Air Quality Management Project in co-operation between Thailand and Sweden

Final Report

A co-operation between

PCD
Pollution Control Department,
Ministry of Science, Technology and Environment,
Bangkok, Thailand

CAVG
County Administration of Västra Götaland, Sweden
(former Provincial Government of Göteborg and Bohus, PGGB)

on a project for

the Enhancement of the Air Quality Management Project to Four Regional Nodes in addition to the Continued Support for Central PCD and the Support to Establish an Air Quality Laboratory at the PCD

CONEXOR

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1 EXECUTIVE SUMMARY

The co-operation in the area of Air Quality Management between Thailand and Sweden has been going on for almost a decade. The Thai counterpart has been the Pollution Control Department (PCD) and the Swedish counterpart has been the County Administration of Västra Götaland (CAVG), previous Provincial Government of Göteborg and Bohus (PPGB).

The co-operation has focused on Air Quality Management (AQM) within the areas of

- ambient air quality monitoring, analysing and reporting;
- emission database development and emission data analyses;
- dispersion modelling ("what-if" scenarios);
- laboratory techniques; and
- quality assurance - quality control (QA/QC) in the areas mentioned.

In addition, the dissemination of AQM information via an Internet based function has also been closely interlinked, however under a commercial contract.

The current phase started in January 1997. The time schedule was somewhat delayed due to the financial crisis in the Southeast Asian region. Some re-allocation of the available budgets was also needed due to the financial problems.

The PCD Air Quality and Noise Management Division is today utilising the Swedish assisted hardware, software, and knowledge and experience transfer in the daily routine work. This work includes the analysing and reporting of ambient air quality data from one of the largest monitoring networks in the world. The emission database is used for follow-up reports and studies regarding the various types of emissions. The dispersion modelling is used to simulate the effects of different actions taken.

The main focus has been on the ambient air quality monitoring, analysing, and reporting. In order to further structure and facilitate the PCD routine work in this area, the project undertook to develop a "Handbook on the Quality Assurance Project Plan for the Ambient Air Monitoring Project". The Handbook was produced in co-operation with an external (Thai) expert at the State of Louisiana.

In general, the Swedish assisted Air Quality Management Project has proven to be successful seen over the decade of implementation. The PCD, and even the Ministry of Science, Technology and Environment (MoSTE), very often use the Swedish assisted Air Quality Management Project as a very good reference of a successful foreign-assisted project. The Asian Development Bank (ADB) has also pays a lot of attention to the Project, and some of the principles are now being used for other ADB-financed projects in the Air Quality Management sector.

The Project is also sustainable in the sense that the equipment and working methods introduced along the way are the tools used in the daily, routine work at the PCD.

2 AIR QUALITY MANAGEMENT IN THAILAND

Air Quality Management (AQM) in Thailand has been a hot issue for many years. A decade ago, the general impression of Bangkok and some other big cities and industrialised areas was that the air quality was very bad.

The Thai Government and Parliament have passed several laws over the last years where the Enhancement and Conservation of National Environmental Quality Act (1992) is the main one. The National Environmental Board (NEB), in which the Prime Minister is the chairman, is working as a kind of "sub-cabinet" where all important environmental issues are not only brought up and discussed, but also decisions are made such as establishment of plans and the setting of standards for environmental quality and emissions. The NEB is widely represented within the Ministries, as a rule at minister level.

The increasing interest from the media, the academia, decision-makers, and the general public for AQM issues has been on the rise for many years. HM The King of Thailand dedicated his annual speech to environmental protection issues some years ago. Unfortunately, the economic crises that hit Thailand in 1997 resulted in somewhat reduced possibilities to implement and enforce very costly actions to reduce air pollution problems.

However, seen over a decade, the Air Quality Management activities have been crowned with success in many areas. The PCD today operates one of the largest ambient air quality networks in the world. The ambient air quality in Bangkok is improving despite the fact that the traffic is increasing. The emissions from traffic are being reduced for certain compounds owing to the introduction of compulsory catalytic converters for new cars and unleaded petrol five years ago. The introduction of various (emission) standards (such as EURO I and II for heavy vehicles) has also contributed to the improving ambient air quality in the country. Other activities that have been addressing the air pollution problems are, among others, the introduction of "curtains" to prevent large amount of dust to be emitted from construction sites, and the introduction of gas-fuelled buses and 4-stroke motorbikes.

Naturally, there are also geographical as well as emission type areas that have not improved so well. The industrial and economic expansion in Thailand is naturally coming into conflict with the interests to reduce emissions - just as in all developing countries.

The ambient air quality work at the PCD consists of activities from supporting the framework of rules and regulations as "consultants", over operating the large monitoring network including reporting to emission inventories and studies. In addition, the PCD staff is often engaged as experts in various matters regarding AQM.

The Swedish assisted Air Quality Management Project has provided support to the PCD in different areas related to ambient air quality, its monitoring, analyzing, and reporting. This also includes work related to emission databases and dispersion modelling ("what-if" scenarios).

The ambient air quality data is gathered from the nationwide monitoring network. The data is received at the central PCD in Bangkok, and also at four regional nodes. The data is analysed in different ways. Daily reports are produced as well as regular reports (monthly, annually). When specific problems occur, such as dramatically increased levels of particular matters (TSP, PM10 etc.) from large forest fires in the region, the stress on the PCD to report on the level of air pollution naturally increases.

The work also includes emission database studies where the emission information from different kinds of sources (stationary = industries, area = harbours and domestic sources, line = traffic) is gathered and analysed. Trends and "what-if" scenarios for the emissions as such can be calculated and reported.

The emission data also serves as input to dispersion modelling. The dispersion modelling can, in turn, give answers to questions like:
"What will the effect on ambient air quality be if a certain industry is emitting more/less, and if another 20% of the 2-stroke motorbikes will be replaced with 4-stroke, and if a road is constructed/rerouted, and if…?"

The data and reports are serving as a basis for decisions on different levels and for various issues. As one practical example, the emission database combined with the dispersion modelling was used for a comprehensive study what effects different traffic regulations and flow changes combined with different engine and exhaust gas cleaning methods would have on the Bangkok ambient air quality. The results were used as an important, but naturally not the single governing, input to the final decisions.

The PCD is today using the computer system, knowledge transferred, and comprehensive training provided from the Swedish assisted Air Quality Management Project in the daily, routine work. It is not to exaggerate to say that part of the PCD Air Quality Management work, in particular air quality monitoring and data analysis, is based on the output from the Thai - Swedish co-operation.

This means that the Air Quality Management Project can be called "sustainable" in its literal sense.

This Final Report describes the work and accomplishments during the Project from January 1997 until January 2001.

3 FORMALITIES

3.1 Background

The co-operation between the Pollution Control Department (PCD), in Thailand and the County Administration of Västra Götaland (CAVG)[1], in Sweden in the area of Air Quality Management has been going on for about a decade. The co-operation has been divided into several phases, which have been reported earlier.

From the beginning, the main objective has been to enable the PCD to effectively carry out its task in the area of Air Quality Management. One of the main tasks has been, and still is, to provide accurate and easy-to-understand information to decision-makers, the media, the layman, other public entities etc., regarding Ambient Air Data. This, in turn, would allow for optimised decisions and effective information to abate the Air Quality problems in Thailand.

In the initial phases of the co-operation, the main focus was on supporting central PCD in Bangkok. In the latter phases, and in particularly the current one, the ambition has also been to extend the knowledge and skills to the regional offices. This, in turn, would allow a more decentralised decision-making and information process, and at the same time reduce some of the workload from central PCD.

This Final Report deals only with the current, last phase.

3.2 Agreements, financing and time schedules

The current phase formally started 27 January 1997 (B.E. 2540) when the Agreement was signed. The initial time schedule was around 30 months.

In parallel to the PCD – CAVG Agreement, the PCD hired with the Thai Government budget an external consultant, Conexor Sensus AB (Conexor). The main content of that Agreement was that Conexor should develop an Internet based Air Quality and Noise Information System (AQNIS) and to cover the local Thai costs incurred in the PCD – CAVG Agreement. The initial duration for the PCD – Conexor Agreement was 24 months from 27 January 1997.

The normal Sida principles regarding the financing of local costs were initially followed, i.e. the local part should cover all costs incurred on the Thai side such as hotel costs for Swedish experts, external local consultants etc. These costs were to be covered via the PCD – Conexor Agreement.

Due to the financial problems in Southeast Asia that started during the summer of 1997 and the weakening of Thai bath, there was a need to re-allocate some of the costs that were to be shouldered by the PCD to be shouldered by Sida in order to keep up the pace and general high ambition level in the Project. Sida made a decision that diverted from the normal policies, which allowed for some of the local Thai costs to be covered by Sida. No additional budgets from Sida were required.

[1] Former Provincial Government of Göteborg and Bohus (PGGB).

Based on this Sida decision and to formally clarify the changes in the Project, the original Agreement was formally amended 28 May 1999 (B.E. 2542). The practical work along the new principles had already started on beforehand.

The time schedule was along extended up to 31January 2001.

3.3 Partners

The following parties have mainly been involved in the Project:

Organisation	Role
County Administration of Västra Götaland.	Formal contractual partner. Project Management.
Pollution Control Department. Air Quality and Noise Management Division.	Formal contractual partner. Project accomplishing division within the PCD.
Conexor Sensus AB.	Running Project Management. Contractual partner for the PCD – Conexor Agreement. General Air Quality Management training.
Swedish Meteorological and Hydrological Institute.	Application software (Airviro System) support. Training in emission database and dispersion modelling.
Manrax AB.	Training in system application and Service & Maintenance.
IVL.	Training in Air Quality Management Laboratory techniques.
Miscellaneous organisations in Sweden.	Study visits by PCD staff.

4 ACCOMPLISHMENT OF THE PROJECT

4.1 Objectives

In the Agreement between the PCD and the CAVG, the following main objectives are listed:

1. To enable the PCD to produce the necessary basis for the future work within its Air Quality Management activities with self-support on the level provided up to now.
2. To enable the PCD to decentralise the work from Bangkok to the provinces.
3. To enable the PCD to continuously follow up and report the ambient air quality situation through the nation-wide network of monitoring stations.
4. To enable the PCD to make more advanced analysis of certain pollution compounds not possible to monitor in the automatic ambient air quality monitoring network via the support for the establishment of an Air Quality Laboratory including Quality Assurance / Quality Control functions.
5. To enable the PCD to drastically improve the possibilities to distribute different kinds of Air Quality Management information via the Internet Based Information System. (This activity is formally handled under the PCD-Conexor Agreement according to paragraph 3.2, but forms an integrated part of the overall Project).
6. To enable colleagues in the ASEAN region to benefit from the experience and knowledge gathered so far by the PCD via a Workshop on ”Air Quality Management development in ASEAN”. (This activity is formally handled under the PCD-Conexor Agreement according to paragraph 3.2, but is part of the overall Project).

4.2 Target groups

The main targets groups have been the working level staff at the PCD Air Quality and Noise Management Division and at the regional offices. Naturally, the related PCD management has also been included, but the focus has been to make the daily routine work more effective.

The PCD has also initiated co-operation with other players in the Air Quality Management field related to the Project. People from universities, Government implementing agencies, other Government research organisations, and private sector companies have been more or less involved in the different activities. This means that the Project practically has had a much wider target group than just the PCD staff.

The Thai Government has a policy to provide scholarships for ambitious and qualified young Government officers to study abroad. Since the staff at the PCD Air Quality and Noise Management Division often fulfils the requirements, the number of people that leave the Project to study abroad is rather high. This is naturally both positive and negative.

4.3 Summarised activities

The main work has been accomplished in the following areas:

a) The quality control and quality assurance process of air quality information from different monitoring instruments. Principles in the development of different data collection protocols that connects over a telemetric system and analysis of the cause of errors and disruptions etc. of the whole data collection chain.

b) The quality control and quality assurance process of meteorological information from different meteorological monitoring instruments. Service and maintenance principles of the monitoring hardware mounted on masts and error detection from datasets etc.
c) Analysis and presentation of historical air quality and meteorological data in the time series database with special emphasis on the analytical tools that is streamlined the effect of meteorological conditions on the air quality and the graphical presentation of this.
d) Preparation of meteorological data in the time series database for the air dispersion model preprocessor etc.
e) Principles and prerequisites of running the different air pollution dispersion models that are contained in the Airviro: Canyon model, Gaussian model and Grid model respectively. Introduction to the mesoscale MATCH model and large scale models used in different parts of the world, including Southeast Asia.
f) Inventory principles, questionnaire preparation and statistical approaches of emission database management. Emphasis on the importance of dynamic air emission information in order to increase the dispersion calculation capabilities to cover diurnal variations in air quality.
g) Quality control and quality assurance of collected emission information representing sources with different technologies and fuels. Special emphasis on QA/QC of major point sources and emission factors of mobile sources.
h) Handling of emission database information together with dispersion modelling tools in such a way that the PCD staff can predict long term scenarios of a geographical area
i) Feed the AQNIS web-application that from PCD continuously is presenting air quality information from the monitoring locations on the Internet to the Public

A more detailed report on the accomplishment and achievements in the areas defined as the main objectives for the Projects is found below.

4.4 Accomplishment and achievements

4.4.1 Enable the PCD to produce the necessary basis for the future work with self-support

This activity has been the overarching work in the Project since it involves the training in various aspects of Air Quality Management.

The training has been focusing on the PCD staff at the Monitoring Subdivision and the Air Quality Subdivision. The System Manager function has also been prioritised.

The practical training has mostly been based on the “on-the-job guidance” principle. This means that the relevant PCD staff has been trained when the Swedish experts have been present at the PCD. Around 50 different visits have been accomplished, which means that each visit has been relatively short; around one week. Normally the Swedish expert has been alone at the PCD, but for some activities there has been a need to double the Swedish presence.

The PCD staff has been formally trained on the various topics for short periods, but most of the training has been directly related to the practical tasks the staff has had to carry out. The Swedish experts have been more like supervisors than formal teachers.

This way of training has proven to be very successful. There are many reasons for this, but the main one might be that a more personal relation has been established this way. This has meant that the PCD staff has felt comfortable to ask different questions that the staff was originally reluctant to.

The training at the regional offices has, for practical reasons, been accomplished in larger groups.

One problem during the training has been that the PCD staff quite often has been urgently assigned to other tasks. This has meant that the training had to be rescheduled to suit the new time schedule, which in turn might have conflicted with other planned activities for the parties involved.

In general, the PCD staff is now capable of handling the daily routine work assigned. When it comes to new tasks, the necessary guidance to bring the staff to accomplish the work must be provided.

Recommendations

The Swedish experts would like to recommend that certain number of the PCD staff will get more dedicated tasks in order to be able to specialise in certain areas without being pulled into a large number of other activities. This would enable the staff to really penetrate certain areas, which in turn probably would reduce the need for some urgent actions since the urgently needed work would already have been done.

The development of the skills and knowledge of the staff at the regional nodes would probably have the same positive effect, since the staff at central PCD would not need to support the regional nodes to the same extent in the long run.

The problem is naturally that the number of long-term as well as acute tasks - and the necessary staff to attend to it - is well beyond the size of the PCD staff.

4.4.2 Enable the PCD to decentralise the work from Bangkok to the provinces

The transfer of the computer equipment to handle the Air Quality Management work at the four regional nodes was accomplished well before the expected Y2K problems related to the turn of the century. In connections with the transfer and installation, the Swedish experts trained the regional staff in

- basic computer system handling like data collection, modem functions, back up, etc;
- basic Air Quality Management; and
- basic ambient air quality analyses and reporting.

The outcome of the training has been rather scattered. The background formal competence, skills, and practical experience have varied a lot with the different nodes and within the groups trained.

Due to some lack of staff at the regional nodes, the decentralisation could have been even higher. The technical functions are, however, available and the staff at the regional offices has been trained as well locally as at central PCD to be able to handle the routine work. This means that the activity has paved the way for a future, more active, decentralisation of the Air Quality Management tasks to the regional nodes.

4.4.3 Enable the PCD to continuously follow up and report the ambient air quality situation

The PCD is today operating one of the largest ambient air quality network in the world - more than 50 stations. Most of the stations are on-line to the central PCD and/or the regional nodes.

However, due to lack of budgets to fully service and maintain the monitoring equipment, some of the stations will provide data of somewhat lower quality. This has been properly addressed by the PCD, and the Swedish experts have been involved in discussions regarding prioritisation, service and maintenance aspects, etc regarding the future network.

All data that have had acceptable quality have been gathered by the Airviro System (provided as the backbone computer system in a previous phase of the Project). The data have been analysed in different ways and reported accordingly.

Since the amount of data is very high, it has been hard for the PCD to fully follow up the quality of the data. This is due to lack of staff suitable for this kind of task. This has, unfortunately, meant that some data from some stations have not been possible to use as intended.

From the Project's point of view, all efforts have been made to support the PCD in these tasks. This is also proven by the various reports issued utilising the Swedish assisted tools, skills and experience build-up.

However, the PCD seems to get increased budgets for service and maintenance over the coming years. This will hopefully mean that the network operated in the future can be properly maintained and the analyses and reporting can be of even higher quality.

4.4.4 Enable the PCD to establish an Air Quality Laboratory including Quality Assurance / Quality Control functions

The overall objective of the project was to find suitable solutions for achieving cost-effective laboratory operation, the needed quality of the analyses, and good working conditions.

Swedish experts from IVL have visited the PCD several times. The activities have mainly been focusing on

- the Air Quality Laboratory (AQL) design in relation to the existing plans.
- equipment needs, laboratory procedures and organisation and structure for a quality assurance/quality control (QA/QC) system
- the so-called Filter Pack technique, which was chosen as a pilot method for sampling and analysis.

PCD staff has visited IVL's different facilities in Sweden several times. The focus has been on

- the building up of a QA/QC system and quality manual structure as well as practical laboratory work. Furthermore, a visit to the Swedish National Testing and Research Institute was performed. (January 1999.)
- presenting an overview of the QA/QC system at the laboratory and examples of monitoring strategies and programmes including the activity of the EMEP network in Sweden. (December 1999.)
- training on preparation of sampling equipment, sampling, preparation before analysis, analysis evaluation and data treatment, with the QA/QC routines included in all steps. In addition, discussions and guidance in preparation of a QA/QC manual in general as well as a structure for description of methods to be implemented were held. (June 2000.)

For a more thorough description of this part of the Project, please refer to Appendix 3.

4.4.5 Enable the PCD to distribute different kinds of Air Quality Management information via the Internet based Information System

The Thai constitution outlines that the public has the right to know facts about the air they are breathing. One way of providing this information is via an Internet based Information System. Although, a small proportion of the Thai population has access to the Internet at present, but the Internet is certainly accessible by the media, decision-makers, schools and universities etc.

The development of the so-called AQNIS (Air Quality and Noise Information System) has been formally handled under the PCD-Conexor Agreement according to paragraph 3.2, but forms an integrated part of the overall Project. The AQNIS is today fully operational and receives data from the nationwide monitoring system, and via the Airviro System and the LAN (Local Area Network) installed at the PCD during the accomplishment of the Project, the data and reports are provided on the Internet.

The direct involvement of the Sida financed parts has been low due to the formal construction, but practically the overall Project has been heavily concentrating on providing high quality information of various kinds to the general public via the Internet.

The AQNIS can be found on
http://www.aqnis.pcd.go.th

4.4.6 Enable regional colleagues to participate in a Workshop on "Air Quality Management development in ASEAN"

The initially planned Workshop on "Air Quality Management development in ASEAN" had, unfortunately, to be indefinitely postponed due to the budget constraints resulted from financial problem in the region. The budget allocated for this part of the Project was re-allocated to other parts.

This activity has been formally handled under the PCD-Conexor Agreement according to paragraph 3.2, but is part of the overall Project.

4.5 Other Project activities

4.5.1 Computer hardware and software

The PCD has financed the enhancement and upgrade of the computer hardware (Airviro System), which is directly related to the Swedish assistance. The hardware (workstations) has enabled some Air Quality Management functions at the regional nodes. The central workstation at the PCD has been upgraded, while the previous computer is now used as a terminal on the Local Area Network.

Some problems have occurred regarding peripherals like tape back-up station, UPS, and harddisk enhancement. All problems have been reported and actions have been taken.

The Airviro System was upgraded to version 2.20 during 1999, well in advance of the expected Y2K problems. All software functions at central PCD were upgraded. The Airviro System installations at the four regional nodes were also upgraded regarding the data acquisition, handling and reporting functions (Indico Administration and Indico Presentation).

4.5.2 Service and maintenance

The service and maintenance of the Airviro System was initially a part of the PCD commitments. From middle of 1999, the service and maintenance have been paid by Sida under the Amended Agreement. Please also refer to paragraph 3.2.

The practical service and maintenance has been carried out in various ways:

- While Swedish experts have been visiting the PCD. The work has been subject to "on-the-job guidance" to optimise the spending of budgets.
- Via remote log-ins by Swedish experts on a regular basis.
- By support via telephone, fax, and e-mail when the PCD staff has experienced problems, which they were not able to fully handle themselves.

The Airviro System has been working without any significant periods of malfunctioning during the whole Project period, which gives good marks to the PCD System Manager as well as for the Service & Maintenance work.

Today, the system is working without problems. There are no urgent needs to upgrade the functionality of the system.

4.5.3 Study visits to Sweden

4.5.3.1 Air Quality Management parts

Three study visits have been accomplished during the Project. The first visit was mainly to plan the Project. The second was to visit a number of different organisations dealing with Air Quality Management issues from various points of views. The third visit mainly focused on the dispersion modelling knowledge and skills. The staff visiting Sweden has been a mix of management staff and working staff.

All study visits have been very well received. It is, however, difficult to immediately transfer knowledge and experience gained during a study visit to the PCD organisation and working schedules. Most probably, the study visits have allowed the PCD staff to get new views on the way things are done at their own office, which in turn will affect the future work.

Please also refer to Appendix 1.

4.5.3.2 Laboratory parts

In addition, there has been two study visits related to the Laboratory parts. Please refer to paragraph 4.4.4 and Appendix 1.

4.5.4 Seminars

Various seminars have been accomplished to distribute the experience and knowledge from the Thai - Swedish co-operation among other agencies dealing with Air Quality Management issues.

The main seminar was accomplished in November 1999. The presence from different other agencies was rather high, around 20 - 30 people.

4.5.5 Quality Assurance / Quality Control (QA/QC)

Parts of the re-allocated budget from Sida were used to hire a local Thai company to carry out dedicated QA/QC work directly related to the service and maintenance of the ambient air quality monitoring stations. The local company trained and supervised the PCD staff in QA/QC aspects of the work when visiting monitoring stations for routine as well as urgent maintenance. In addition, more formal classroom training was carried out.

The work was also integrated with the development of the Air Quality Management Handbook described in paragraph 4.5.6

4.5.6 Air Quality Management Handbook

There was a need to structure and formally substantiate the different regulations, routines, equipment etc related to the Air Quality Management work at the PCD. Parts of the re-allocated budget from SIDA were used to hire an external expert (Thai / American person working at the State of Louisiana) to support the development of an Air Quality Management Handbook.

The Handbook should cover formal as well as most hands-on parts of the routine work Air Quality Management at the PCD. It was produced in co-operation between all parties involved (the external expert, the PCD, the Swedish experts) and is now being released in its first version in Thai as well as in English. Provided sufficient resources are allocated to maintain and develop the Handbook, the Handbook will surely be most useful in the future, since it provides a firm foundation stone for new as well as well experienced staff in their daily work. A practical problem might be to keep the two versions (Thai and English) consistently updated.

5 LESSONS LEARNED – POSITIVE AND NEGATIVE

5.1 Training techniques

This issue has been discussed earlier in paragraph 4.4.1, but since it is probably the dominating single reason for the relative success of the Project, it is once more highlighted in a somewhat different way.

The training techniques used ("on-the-job" guidance") have proven to be very effective. Through the close contacts that this technique requires, even personal friendships have arisen. Since the Thai culture is very relation-oriented, this has proven to be most positive since the Thai staff has no longer been shy to ask questions they were previously reluctant to ask.

This technique is highly recommended for this type of projects. It naturally requires the same foreign staff all the time and the staff must be very observant on cultural differences.

5.2 The workload and development of the PCD staff

This issue has also been discussed earlier in paragraph 4.4.1, but since it is probably the dominating single issue in order to increase the effectiveness of the future Air Quality Management work at the PCD, it is once more highlighted in a somewhat different way.

The workload for the PCD staff is very high since the interest for Air Quality Management – and environmental protection issues in general – in Thailand is increasing. This has meant that the PCD staff sometimes has needed to carry out various urgent tasks, which in turn has meant that a planned training session for a group of people must be changed. The same training session has consequently been provided several times.

The PCD staff handling the different functions in the overall Air Quality Management work is naturally the most crucial link in order to maintain - and develop - a high-quality function. The skills and knowledge to day compared to a few years ago have dramatically increased. The PCD staff today is generally competent to handle its tasks. The heavy workload, however, impose some limits on the development speed of the functions related to the Air Quality Management Project reported here.

The Swedish experts would like to recommend that certain number of the PCD staff will get more dedicated tasks in order to be able to specialise in certain areas without being pulled into a large number of other activities. This would enable the staff to really penetrate certain areas, which in turn probably would reduce the need for some urgent actions since the urgently needed work would already have been done.

The development of the skills and knowledge of the staff at the regional nodes would probably have the same positive effect, since the staff at central PCD would not need to support the regional nodes to the same extent in the long run.

The problem is naturally that the number of long-term as well as acute tasks - and the necessary staff to attend to it - is well beyond the size of the PCD staff.

Regarding the medium to long term staffing of the PCD and a project of this kind, there is always the risk that the "brain drain" effect severely affects the staffing platform of a project. The risk increases with the duration of the project. In a long term project like this it is not even possible to safeguard this because people has to consider their career even if they are involved in long term project.

The Thai Government also runs a scholarship program for ambitious young staff. This program encourages the staff to study abroad for various degrees. The Thai Government provides a scholarship to cover most of the costs and expenses incurred during the studies, under the condition that the student will "pay back" via a number of years of Government services once he or she return to Thailand. Since the area of Air Quality Management attracts some ambitious and qualified people, the scholarship program is a source of "brain drain" from the project in a short term sense. In a long term sense, the students hopefully will return with even higher capacity to contribute to the development of the Air Quality Management work in Thailand.

5.3 Regional nodes resources lacking

The re-location of responsibilities and practical work to the regional nodes has proven to be hard to implement. There are various reasons for this, but one is probably the lack of practical resources for the specific Air Quality Management tasks in competition with numerous other tasks at the regional offices. Another reason is the negative impact the Southeast Asian financial crises, which meant that the intended resources to the establishment of the regional nodes suddenly were drastically reduced.

5.4 Combining different types of financing

The Air Quality Management Project has been built up from a combination of Sida financed parts mainly for training resources, the PCD contribution in terms of work and internal resources, and "commercial" projects like the Internet system, development of the Emission Database etc accomplished by contracted companies. In the latter case two Swedish companies, Conexor Sensus AB and SMHI, have been contracted to support the project via separate, but related, contracts.

Sometimes there are difficulties to "link" commercial projects to "aid" projects because of problems to separate the costs between the different projects. On the other hand, the contribution from and co-operation with the private sector is also very valuable since other aspects on Air Quality Management as well as project accomplishment have to be considered.

"High-tech projects" of this kind (at least in the environmental field) are very sensitive to the financial resources of the receptor country. This makes the risk of cost sharing regarding e.g. hardware obvious. During the accomplishment of this project, the re-allocation of some budget parts became necessary.

5.5 Good reference

In general, the Swedish assisted Air Quality Management Project has proven to be very successful seen over the decade of implementation. The PCD, and even the Ministry of Science, Technology and Environment, very often use the Swedish assisted Air Quality Management Project as reference of a successful foreign-assisted project.

The Project is also sustainable in the sense that the equipment and working methods introduced along the way are the tools used in the daily, routine work at the PCD.

The Asian Development Bank (ADB) has also paid a lot of attention to the Project, and some of the principles are now being used for other ADB-financed projects in the Air Quality Management sector.

6 BUDGETS

Income (project budget)	4 837 000 SEK
Costs	
Consultancy costs(IVL, SMHI, Conexor)	3 622 045
County Administration Management	813 916
Other costs, incl. PCD´s visits in Sweden	227 872
Remaining funds	**173 167**

7 APPENDIX 1: SUMMARY OF THE STUDY VISITS TO SWEDEN

7.1.1.1 Air Quality Management parts

Visitor(s):		Dr Supat Wangwongwatana Dr Oranut Paisarnuchapong Mr Sakda Jundejchanawong Ms Supara Sakthassana	
Proposed visiting site:		Norrköping, Falun and Stockholm, Sweden	
Proposed visiting time:		9 -- 15 March 1997 (2540)	
Status:	Accomplished	**Approved by:**	Dr Supat
		Approval date:	February 1997
Purpose of visit:			
Kick-off meeting for the new phase of the Project. 9 March: Pick-up at Arlanda airport. Visit to SMHI in Norrköping. 10 March: Continued information and training at SMHI. 11 March: Transportation to Falun. Agenda 21 information. Dinner hosted by Ms Ingalill Persson, Municipal Commissioner for Environmental Protection, City of Falun. 12 March: Planning for the Project. 13 March: Study visit to ESRI, Falun, for GIS application discussions. (Dr Supat had to leave for Milan, Italy.) 14 March: Transportation to Stockholm. Study visit to Stockholm Air Quality and Noise Analysis. 15 March: Return flight to Bangkok.			

Visitor(s):		Mr. Sarawut Thepanondh Mr. Vitsanu Wingpud Ms. Siwaporn Rungsiyanon Mr. Aunnop Rungraksathum	
Proposed visiting site:		Study visit to different organisations in Sweden according to separate program	
Proposed visiting time:		28 November -- 11 December 1999 (2542)	
Status:	Accomplished	**Approved by:**	Dr. Oranut
		Approval date:	19 November 1999
Purpose of visit:			
Study visit regarding QA/QC activities.			

Visitor(s):		Mr. Sakda Jandetchanawong Mr. Aunnop Rungraksathum Ms. Naparat Thongkode Ms. Suwimol Wattanawiroon	
Proposed visiting site:		SMHI, Norrköping, Sweden	
Proposed visiting time:		29 May -- 9 June 2000 (2543)	
Status:	Accomplished	**Approved by:**	Dr Oranut
		Approval date:	3 May 2000
Purpose of visit:			
Training in dispersion modelling. Training in System Manager functions related to dispersion modelling.			

7.1.1.2 Laboratory parts

Visitor(s):		Mr Sarawut Thepanondh Ms Siwaporn Pantong	
Proposed visiting site:		IVL, Göteborg and Stockholm, Sweden	
Proposed visiting time:		11 -- 15 January 1999 (2542)	
Status:	Accomplished	**Approved by:**	Dr Oranut
		Approval date:	4 December 1998
Purpose of visit:			
Visit to the IVL in Göteborg and Stockholm for training on QA/QC in Laboratory work.			

Visitor(s):		Ms. Siwaporn Phantong Ms Jintana Vararussami Mr. Nawarat Mitrjit	
Proposed visiting site:		IVL, Göteborg, Sweden	
Proposed visiting time:		1 -- 12 May 2000 (2543)	
Status:	Accomplished	**Approved by:**	Dr Supat
		Approval date:	18 April 2000
Purpose of visit:			
Visit to the IVL in Göteborg for training on QA/QC in Laboratory work.			

8 APPENDIX 2: STUDY PROJECT OF THE GRID MODEL FOR INNER BANGKOK AREA

As an example of the level of training and the achieved skills in the Project, the following report included. The report is produced as a from the PCD staff undergoing dispersion modelling training at SMHI in June 2000.

The Report also includes valuable information about the ambient air quality network, ambient air quality data and analyses, emission database results besides the dispersion modelling parts.

The training study project of

GRID MODEL For Inner Bangkok area

During December 1999

By

Sakda Jandetchanawong
Aunnop Rungraksatham
Naparut Thongkode
Suwimol Wattanawiroon
Air and Noise quality management division,
Pollution Control Department, Thailand

Co-operated with

SMHI

Training report
June 2000

1. Introduction

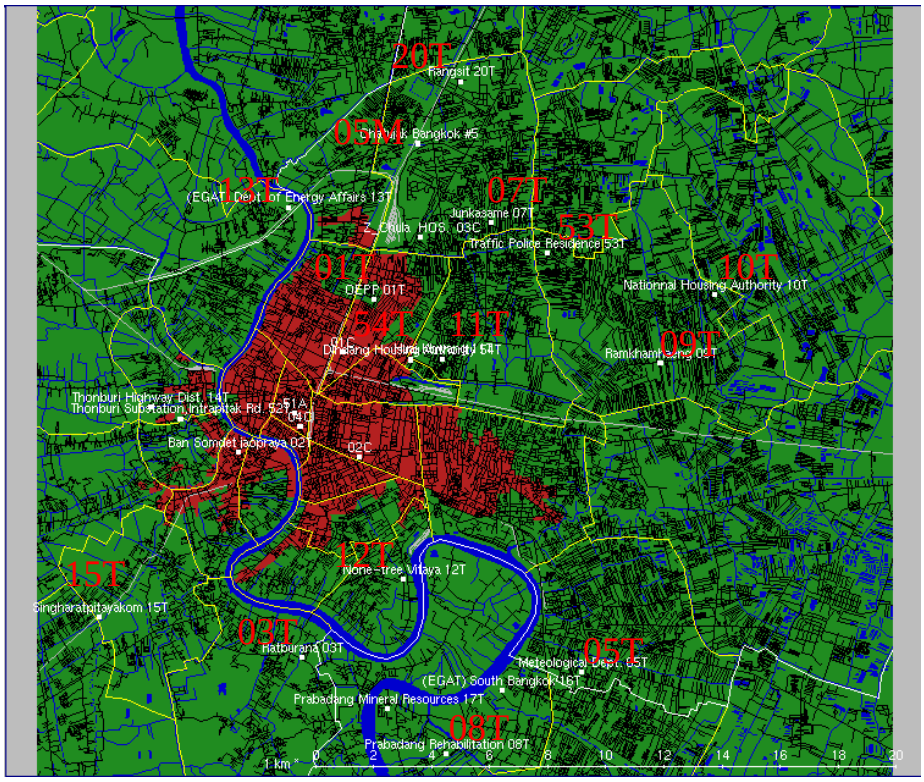
(which input data, which model period, monitor locations etc)

The area used in this study is the inner area of the bangkok, Thailand. Location of the city is in the middle of the country where is the flat terrain. The Bangkok inner area is the most crowded area in city containing a lot of line, point and area sources also the big buildings.

The input data for the model are :

- Emission database of CO for line sources, point sources and area sources which is 'aq_m2: testVKT'. The database has been updated in 1997-1998.
- Meteorological data from 6 stations which are Chatujuk05M, Huai Kwang11T, Junkasam07T, National Housing10T, Ramkhamhang09T and Ratburana03T.

The dispersion Grid Model has run for December 1999 period and compared to the air quality data for CO from 16 stations as indicated in the figure 1.



01T : OEPP
02T: Ban Somdet
03T: Ratburana
05M: Chatujuk
05T: Met Dept.
07T: Junkasem
08T: Prabadang
09T: Ramkhamhang
10T: National Hous.
11T: Huai Kwang
12T: Non-tree
13T: Egat-North
15T: Singharat
20T: Rangsit
53T: Traffic Pol
54T: Dindang

Figure 1 : The 16 monitoring stations used in comparing with the model results.

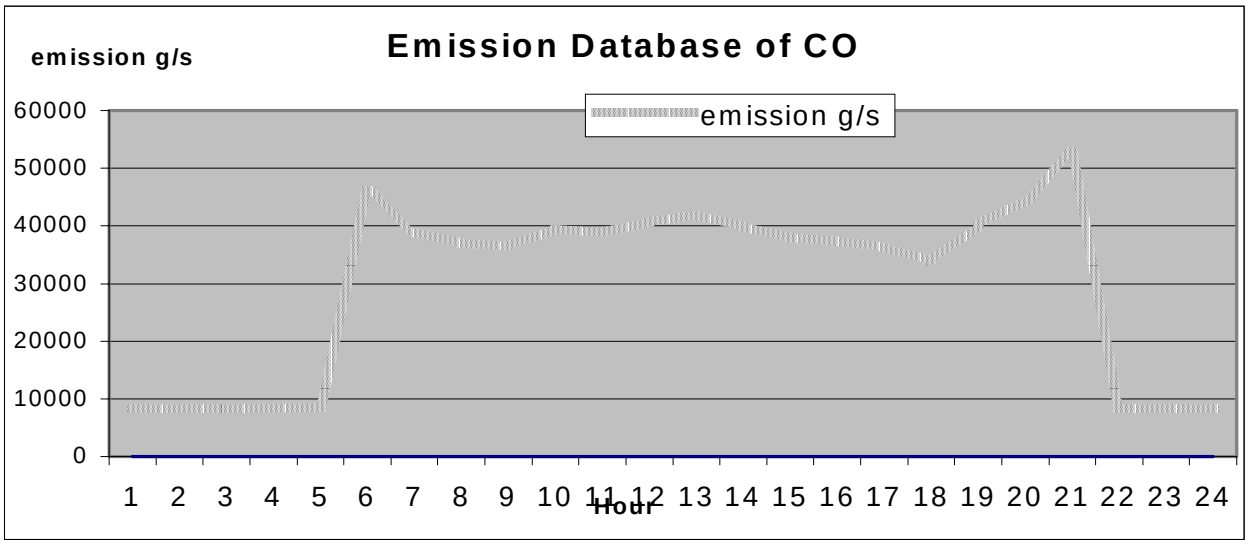
2. Emissions

(excel diagram showing hourly variation of CO emissions all map area, all sources).

The emission data is come from the emission database file collecting in 1997-1998 to updated the old database which was first created in 1995. The CO has the total amount of 930,687 ton /year or 29,492 grams/second. The hourly CO emission has the peak in the hour of 5-8 and 19-21. The difference in the emission is about 4 times of the emission more in the daytime compare to the nighttime. (see the figure 2). CO database then related to the traffic pattern in the rush hours of the Bangkok.

Confirmingly, high emission of the CO has the high level in the area of the line sources which is more than 30 (ton/year) / km^2 while other sources yield less than 3 (ton/year) / km^2 (see figure 3).

Figure 2: Emission database of CO shows hourly variation emission in grams /day



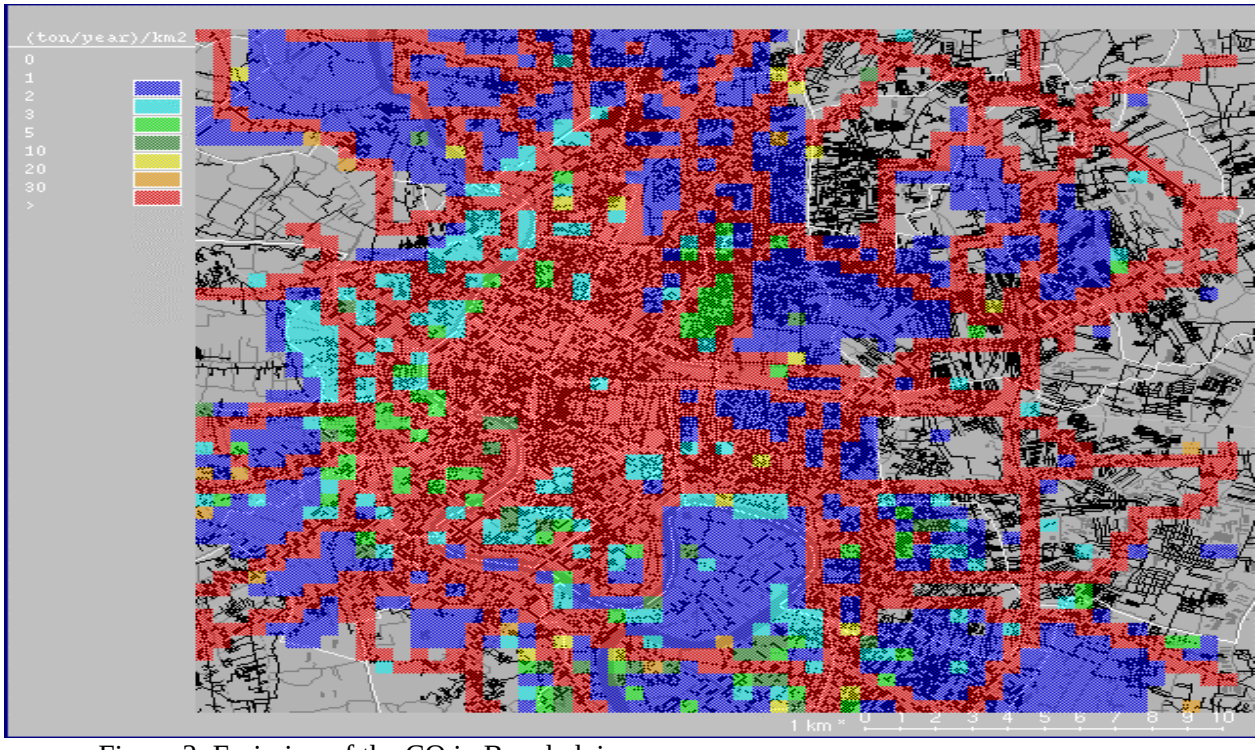


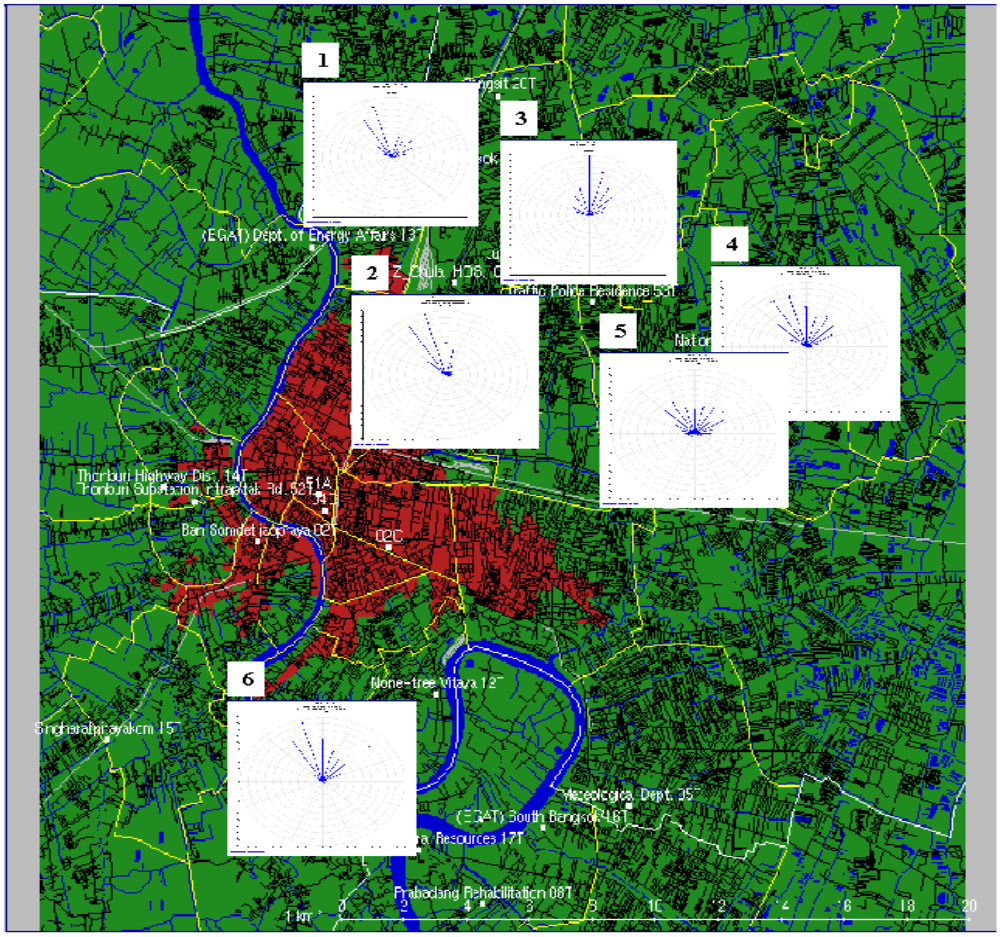
Figure 3: Emission of the CO in Bangkok inner area

3. Meteorological data

This is a Lars Gidhagen comment:
Please also include here
a) An EXCEL bar diagram showing mean wind velocity at the same stations that are presented in the "wind rose over map" figure. This can be put before the wind rose figure.
b) An Indico daily variation diagram showing the temperature and the vertical temperature gradient at 8 m and 20 m (normalize with the distance 8-2=6 m and 20-8=12 m, respectively). Use also Marks & Title (under Options) to mark the "0" line for the temperature gradient!

Meteorological data used in the model are from 6 stations which are Chatujuk05M, Ratburana03T, Junkasam07T, Ramkhamhang09T, National housing10T, Huai Kwang11T. Only one station which is Chatujuk05M has the meteorological tower at 10, 50 and 100 meters, also the different temperature. The others have the data measured at 10 meters and no different temperature data. Most of the stations are located in the north of the study area except for the National housing10T.

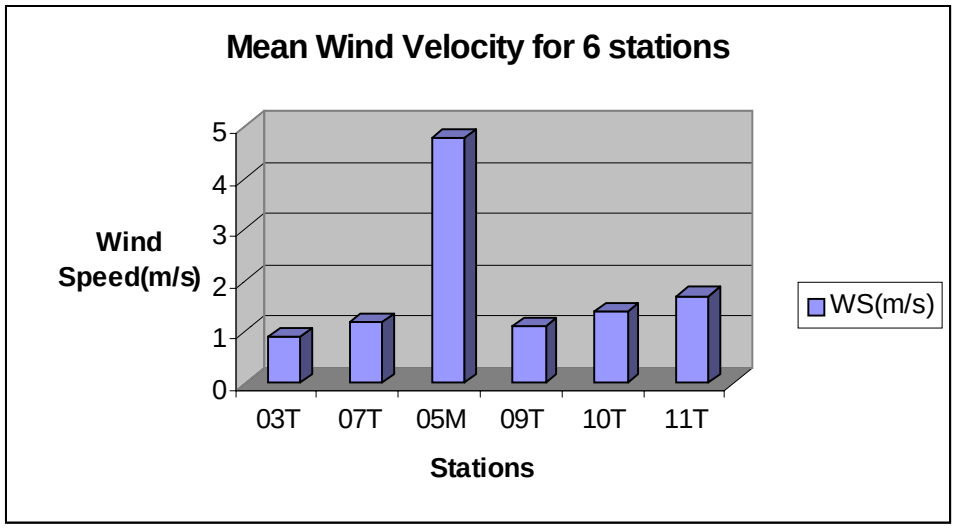
Wind direction of all stations shows the north wind contribution in the area (figure 4). Wind speed averaging is 1 meter/second which is not very high. At the 50meter wind speed of Chatujuk is 5 m/s which is higher than at 10 meter, usually and considered a medium wind. (See figure 5). The Monin-Obukov length scale (LMO) shows the stability condition which has the unstability (< 0) at the hour 7-17 daytime and stability (>0) during nighttime.



Station Name

1. Chatujuk 05M	**2. Huai kaung 11T**	**3. Junkasam 07T**
4. National H. 10T	**5. Ramkamhang 09T**	**6. Ratburana 03T**

Figure 4 : Wind direction at 6 stations for december 1999, Bangkok inner



Note: 05M is 50 meter measurement, the rest is 03 meter measurement

Figure 5 : Mean wind velocity at 6 stations for december 1999, Bangkok inner

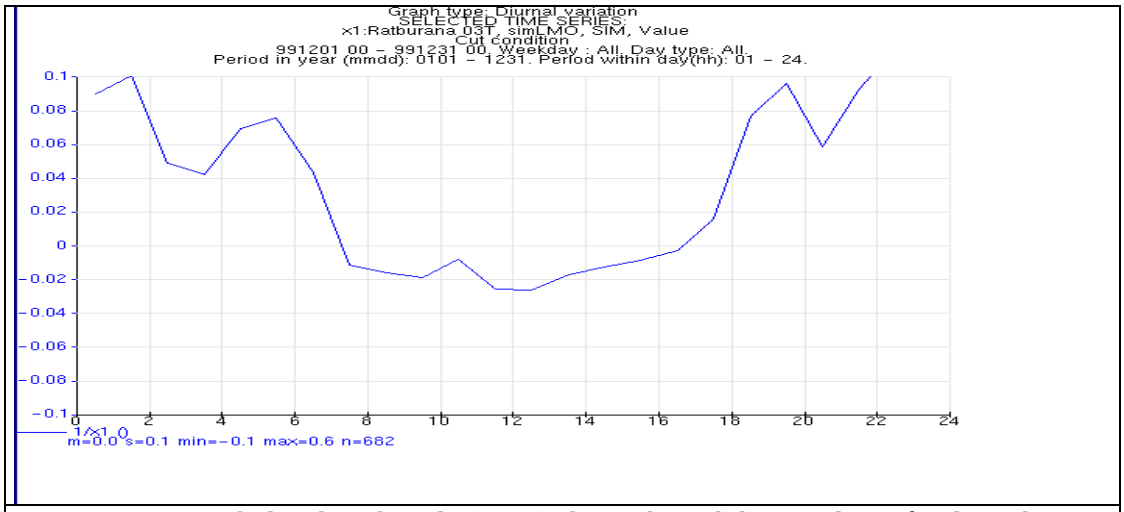
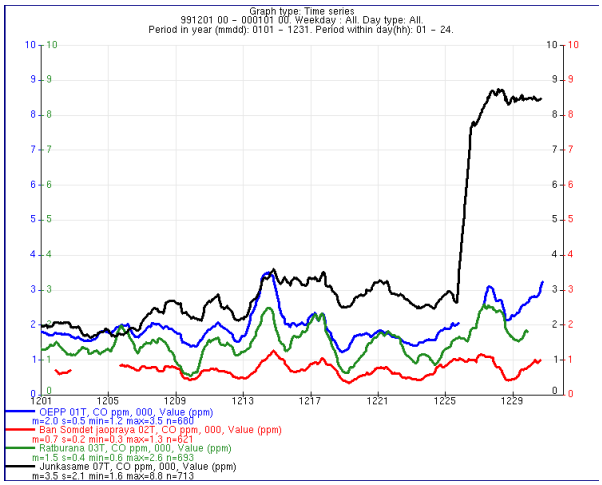


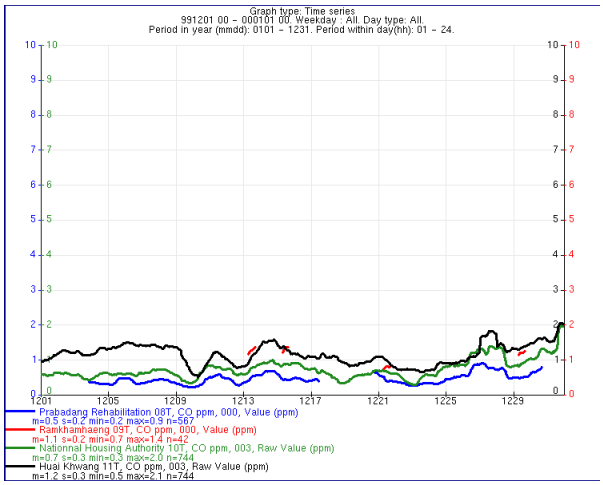
Figure 6: Monin-Obukov length scale (LMO) shows the stability condition for december 1999, Bangkok inner

4. Air quality data

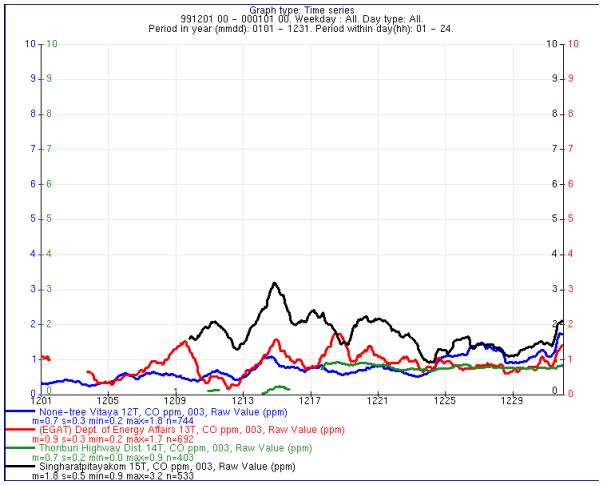
Air quality data from 16 stations have been evaluated . There are a lot of missing data for many stations. The CO concentrations are less than 10 ppm. Most of the stations shows concentration less than 3 ppm except Junkasam07T, Dindang54T and Singharat15T. Rangsit20T and Thonburi14T are well below 1 ppm which these two stations represent outer area of Bangkok and are quite the rural area. Junkasam07T has a high peak of CO which may caused by the error function of the equipment. Dindang54T station is located at the roadside, then yielding the high concentration and a slope trend for the higher concentration.



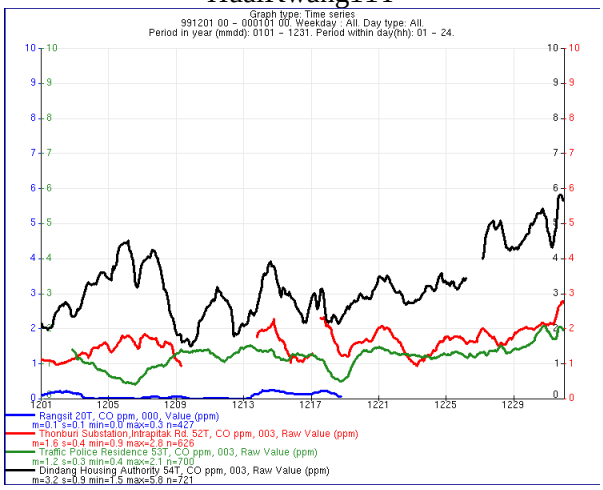
Air quality data from OEPP01T , BanSomdet02T, Ratburana03T, Junkasam07T



Air quality data from Prapadang08T, Ramkhamhang09T, National housing10T, HuaiKwang11T



Air quality data from Nontree12T , Egat13T, Thonburi14T, Singharat15T



Air quality data from Rangsit20T, Thonburi substation52T, Traffic53T, Dindang54T

Figure 7: Air quality data from 16 stations on december 1999, Bangkok inner

5. Comparison model and monitor data

Grid model has run for CO in december 1999. When comparing model output to the measured give the picture of much higher predicted concentrations over the measurements except at Junkasam07T and Thonburi substation.

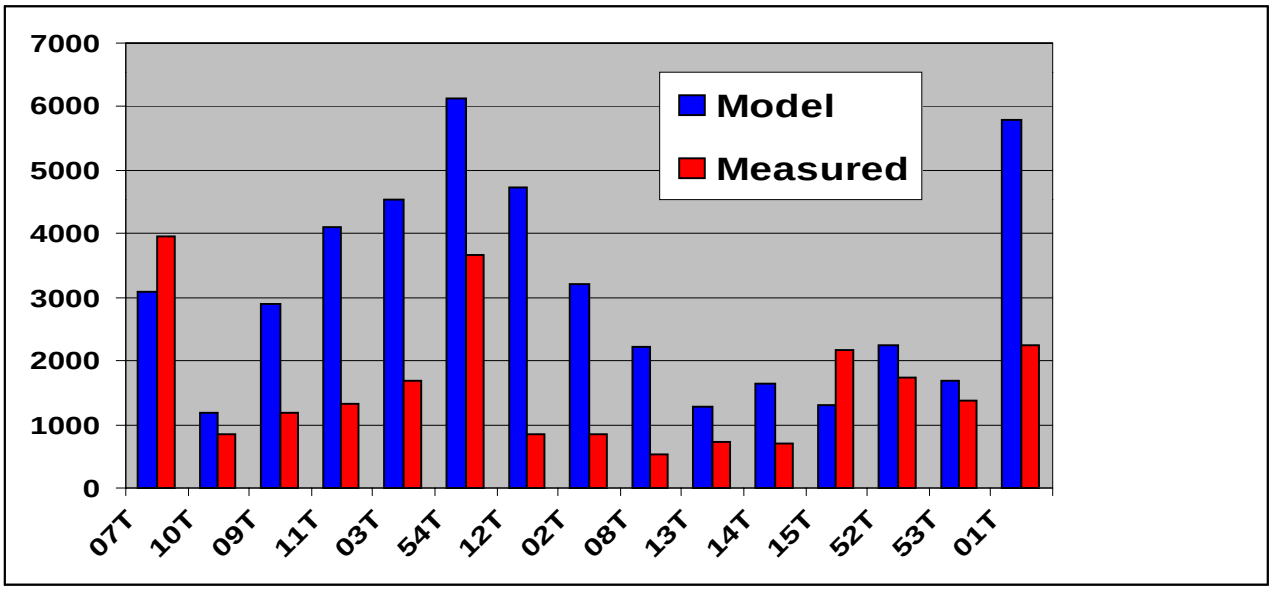
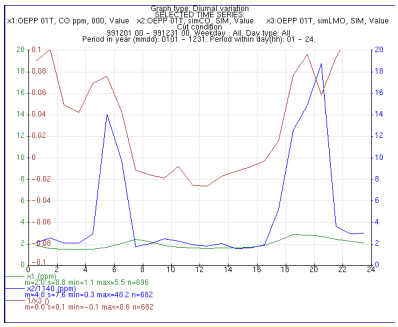
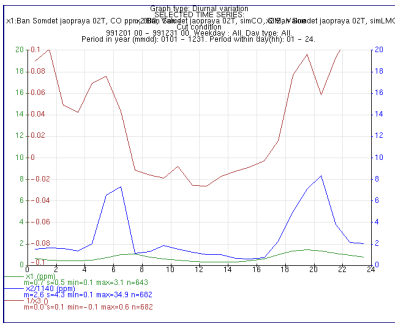


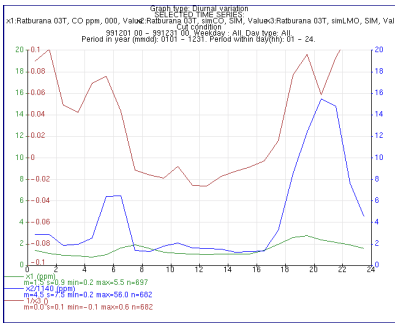
Figure 8 : Comparison of the grid model result to the measured data on december 1999, Bangkok inner



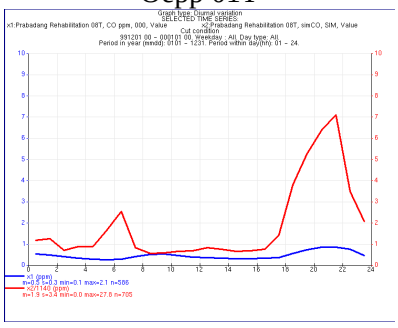
Oepp 01T



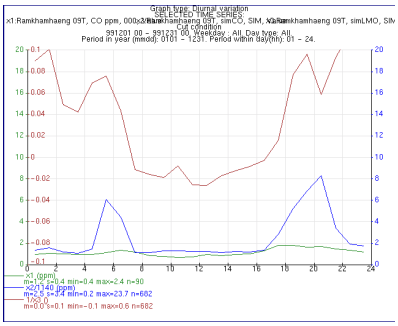
Ban somdet 02T



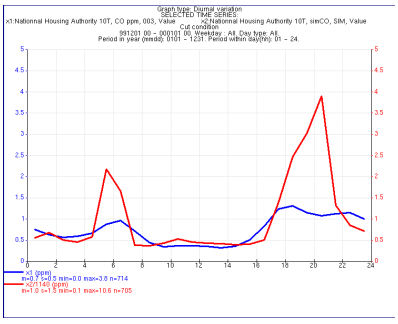
Ratburana 03T



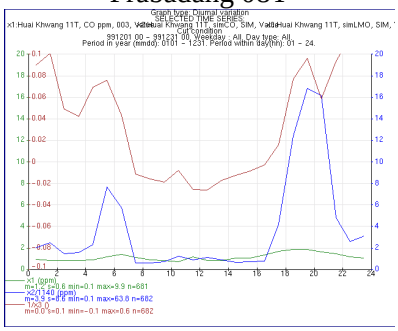
Prabadang 08T



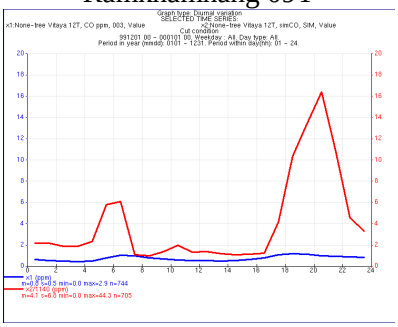
Ramkhamhang 09T



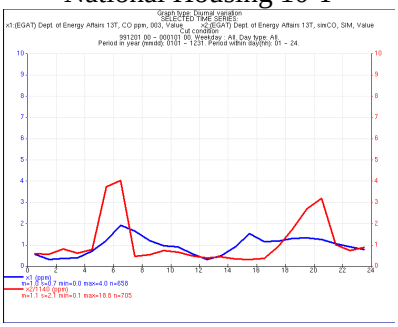
National Housing 10 T



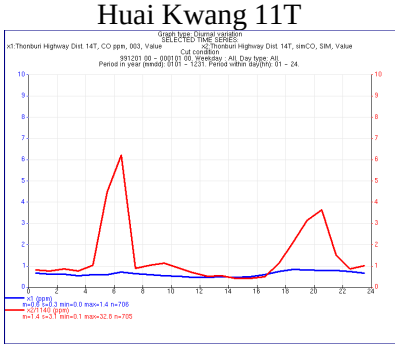
Huai Kwang 11T



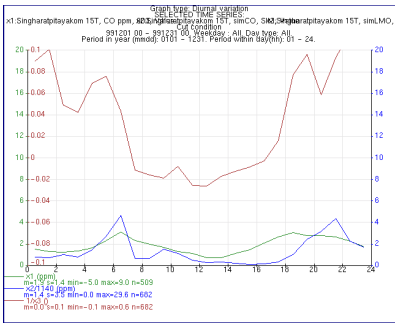
Non-tree 12T



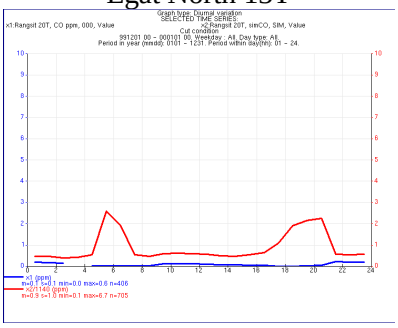
Egat North 13T



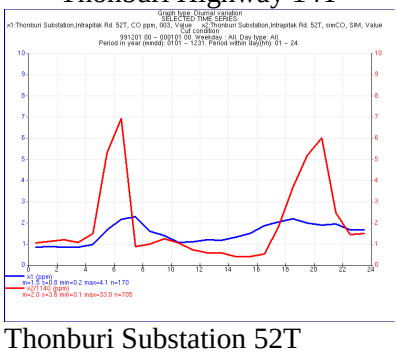
Thonburi Highway 14T



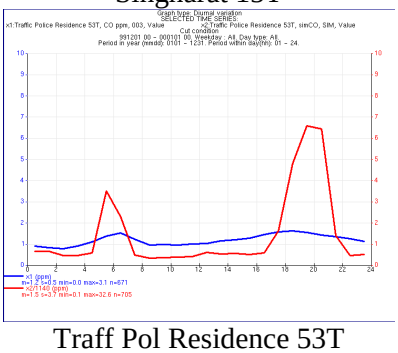
Singharat 15T



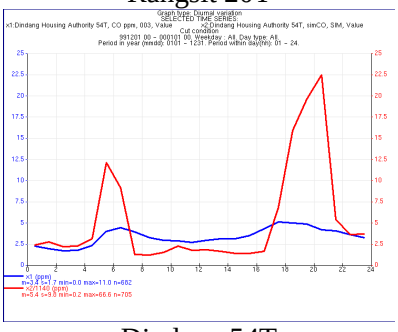
Rangsit 20T



Thonburi Substation 52T



Traff Pol Residence 53T



Dindang 54T

6. Discussions

The concentration calculated in the model yield the over predicted level compares to the measured. Since we believe in our quality of measurement except in some of the station that might have an local influence from the traffic emission. The picture of the diurnal concentration of the model are alike the picture of the emission database except the period of day that have an instability condition , the concentration drops down to almost the same with the measured. If we cut off those two peaks, the concentration would come down closed to the measured.

In order to make an adjustment to have the more valid model , we need to check with the emission database of the line source. Eventhough the emission database used for this project is the updatemost, it might not represent the present situation in Bangkok. In 1997-1998 the traffic emission might not have the same pattern as in december 1999.

The other reason that might skewed the predicted value is the meteorological data that put in the calculation at 3 meter instead of 10 meter. Also, the topography and surface roughness of the area need to be put in since there are no house height, heat island effects to be taken into account. In the real situation bangkok has the very tall buildings and bridges which affects the dispersion condition of temperature and wind fields.

7. Conclusions

The CO concentration of the Bangkok is mostly below 3 ppm. The model outcome gives the higher mean value except for some stations and gives two peaks of the high concentrations follow the same pattern of the traffic emission in the emission database. During the daytime while the model calculates the instability condition which gives the good dispersion, predicted value has the good prediction on the concentration.

8. Recommendations

For the future works, it is recommended by SMHI we need to study the other periods of the year, to create the seasonal pattern (if it has). To Compare the calculated wind speed and wind direction with the measured met stations. To Introduce the heat island effect (house heights, topography) to the model.

Also, we need to evaluate the emission database, measured met data and monitored data to keep track of the good data quality of the data collection.

Eventually, it is also recommended to continue an air quality assessment study based on an updated EDB and validate results on the air quality data to have a good model tool to be used.

9 APPENDIX 3: SUPPORT TO ESTABLISH AN AIR QUALITY LABORATORY AT THE PCD

Support to Establish an Air Quality Laboratory at the PCD

A summary of the activities 1997-2000

Göteborg 2000-09-27
SWEDISH ENVIRONMENTAL RESEARCH INSTITUTE (IVL)

Curt-Åke Boström
Åke Iverfeldt
Karin Sjöberg

Introduction

This report gives a brief summary of the activities which have been performed in the co-operative project ”Support to Establish an Air Quality Laboratory at the PCD” as a part of the ”Project between the PCD, Pollution Control Department, Ministry of Science, Technology and Environment, Bangkok, Thailand, and CAVG, County Administration of Västa Götaland Göteborg, Sweden, for the Enhancement of the Air Quality Management Project for Four Regional Nodes in addition to the Continued Support for Central PCD, and the Support to Establish an Air Quality Laboratory at the PCD”.

The project has been carried out in co-operation between the PCD and the Swedish Environmental Research Institute (IVL).

The overall objective of the project was to find suitable solutions for achieving cost-effective laboratory operation, the needed quality of the analyses, and good working conditions.

June 1997

In June 1997 two experts from IVL (Curt-Åke Boström and Åke Iverfeldt) visited the PCD in order to review the existing plans for the new Air Quality Laboratory (AQL) and to investigate existing equipment as well as the needs for additional equipment investments.

In the report ”Review of the PCD Air Quality Laboratory Plans” (Draft 1997-07-04) conclusions and recommendations were given regarding laboratory design in relation to the existing plans. In addition, the key principals of establishment of a well functional AQL were included in the report, such as equipment needs, laboratory procedures and organisation and structure for a quality assurance/quality control (QA/QC) system.

Relevant documentation concerning standardized methods for analysis as well as QA/QC systems was also sent to PCD in August 1997.

November 1998

IVL (Mrs Gun Lövblad) visited PCD during the second week in November 1998 to discuss the future direction of the project as the finalising of the new laboratory building was postponded.

January 1999

During one week in January 1999 two representatives from the PCD AQL (Ms. Siwaporn Phantong and Mr. Sarawut Thepanondh) visited the IVL Laboratories in Göteborg and Stockholm. The visit was planned to June 1998, but was postponed due to a fire in the laboratory at IVL.

The course covered training in both building up of a QA/QC system and quality manual structure as well as practical laboratory work. Furthermore, a visit to the Swedish National Testing and Research Institute was performed.

June-July 1999

The new PCD AQL was planned to be in operation in 1998. Due to financial problems in Thailand the finalising of the laboratory was postponed. As the area for the AQL also had to be reduced a second revision of the layout of the laboratory was made by IVL. A draft report, was send to PCD 1999-07-06.

December 1999

During a study visit in Sweden for four representatives from PCD (Sarawut Thepanondh, Vitsanu Wingpud, Sivaporn Ringsiyanon, Aunnop Rungraksathum) a one day seminar was held at IVL, presenting an overview of the QA/QC system at the laboratory and examples of monitoring strategies and programmes at IVL, including the activity of the EMEP network in Sweden.

June 2000

As a part of the training and education in QA/QC work three representatives from the AQL at PCD (Siwaporn Phantong, Jintana Vararussamee, Narawat Mitjitr) visited the IVL Laboratory during two weeks in June 2000. The so-called Filter Pack technique was chosen as a pilot method for sampling and analysis.

The training included preparation of sampling equipment, sampling, preparation before analysis, analysis evaluation and data treatment, with the QA/QC routines included in all steps. In addition, discussions and guidance in preparation of a QA/QC manual in general as well as a structure for description of methods to be implemented.

August 2000

Two experts from IVL (Curt-Åke Boström and Karin Sjöberg) visited the AQL at PCD. Further training in the practical work using the Filter Pack technique was conducted, including filter preparation and impregnation, handling of filters in general, loading of Filter Pack samplers, transport and storage, sampling in field, dissambling of Filter Pack samplers, filter leaching and analytical routines.

Method descriptions, including both the analysing process and the routines for quality assurance/quality control, for determination of lead in suspended particulate matter (SPM) and TSP/PM_{10} respectively were reviewed.

The new PCD laboratory building was visited, as well as the field station at Bangkok University for Commercial and Economic Studies where the siting criterias and equipment installations were reviewed.

Achievements

Discussions and revisions of the original plans for the AQL has resulted in a design of the new PCD AQL which is in good agreement with the second revised layout given by IVL.
In the view of the activities performed today and possible activities in the future at the laboratory, IVL are convinced that the new laboratory will meet the needs for a modern Air Quality Laboratory.

The discussions and training in QA/QC has also resulted in some achievements. The work with method descriptions has started for some of the sampling and analytical methods, and for those the QA/QC routines are well implemented. This is a positive sign for the future QA/QC work.

However, the structure of the QA/QC work at the PCD AQL has not yet been documented in a quality manual. The work with the Quality Manual have been delayed, partly as a consequence of the postponed construction of the new laboratory building.

The organization regarding QA/QC seems confused, which may well have affected the writing of a quality manual. To compile the necessary documents to a complete quality manual it would probably be most efficient for the staff at the AQL to work in team with experts with adequate experience. Such expertise is available at IVL. We are convinced that this team work should be carried out on site at the PCD AQL in Bangkok.

The training and education for the Filterpack method have been successful and the method will now be used for monitoring at several sites in Thailand within a joint Asian project regarding long range transport of air pollutants and deposition of acidifying substances.

Lessons learned

It would have been desirable with a better project organization. In particular, clear identification of responsible persons for the laboratory project would have been helpful. Furthermore, the project would probably have benefited from closer supervision and involvement from IVL.