come from? Could it be malfunctions in any of the measurements?

3. SO_2 and NO_2 concentrations



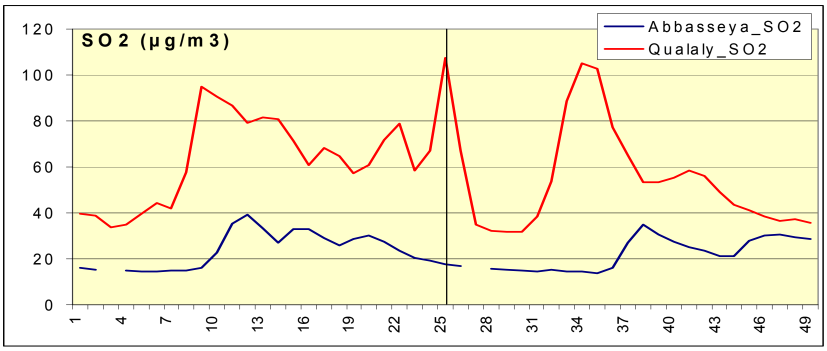


Figure 2: Concentrations of SO_2 and NO_2 measured at Abbasseya, Quolaly and Maadi.

As seen from Figure 2 the concentrations of SO_2 also were quite high during the midnight between 9 and 10 October. This was the case both in Maadi and at Quolaly. There are thus reasons to believe that it has been a “cloud of pollution” passing over the monitoring sites at this hour. But why did the SO_2 concentrations stay low at Abbasseya, where the highest PM_{10} concentrations were measured.

So where did the pollutants come from?

4. Wind directions and wind speeds

This was not the classical air pollution “episode” over Cairo as reported several times earlier during the months of October. No stagnation, calm conditions or variable winds were recorded.

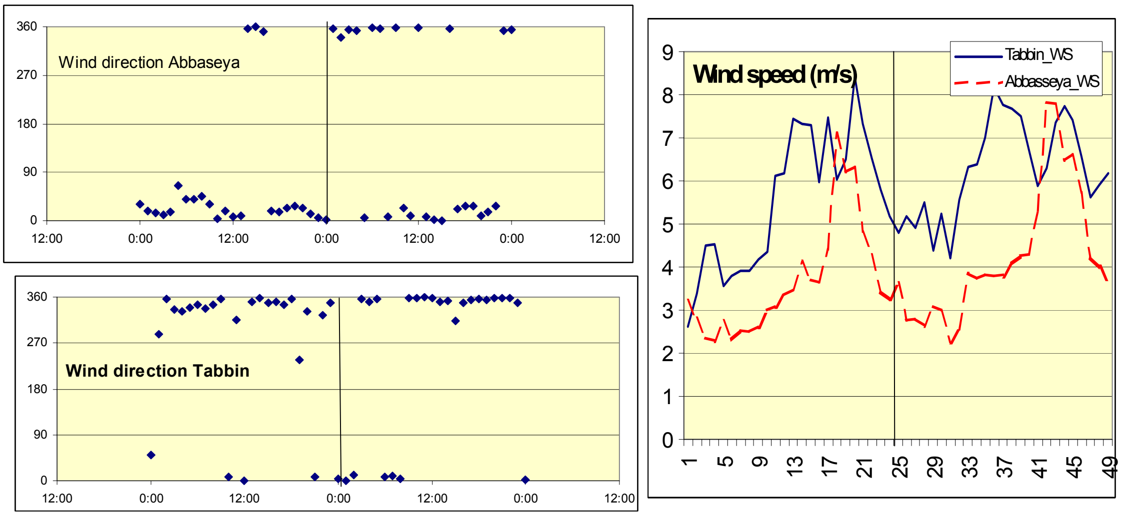


Figure 3: Wind directions and wind speeds observed at Abbasseya and Tabbin during 9 and 10 October 2003.

Figure 3 indicates that the wind was steady from around north at both sites. The wind speeds during the evening of 9 October were ranging between 6 and 8 m/s. The wind speed dropped to about 3 to 5 m/s during midnight, but was still brisk

There seemed to be several explanations for the high PM_{10} concentrations and the large difference between Abbasseya and the two sites inside Cairo:

- There was a local source for PM_{10} at Abbasseya and Tabbin, which did not impact on Cairo city centre
- The measurements at Fum Al-Khalig and Quolaly were subject to errors
- The measurements at Abbaseya was wrong.

5. Dusty intakes

One possible reason for underestimating PM_{10} concentrations, could be the fact that the intake structures to the monitor was so dusty/dirty that it influenced the PM_{10} measurements. This was investigated on 12 October, and very dirty intakes were cleaned and installed at the sites again.

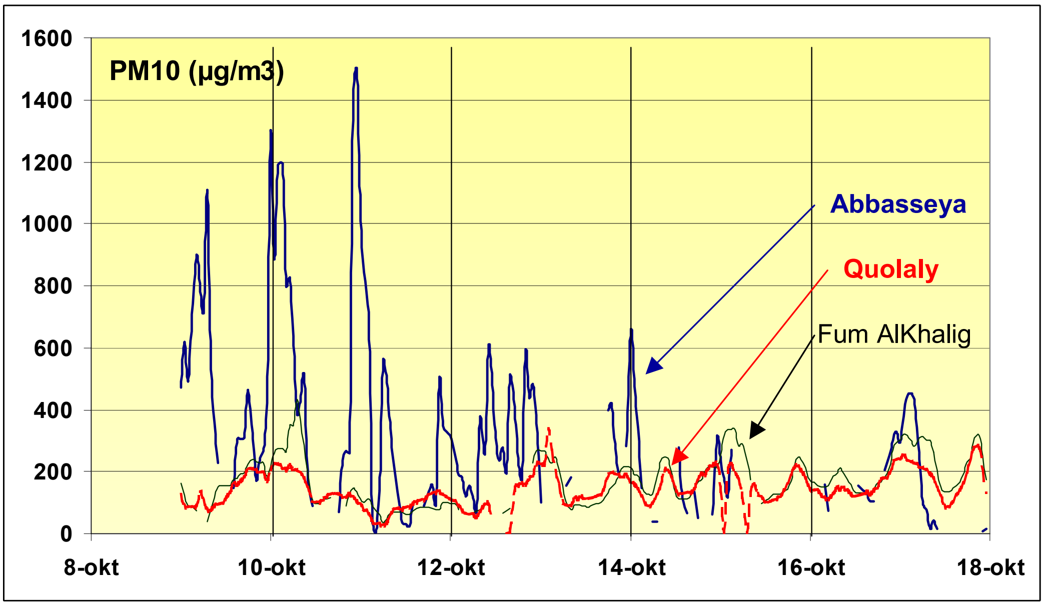


Figure 4: PM_{10} concentration measurements from 9 to 18 October at 3 sites in Cairo.

After cleaning the PM_{10} concentrations measured did not seem to increase considerably. On the other hand we identified malfunctions in the Abbasseya measurements. After 14 October all stations seemed to be well correlated. However, Abbasseya had to be re-visited.

The general aspects of influencing the measurements due to dirty and dusti intake structures has been covered in another memo from October 2003.

Appendix D2: Monthly report June 2003 - Summary

**Environmental Information
and Monitoring Programme
Phasing out Phase
EEAA - Danida - COWI
30 Misr-Helwan Str. Maadi, Cairo, Egypt
Tel: 202 525 6442, Fax: 202 525 6467**

Memo

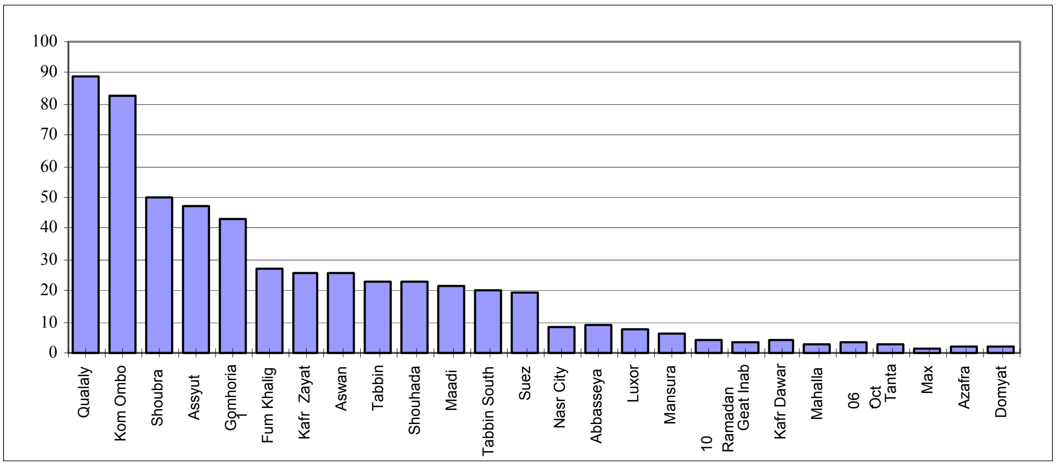
Date: 8 October 2003
To: EIMP Phase out
From: Bjarne Sivertsen, Ashraf Saleh and Haytham Ahmed

Monthly report June 2003 - Summary

Introduction

The following short summary and comments have been based on the monthly report for June prepared by **Ashraf Saleh and** Haytham Ahmed. The report was originally prepared in Arabic language.

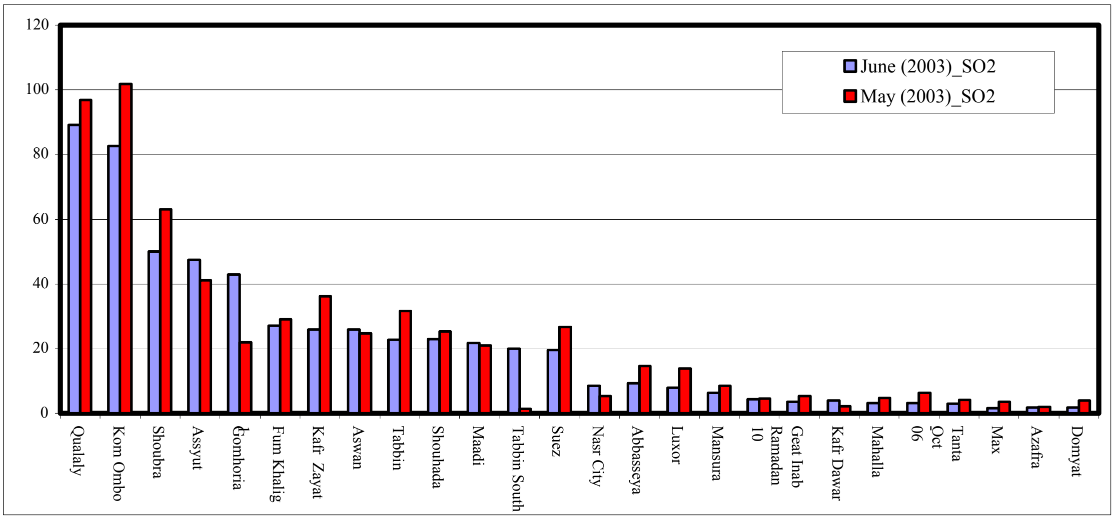
SO_2 concentrations



Monthly average SO_2 concentrations at all sites in Egypt, Junel 2003

Exceedance of 60 µg/m^3 (annual average AQL) was found in at Kolaly and Kom Ombo. The monthly average concentrations at Shoubra ElKheima, Assyut and

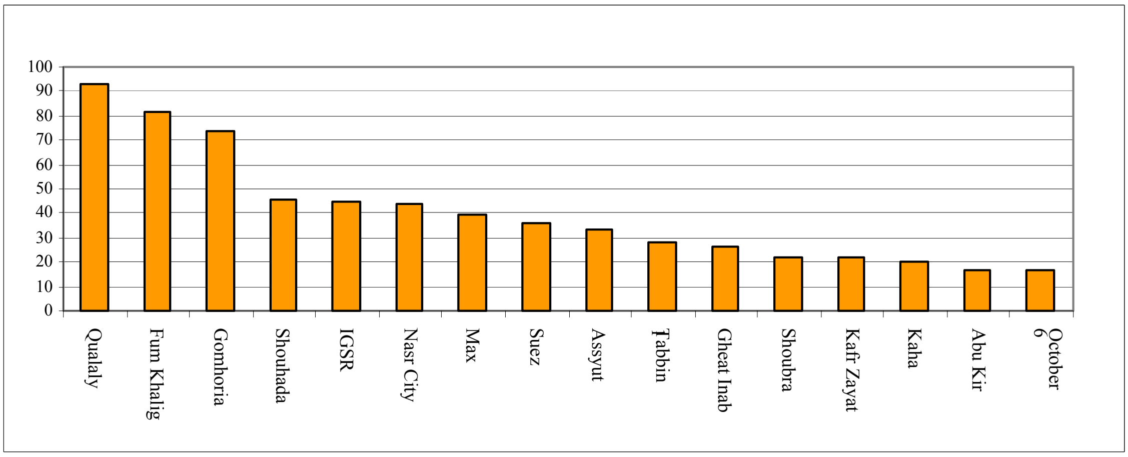
Gomhoreya were between 40 and 50 µg/m^3. The typical monthly average concentrations of SO_2 ranged between 10 and 30 µg/m^3 in the greater Cairo area.



Monthly average SO_2 concentrations measured in June 2003 compared to concentrations of May 2003.

Concentrations at the three most impacted sites were all lower in June than in May.

NO_2 concentrations

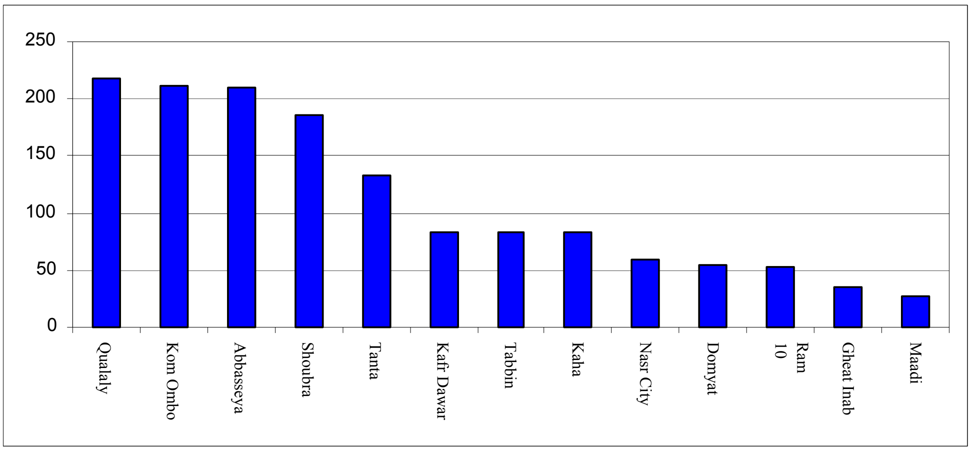


Monthly average NO_2 concentrations from 16 sites in Egypt, June 2003

The NO_2 concentrations were on the average highest in the city centre of Cairo with monthly average concentrations ranging between 70 and 90 µg/m^3. Also the city centre site in Alexandria had NO_2 concentrations giving a monthly average of 45 µg/m^3.

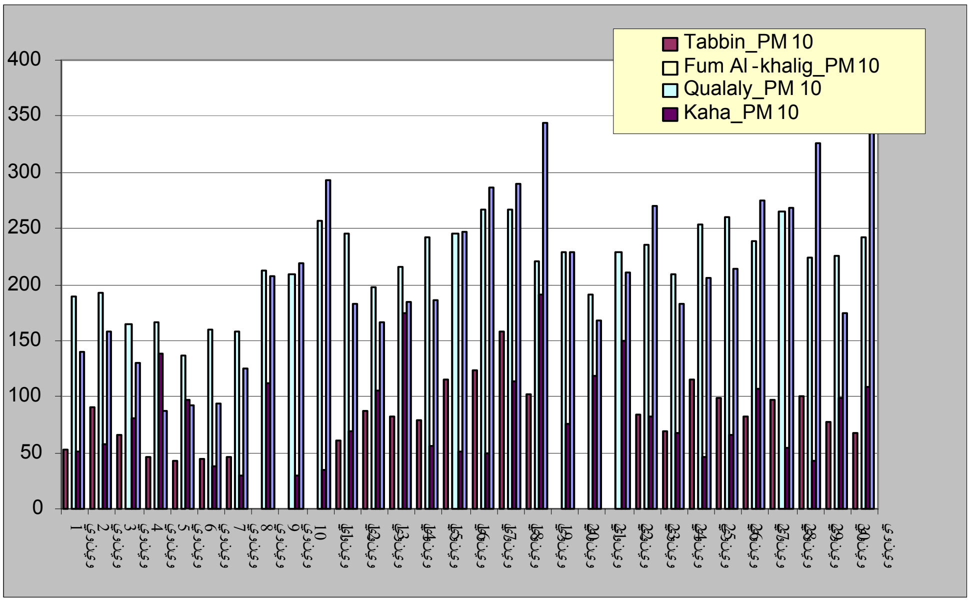
PM_{10} concentrations

PM_{10} concentrations are exceeding national and international air quality limit values at all sites in Egypt. Monthly average concentrations around 200 µg/m^3 were measured in the urban area of Cairo in June 2003. At the two sites influenced by industrial activities the monthly average PM_{10} concentrations were also around 200 µg/m^3.



Monthly average PM_{10} concentrations

The daily average concentrations of PM_{10} are presented for June 2003 in the following Figure.



Daily average PM_{10} concentrations at 4 sites in the greater Cairo area.

On a few days the 24-hour average PM_{10} concentrations exceeded 300 µg/m^3 at the sites in Cairo city centre. PM_{10} concentrations exceeded more than 4 times to AQ limit value of 70 µg/m^3 during 6 occasions in June 2003.

Summary of June 2003 data

Maximum one-hour average concentrations for June 2003 are presented in the following table.

	CO**	Ozone	PM10	NO2	SO2
1. Kolaly			497	285	243
2. Gomhorya				197	133
3. Abbassya		174	1116		68
5. Maadi					71
6. Tabbin			282 x)	84	105
8. Fum Khalig	9		1560	212	99
10. Shoubra El K					395
12. Kaha		168	461	93	
15. Suez				123	110
20. Assuyt1				102	484
26. Aswan		129			103
30. Shouhada				111	60
31. IGSR	6			139	
33. Alex. Reg.		111			
35. Kafr Zayat				57	255
37. Mahalla					5
38. Mansura					22
	30	**200**	**-**	**400**	**350**

x) error in monitor

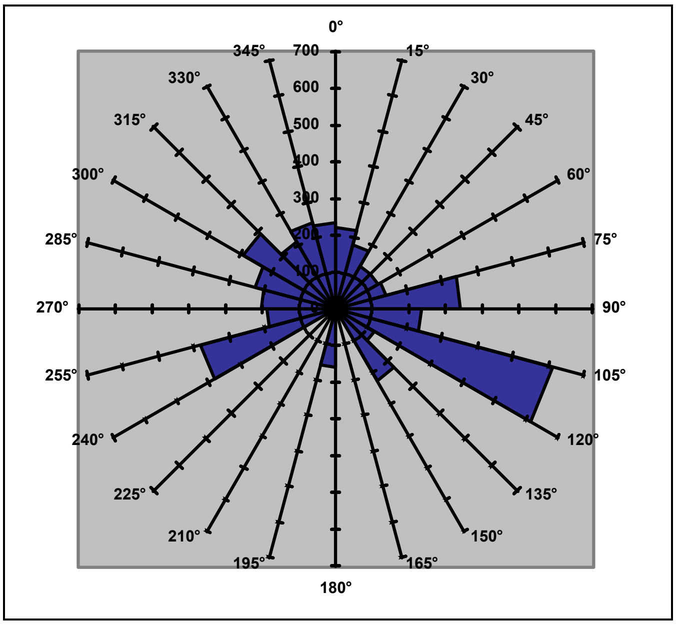
PM_{10} concentrations were as always high. However some of the PM_{10} monitors did not work properly throughout the whole month.

SO_2 concentrations at the industrial impacted sites of Assyut and Shoubra El-Kheima exceeded the air quality limit values in June. Also Kolaly and Kafr Zayat observed SO_2 concentrations at more than 60 % of the limit values.

CO, ozone and NO_2 concentrations did not exceed the limit values for one-hour average concentrations at any of the sites in June 2003. NO_2 concentrations at Kolaly and Fum AlKhalig were more than 50 % of the one-hour average limit value.

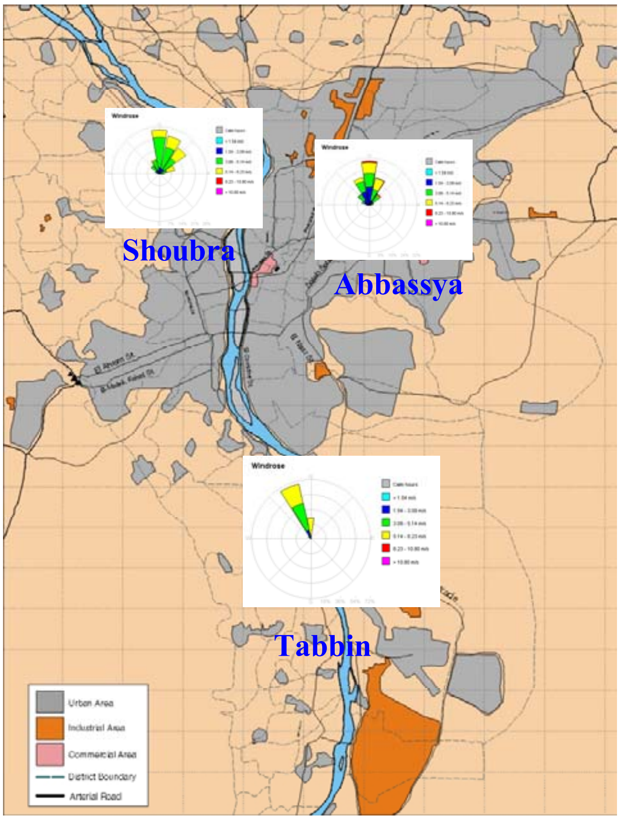
PM_{10} as function of wind directions

The average PM_{10} concentrations as functions of wind directions are shown in the next figure (Breuer diagram) for measurements at Abbasseya in June 2003.



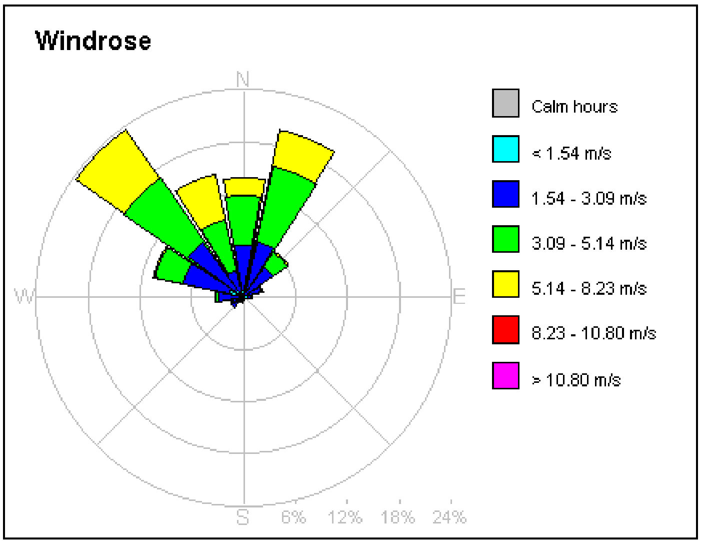
Breuer diagram for PM_{10} concentrations at Abbasseya station during 2003

The highest concentrations of PM_{10} occurred for wind from southeast and southwest. As seen below these wind directions occurred very rarly during June. For the most predominant wind from north, the average PM_{10} concentration was 220 $\mu g/m^3$.



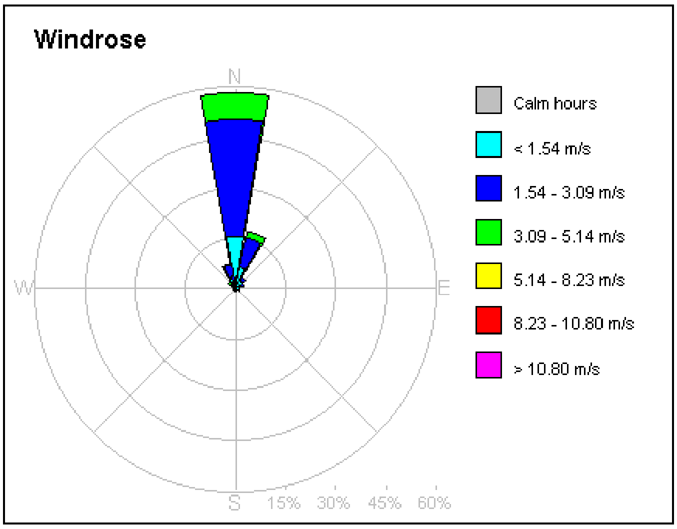
Wind roses for three sites in Cairo, June 2003.

Winds from around north were domination in Cairo during June 2003.



Wind rose from Kaha, June 2003

At Kaha the wind directions were more spread out blowing dominantly from northwest and north-northeast. Northerly winds (NNW± 45 degrees) were dominating.



Wind rose from Aswan, June 2003

At Aswan the winds were strongly canalised from north. About 90 % of the time the winds were blowing fro N± 20 degrees.

Appendix D3: Paper for "Environment 2003"

Baseline of Air Pollution from 2000 to 2002

Bjarne Sivertsen♠ Haytham Ahmed*, Ashraf Saleh* and Ahmed Abu El Seoud*

* Egypt Environmental Affairs Agency (EEAA),
Cairo, Egypt
♠ Norwegian Institute of Air Research

1. *Introduction*

Industry is one of the main sources of Egyptian economy; therefore the Egyptian government has focused on the modernization, expanding and investing in this sector. This process has been started since the year of 1981 and still running to improve the level of the Egyptian industry. Although this process has achieved part of its goals, it also led to the increase of pollution in the industrial areas. At early stage the Egyptian Environmental affairs agency (EEAA) as part of the Egyptian government has realized the effect of industrial pollution on the environment. Taking this point into consideration the Agency has been supported by Danida to establish an Environmental Information and Monitoring Programme (EIMP) for Egypt. The EIMP components were launched in 1996 with EEAA as the implementing agency for an environmental information and monitoring programme covering institutional support, coastal waters, air pollution, point sources emissions and the development of reference laboratories for improvement of the quality of monitoring data. The national air pollution-monitoring programme developed by EIMP consists of a total of 42 measurement sites covering most of Egypt.

2. *The air quality measurement programme*

A total of 42 measurement sites have been selected covering most of Egypt. Two monitoring institutions have been selected for undertaking the field operations and collection of data. The Center for Environmental Hazard Mitigation (CEHM) at Cairo University and the Institute of Graduate Studies and Research (IGSR) at Alexandria University are operating, on behalf of EEAA, a total of 14 sites located in the greater Cairo area, 8 sites in Alexandria, 10 sites in the Delta and Canal area, 9 sites in upper Egypt and 1 site in Sinai. The monitoring program has been designed and established by EIMP. The monitoring laboratories both at CEHM and at IGSR are submitting quarterly reports as a support for the data collection and. These reports briefly describe data quality, data availability and the air quality. A Reference Laboratory has been set up at the National Institute for Standardization (NIS).

2.1 Selected sites

The EIMP Air Quality Monitoring Programme is providing information to support and facilitate the assessment of air quality in the selected areas. The information provided by the EIMP Programme will:

- Provide a general description of Air Quality, and its development over time (trend)
- Enable comparison of Air Quality from different areas
- Produce estimates of individual source contributions
- Indicate the exposure of air pollution to the population
- Evaluate levels of pollution compared to national and international limit values
- Represent input to future information and assessment of air quality

The number of sites and area types are presented in Table 1.

Table 1:Number of sites in different types of areas

Area type	Cairo	Alex.	Delta and Canal	Upper Egypt	Sinai	Total
Industrial	3	3	3	2		**11**
Urban	1	1	3	4		9
Residential	4	2	2	2		10
Street/road	3					3
Regional/back kr.	1	1			1	3
Mixed areas	2	1	2	1		6
Total	14	8	10	9	1	**42**

The design, development, construction and installation of the measurement programme started in 1997 and were completed in July 1999. CEHM is operating 27 Monitoring and Sampling sites in Cairo, Canal area, Upper Egypt and Sinai while 15 sites are being operated by IGSR in Alexandria and Delta.

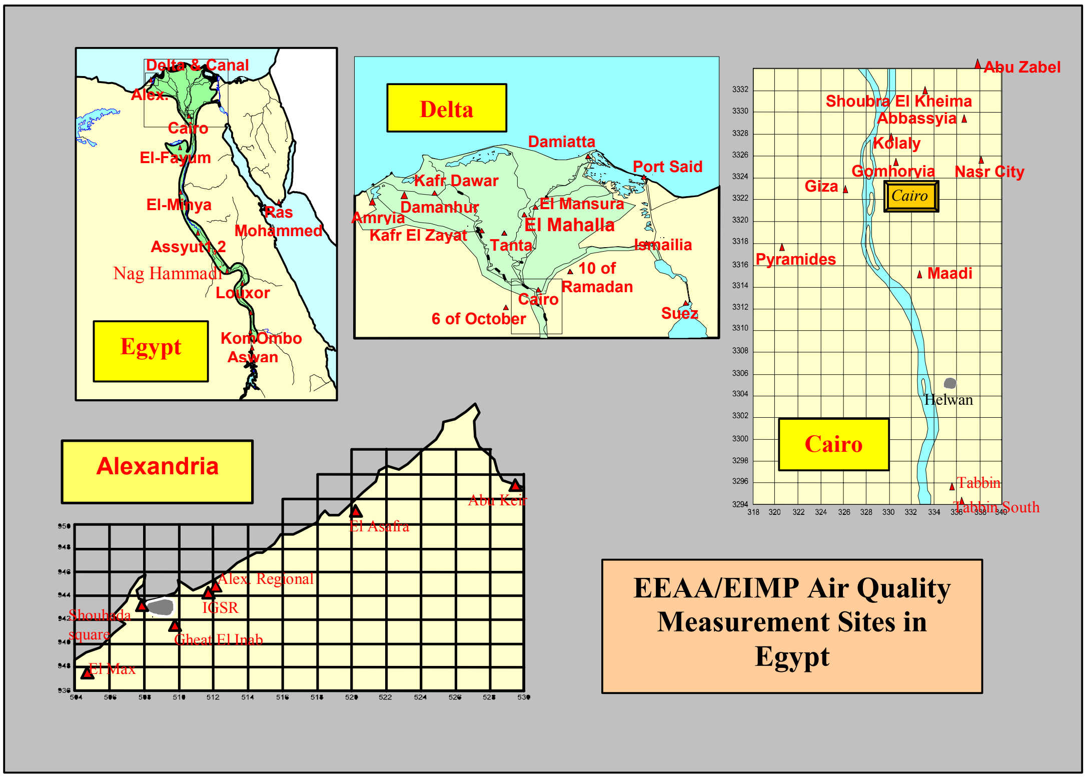


Figure 2: The EEAA/EIMP Air Quality Measurement Sites in Egypt

2.2 Indicators

A set of environmental indicators have been selected by the EIMP Programme to:

- Provide a general picture
- Be easy to interpret
- Respond to changes
- Provide international comparisons
- Allow development of trend analyses.

To enable a balanced interpretation of the measured data, the results are being compared to international and national Air Quality Limit values, Standards or guidelines [8]. The guidelines as given by World Health Organization include a selection of a few priority pollutants [11]. The indicators selected by EIMP were:

- Sulphur dioxide (SO_2)
- Nitrogen dioxide (NO_2) and/or NOx (Nitrogen oxides),
- Total Suspended Particulate matter (TSP), or better PM_{10} (suspended particles with diameter less than 10 micrometer).
- Ozone (O_3)
- Carbon monoxide (CO)
- Lead (Pb)

Not all parameters are being measured by the EIMP/EEAA Programme at all sites. This depends on site specification and typical dominating sources in the specific area. Also VOC (Volatile Organic Compounds) and Dust Fall are being measured in some sites in Egypt.

3. Air quality limit values

Air Quality Limit values are given in the Executive Regulations of the Environmental Law no. 4 of Egypt [1]. These Air Quality Limit values are presented in Table 2.

Table 2: Ambient Air Quality Limit values as given by Law no.4 for Egypt (1994) [1] compared to the World Health Organisation (WHO) air quality guideline values [11].

Pollutant	Averaging time	Maximum Limit Value	
		WHO	Egypt
Sulphur dioxide (SO_2)	1 hour 24 hours Year	500 (10 min) 125 50	350 150 60
Nitrogen dioxide (NO_2)	1 hour 24 hours Year	200 - 40-50	400 150
Ozone (O_3)	1 hour 8 hours	150-200 120	200 120
Carbon monoxide (CO)	1 hour 8 hours	30 000 10 000	30 000 10 000
Black Smoke (BS)	24 hours Year	50 * -	150 60
Total Suspended Particles (TSP)	24 hours Year	- -	230 90
Particles <10 µm (PM_{10})	24 hours	70 **	70
Lead (Pb)	Year	0.5-1,0	1

* Together with SO_2 ** Norwegian Air Quality Limit value

Dust fall (DF), which are measured as part of the programme, have no Air Quality Limit value. However, some countries normally state that when dust fall values exceed 10 g/m^2 per 30 days, the area may be considered unclean (polluted).

4. *Suspended dust*

Particles can be suspended in the air for long periods of time. Some particles are large or dark enough to be seen as soot or black smoke. Others are so small that individually they can only be detected with an electron microscope. Some particles are directly emitted into the air. They come from a variety of sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning of waste and wood.

Thoracic particles that may be transported to the lung after breathing is from a health point of view the most interesting indicator for ambient dust. These particles are less than 10 micrometer in diameter and are called PM_{10}. A part of the PM_{10} is black smoke or soot most often originating from combustion. The total mass of suspended particles varies in size from the smallest sub micron particle to the larger particles up to about 50-100 micrometer in size. This total mass can only be measured by high volume samplers and is referred to as Total Suspended Particles (TSP).

4.1 Thoracic particles, (PM10)

Concentrations of suspended dust measured as PM_{10} are exceeding national and international air quality limit values at all sites in Egypt. Monthly average concentrations are commonly recorded at between 200 and 300 µg/m^3, and as seen from Figure 1, annual average concentrations ranged between 100 and 250 µg/m^3 in urban and residential areas and up to 450 µg/m^3 near industrial sites.

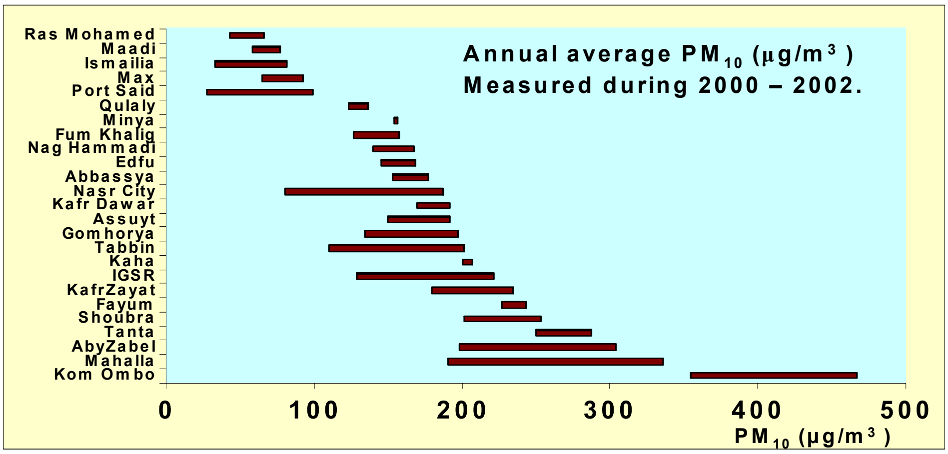


Figure 2: The range of annual average PM_{10} concentrations measured at 25 sites in Egypt (2000 - 2002)

In the greater Cairo area the air quality limit value (AQL) of 70 µg/m^3 as a 24-hour average concentration was exceeded between 45 and 98 % of the time in 2002. Similar periods of exceeding were found in 2000 and 2001.

4.2 The background PM_{10} concentrations in Egypt

PM_{10} concentrations measured with different type of instruments; in different measurement programmes at a variety of sites and at different seasons indicate that the typical average background concentration of PM_{10} seems to be around 70 to 80 µg/m^3. (Sivertsen, 2003) A level of 70 µg/m^3 is equivalent to the Air Quality Limit value for 24-hour average PM_{10} concentrations as given by the Law no. 4 of Egypt.

These levels can be found also in areas where local anthropogenic sources do not impact the measurements. The "natural background" levels are thus assumed to be originating from wind generated dusts in the desert areas surrounding the large urban areas such as Cairo

4.3 Black smoke (soot)

Also the black smoke concentrations are frequently found to exceed the Air Quality Limit value of 150 µg/m^3 as a 24-hour average concentration. Figure 2 presents the frequency of exceedance of the AQL value at five selected sites in Egypt.

At industrial sites such as in Kom Ombo (downwind from a sugar factory) and in the southern Tabbin area (brick factories) the black smoke concentrations were above the AQL value during 8 to 43 % of the time annually from 2000 to 2002.

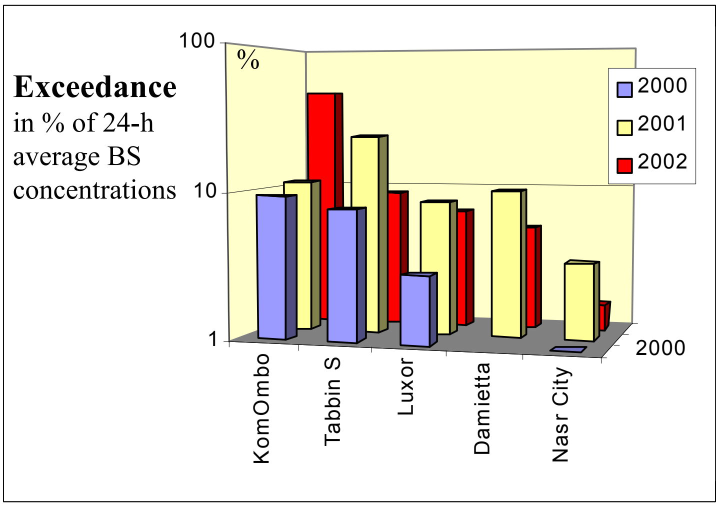


Figure 3: The frequency (in %) of exceeding the Air Quality Limit value of 150 µg/m^3 as daily average concentration at 5 selected sites in Egypt during 2000, 2001 and 2002.

Measurements of black smoke in Luxor, Damietta and in a street in Nasr City show that exceeding of the daily limit values occurred also at these sites (1 to 8 % of the time).

4.4 Total suspended particles (TSP)

The annual average TSP concentrations measured at 5 sites in Egypt from 2000 to 2002 is presented in Figure 3.

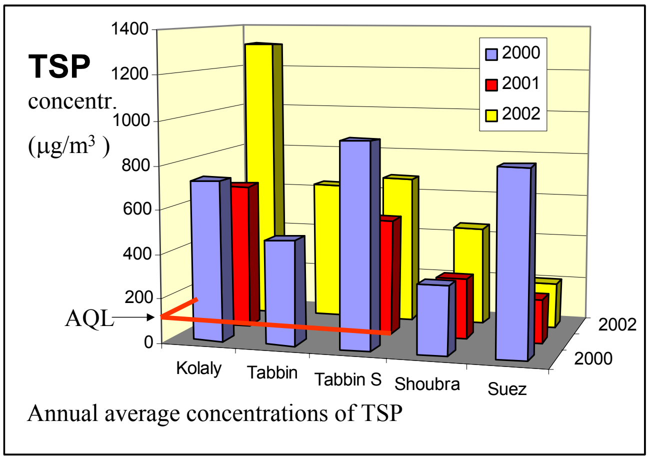


Figure 4: Annual average TSP concentrations measured in 2000, 2001 and 2002.

The Air Quality Limit (AQL) value for Egypt, 90 µg/m^3 as annual average, was exceeded at all sites. Sites surrounded by traffic, industries and high activity, such as Kolaly in Cairo city, Tabbin with cement factories and other industrial activities had very high TSP concentrations. At Suez there was a significant improvement in TSP concentrations when the bus station that surrounded the site moved out of the city.

High TSP concentrations may in many cases also be generated by wind blown dust, e.g. during the Khamsin period.

5. Sulphur dioxide (SO2)

Sulphur dioxide, or SO_2, belongs to the family of sulphur oxide gases (SO_x). These gases dissolve easily in water. Sulphur is prevalent in all raw materials, including crude oil, coal, and ore that contains common metals like aluminium, copper, zinc, lead, and iron. SOx gases are formed when fuel-containing sulphur, such as coal and oil, is burned, and when gasoline is extracted from oil, or metals is extracted from ore. SO_2 dissolves in water vapor to form acid, and interacts with other gases and particles in the air to form sulphates and other products that can be harmful to people and their environment.

The SO_2 concentrations measure at a variety of sites in Egypt occasionally exceed the AQL values as given by Law no. 4. SO_2 is, however, not an air pollution problem of the same magnitude in Egypt as suspended particles. The limit values are most often exceeded in or near industrial areas and in some few cases inside urban areas as in the Cairo city center. As an example the exceedances of the 24-hour average concentrations are presented for 5 sites in Figure5.

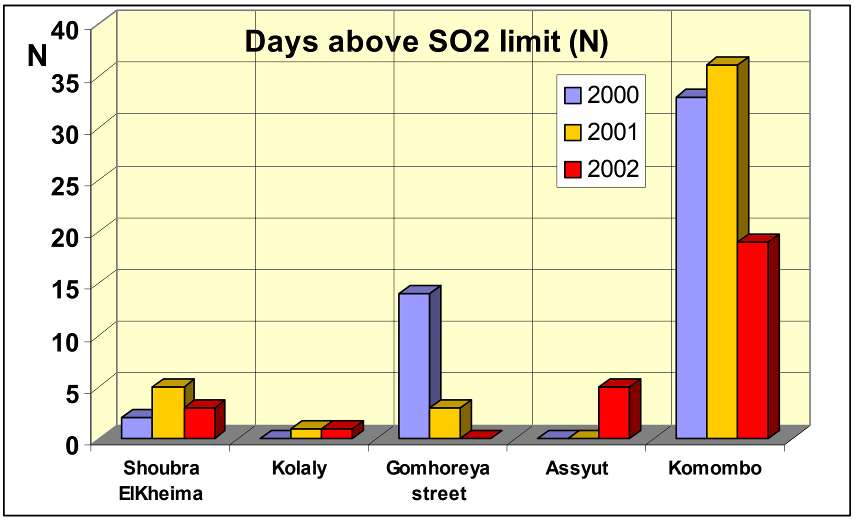


Figure 5: The number of days when the AQL values for SO_2 (24-h average) have been exceeded in 2000, 2001 and 2002 at 5 selected sites in Egypt.

Industrial areas like Shoubra ElKheima (several industries) and Kom Ombo (where the measurements are taken only 1 km downwind from a sugar factory) have revealed frequent exceeding of the limit values, while the urban stations inside Cairo only occasionally have exceeded the limit values. Also in Kafr Zayat and in the southern Tabbin area we have recorded the SO_2 concentrations to exceed the limit values.

The short-term concentrations given by the one-hour average concentrations are normally exceeded during less than 1 % of the time inside Cairo.
Annual average concentrations have been estimated from different type of measurements, and concentrations above AQL have been found in many areas and at several measurement sites.
Long-term average concentrations estimated from passive sampling of SO_2 are presented in Figure 6.

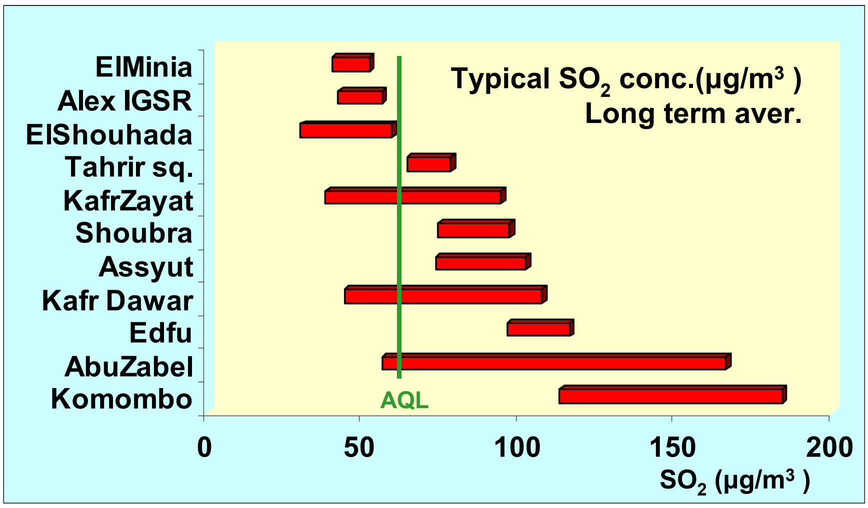


Figure 6: Typical ranges of long-term average (annual) concentrations of SO_2 measured by passive samplers at 11 selected sites in Egypt.

Again we see that sites impacted by industrial emissions are exposed to the highest concentrations of SO_2. Even at Tahrir Square, in the city centre of Cairo, the SO_2 level was slightly higher than the limit values.

6. Carbon Monoxide (CO)

CO is a component of motor vehicle exhaust. High levels of CO generally occur in areas with heavy traffic congestion. In cities, 85 to 95 percent of all CO emissions may come from motor vehicle exhaust. Other sources of CO emissions include industrial processes (such as metals processing and chemical manufacturing), residential waste and wood burning, and some natural sources such as forest fires.

Inside the city centre of Cairo traffic jam often occur and the typical daily average concentrations of CO thus will exceed the Air Quality Limit values.
Figure 6 indicates the frequency of exceedance of the 8-hour average concentration of 10 mg/m3

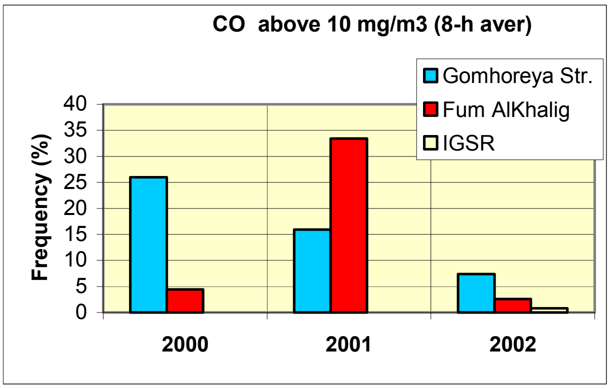


Figure 6: The occurrence of 8-hour average CO concentrations above the AQ limit value of 10 mg/m3 measured at one street canyon and two roadside stations.

In the streets of Cairo, such as around the old opera square (Gomhoreya street) and at some of the streets with high traffic density such as FumAlKhalig the daily 8-hour average CO concentration was exceeded in 5 to 33 % of the time.

The one-hour average limit value of 30 mg/m3 was rarely exceeded. This happened only during a few hours each year in the Gomhoreya street canyon.

7. Nitrogen dioxide (NO2)

Nitrogen oxides, or NOx, are the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colourless and odourless. However, one common pollutant, nitrogen dioxide (NO_2) along with particles in the air can often be seen as a reddish-brown layer over the urban area.

Nitrogen oxides form when fuel is burned at high temperatures, as in a combustion process. The primary sources of NOx are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.

NO_2 is being measured by the EIMP programme at 22 sites in Egypt. Annual average concentrations ranged in 2002 between 25 and 83 $\mu g/m^3$. In the streets of Cairo the average concentrations were between 75 and 83 $\mu g/m^3$.

The one-hour average limit value of 400 $\mu g/m^3$ was not exceeded in 2002. However, the 24-hour average limit value of 150 $\mu g/m^3$ was exceeded during one to five days in the streets of Cairo. Passive sampling data indicate that there may be other areas with high traffic density where the limit values occasionally were exceeded.

8. Ozone, (O3)

Measurement data indicate that ground level ozone together with small particles is one of the major air pollution problems of Egypt. We therefore have to understand the formation and occurrence of ozone.

Ozone (O_3) at the surface is most often created by a chemical reaction between oxides of nitrogen and volatile organic compounds (VOC) in the presence of heat and sunlight.

VOC + NOx + Heat + Sunlight → Ozone

Ozone has the same chemical structure whether it occurs miles above the earth or at ground level and can be "good" or "bad," depending on its location in the atmosphere. In the earth's lower atmosphere, ground-level ozone is considered "bad." Motor vehicle exhaust and industrial emissions, gasoline vapours, and chemical solvents are some of the major sources of NO_x and VOC, which help to form ozone. Sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air.

In the greater Cairo area the transport time during hot summer days is long enough so that large amounts of harmful ozone is being created in the area. Afternoon maximum concentrations as recorded at Giza (Cairo University) and at a roof station at Abbaseya are typical examples of this kind of regional formation of ozone. Both these sites represent the kilometre scale urban areas away from local sources.

Figure 7 illustrates the annual average diurnal variation of ozone at 4 selected sites in Egypt.

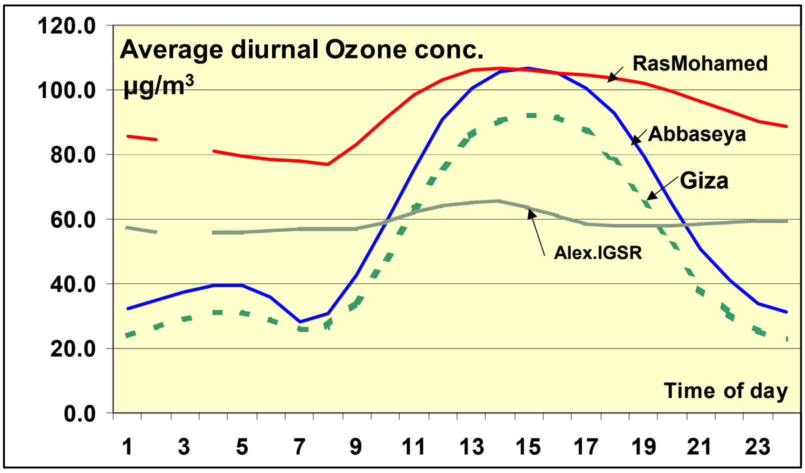


Figure 7: Annual average diurnal variation of ozone measured at 4 sites in Egypt 2000-2002.

The regional background measurements undertaken at Ras Mohamed at the southern tip of Sinai indicate that the background ozone level is on the average higher than the levels measured in Cairo and Alexandria. However at daytime during summer conditions the concentration levels that are reached in the greater Cairo area are higher than the maximum background concentrations. In the morning rush hours we see that the NOx emissions from cars are reducing the ozone by using ozone to form NO_2. The ozone concentrations therefore reach a minimum at about 08:30 in the morning.

Ozone may also be formed at far distances (tens to hundreds of kilometres) downwind from large cities like Cairo and Alexandria. From Cairo high concentrations may be found in the Nile valley south of the city. From Alexandria the maximum concentration may be found in the Delta.

At the measurement site itself in Alexandria we see from Figure 7 that the ozone levels are influenced by NOx emissions from traffic in the city. The "fresh" NOx emissions are "using" ozone. The concentrations are therefore relatively low as the site clearly is located inside the urban boundary layer.

The one-hour average concentrations rarely exceeded the Air Quality Limit value of 200 µg/m^3. These concentrations were exceeded during less than 1 % of the time.

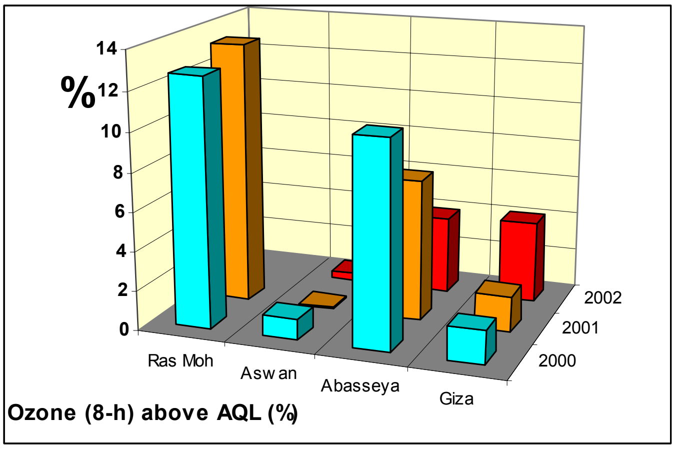


Figure 8: The frequency (%) of 8-hour average ozone concentrations exceeding the AQL of 120 µg/m³.

The 8-hour average limit value (120 µg/m^3) however, was exceeded more frequently, as the relatively high ozone concentrations during the summer season seem to last for several hours.

At Ras Mohamed the 8-hour average concentration was exceeded during 13,4 % of the time in 2001, at Abbaseya 10,5 % of the time in 2000 and at Giza and Aswan up to about 4 % of the time. During the summer season exceedances are found more frequently.

9. Summary and conclusions

Suspended dust (measured as PM_{10} and TSP) is the major air pollution problem in Egypt. Annual average concentrations of PM_{10} range between 100 and 200 µg/m^3 in urban and residential areas and between 200 and 500 µg/m^3 near industrial areas. Daily average concentrations of more than 6 times the Air Quality Limit value for Egypt are being recorded occasionally (2 to 3 % of the time) in the urban areas of Cairo. The natural background concentration of PM_{10} in Egypt has been evaluated to represent levels close to or around the Air Quality Limit value of 70 µg/m^3 as a daily average.

The concentration levels of SO_2 have also been observed to exceed the Air Quality Limit values in industrial areas and during some occasions in the big cities. Both the long term (annual averages) and the short-term (1-hour average) Air Quality Limit levels have been exceeded.

Eight-hour average CO concentrations in streets and along roads in Cairo frequently exceeded the Air Quality Limit value. In the streets of Cairo, with high traffic density, the 8-hour average CO concentration, especially during daytime hours, was exceeded in 5 to 33 % of the time.

High concentrations of surface ozone have been observed as a result of regionally produced secondary pollutants in the Cairo region. Also the background measurements of tropospheric ozone at Ras Mohamed, at the southern tip of Sinai, show high concentrations especially in the summer season. On an annual basis the 8-hour average limit value (120 µg/m^3) was exceeded in the urban area of Cairo; at Abbaseya 10,5 % of the time in 2000 and at Giza about 4 % of the time.

NO_2 is not a big problem in Egypt based on a rather high air quality limit value of 400 µg/m^3 as a one-hour average limit value. The 24-hour average limit value of 150 µg/m^3 , however, was exceeded during one to five days in the streets of Cairo.

10. References

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REPORT SERIES SCIENTIFIC REPORT	REPORT NO. OR 79/2003	ISBN 82-425-1515-8 ISSN 0807-7207	
DATE	SIGN.	NO. OF PAGES 89	PRICE NOK 150,-
TITLE EIMP Phasing-out Phase, 2003-2004 End of Mission Report, Air Quality Monitoring, Mission 03, October 2003		PROJECT LEADER Bjarne Sivertsen	
		NILU PROJECT NO. O-96013	
AUTHOR(S) Bjarne Sivertsen and Rolf Dreiem		CLASSIFICATION * A	
		CONTRACT REF.	

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ABSTRACT
The EIMP Phasing-out Phase has been formulated to consolidate EIMP achievements, while gradually integrating the EIMP activities and staff into the existing EEAA administrative and organisational structure. The third Mission during the EIMP Phasing out Phase Air Quality component was undertaken during 4 October to 29 October 2003. Bjarne Sivertsen and Rolf Dreiem participated in the Mission. Continued training in reporting and air quality assessment were important parts of the Mission. New sites were visited to update and improve the national monitoring programme.

Site visits were also undertaken to check the quality of measurements, maintenance and repair. The quality assurance programme was modified to start calibrating using travelling standards at the stations. Several meetings were held during the Mission, and various type of support was given to EEAA to upgrade and improve the air quality monitoing network.

NORWEGIAN TITLE
Overvåkingsprogram for luftkvalitet i Egypt

KEYWORDS		
Air Quality	Monitoring	Training

ABSTRACT (in Norwegian)

** Classification*	*A*	*Unclassified (can be ordered from NILU)*
	B	*Restricted distribution*
	C	*Classified (not to be distributed)*