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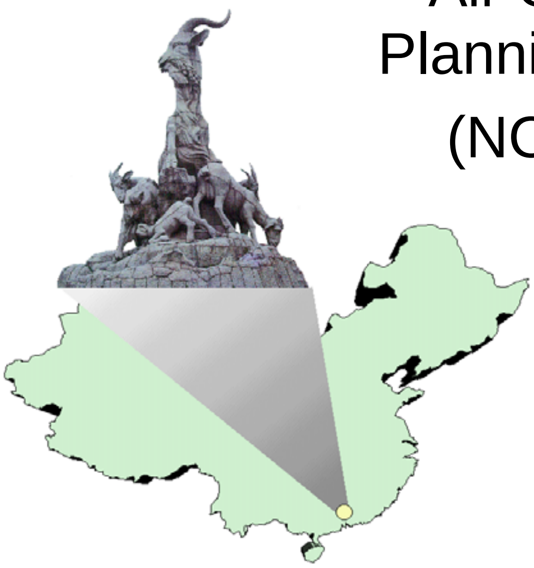
Annual Report 1998

Steinar Larssen (ed.)
Project Leader

Air Quality Management and Planning System for Guangzhou (NORAD Project CHN 013)



DRAFT, 1 March 1999

Participating Institutions:

P.R. China: GMSTC, GEPB, GRIEP, GEMC
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Annual Report 1998

Guangzhou Air Quality Management and Planning System

Steinar Larssen (ed.),
Project Leader

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Side

Summary ... **3**

1. Main goal and objectives of the project ... **5**

2. Summary of 1998 Project Activities, and Status per December 1998. ... **6**
- 2.1 1998 Plans. Summary ... 6
- 2.2 Status of 1998 Project Work. Summary ... 9
- 2.3 Workshop Activities, 1998 ... 11
- 2.4 Exchange Program, 1998 ... 12
- 2.5 AirQUIS installation, training and demonstration ... 13

3. Action Plans Development ... **14**
- 3.1 Original Plan ... 14
- 3.2 Action Plan Development Work in 1998 ... 14
- 3.3 Draft Action Plan 2001 ... 15

4. Degree of Fulfilment of Overall Objectives ... **16**

5. Objectives and Work Plan for 1999. Summary ... **18**

6. List of Reports and Publications ... **21**

7. Budget and Costs Summaries ... **23**
- 7.1 1998 Budgets and Costs ... 23
- 7.2 Budget for 1999 ... 25

Annex 1 Workshops 1998 - Programs ... **28**

Annex 2 Exchange Program Reports from Participants ... **32**

Annex 3 AirQUIS installation and Training Report ... **78**

Annex 4 Draft Action Plan for Guangzhou, from 2001 (Version of 5 February 1999) ... **84**

Annex 5 Agreement between GZ and NORCE, of Nov. '98 ... **97**

Annex 6 Proposed Report Front Page ... **103**

Summary

This annual report for 1998 gives a summary of the project activities and status per December 1998.

Transfer of knowledge and tools, and the exchange/training program have progressed mostly according to plans. This will be completed in 1999. The planned 1st Air Quality Management Analysis sequence was completed in 1998. Its purpose was to be a "trial run" to provide training in the type of analysis which is necessary to develop an action plan, prioritized according to cost analysis.

The improvement of the monitoring system is in progress. Instruments have been purchased and put into operation. Evaluation of the system, and proposals for modifications is underway. Guidance on data quality procedures is in process.

There are some delays in the project, which are not critical, seen in relation to a timely completion of the project.

Especially the development of the Action Plans is described (ch. 3). A draft Action Plan has been developed, listing a number of viable abatement measures for various source categories, looking at the pollutants SO_2, NO_x and particles (Annex 4). The measures have been prioritized according to their potential for reducing the air pollution exposure of the population. This evaluation of the potential was based on the quantitative air quality assessment established as part of the first AQMS analysis sequence.

By the end of 1998, 2 of the 3 years of the project are completed. Based upon the above status, the degree of fulfilment of the main project objectives (ch. 1) is qualitatively described in ch. 4.

Objectives and work plans for 1999 are then summarized in ch. 5, and a preliminary list of technical reports and publications is given in ch. 6.

Ch. 7 gives cost and budget summaries for 1998 and 1999.

The NORCE budget for 1998 was slightly overspent. The budget has been used fully by most of the tasks that were to be completed by the end of 1998 (Tasks 1, 3, 5, 8). NORCE will provide assistance to complete these tasks, including the reporting.

ANNUAL REPORT, 1998

1. Main goal and objectives of the project

The main objectives of this project, as taken from the formulations in the final version of the Project Plan (13 February, 1997 version), are given below.

In chapter 4, the project status is qualitatively evaluated against these main objectives.

At the present stage, it is also beneficial to formulate an overall goal of the project, to give a direction of the large effort put into this 3-year project, towards future activities:

> *The overall goal of the project is to contribute to the active use of Air Quality Management, based upon cost analysis, in P.R. China, especially for urban areas.*

Main objectives:

- Develop and establish an air quality management and planning system for Guangzhou based upon the URBAIR concept.
- Develop an air quality action plan as part of a city Environmental Master plan to reduce the air pollution in Guangzhou. This priority list of actions may be part of the Government Agenda 21 for the Environment.
- Update and improve the monitoring system by additional measurements (parameters and measurement points), in Guangzhou.
- Transfer tool and knowledge to the extent necessary to enable the Guangzhou counterparts to continue the Air Quality Management Strategy work in a qualified fashion.

It is noted here that the action plan shall be developed by the Chinese counterpart. The Norwegian counterpart will perform transfer of and training in tools and knowledge, and assist in the action plan development.

Possible short-term, obviously cost-effective control measures will be sought throughout the project. Any such measures will be given a brief description and presented for NORAD and other suitable organizations for evaluation.

The action plan will be the basis for detailing a prioritized investment program to improve air quality.

2. Summary of 1998 Project Activities, and Status per December 1998.

2.1 1998 Plans. Summary

The objectives and plans for 1998 are copied here from Annual Report 1997, as a basis for evaluating the project work in 1998.

"Project Objectives, 1998

A summary of the project objectives for 1998 is as follows:

– For the task work: To continue
  - towards improved knowledge in each task topic;
  - training in the use of the tools;
  - completion of the data collection.

  The effort to complete the data collection is particularly important. Important is also to assure the quality of the data collected.

– For the AQMS analysis: To complete the first full sequence of analysis of costs and benefits of air pollution control in Guangzhou, based on some selected short-term abatement alternatives. This will be a "trial run", gaining experience for the subsequent more complete analysis, with development of an action plan for short- and medium-term abatement and control alternatives.

– For the action plan development: A first draft of an action plan for short-term control options shall be developed by the end of 1998.

A detailed task/time schedule for the work in 1998 and later has been developed, and presented in Figures 1 and 2. The schedule shows the flow of information between the various tasks, and the sequence of calculations and analysis that leads to the development of strategies for air pollution control, and action plans."

"Summary of the work plan for 1998

An overall summary of the plans for 1998 is as follows:

– The task/time sequence figures (Figures 1 and 2) show the main activities of each task in 1998. The task work in 1998 is geared towards fulfilling the project objectives described above. Some fine-tuning of the Detailed Work Plans (DWPs) is still necessary to make sure that there in compatibility between the objectives and the task plans, and that the sequence of analysis can be followed.

  It is an important task for the Project and Technical Leading Groups to follow up the task work to make sure that the objectives of 1998 will be fulfilled.

– The planned exchange program for 1998 includes training periods in Norway for 5 people from Guangzhou on the following tasks: Task 1, 6.1, 7, 8, 9.

– Two workshops are planned for 1998:
  - In Norway, probably in May;
  - In Guangzhou in October/ November.

– Task visits to Guangzhou are planned for all tasks.

– Procedures for accepting and publishing reports from the project will be made."

Figure 1

GZ AIR Quality Management & Planning System

Task / time schedule, information flow

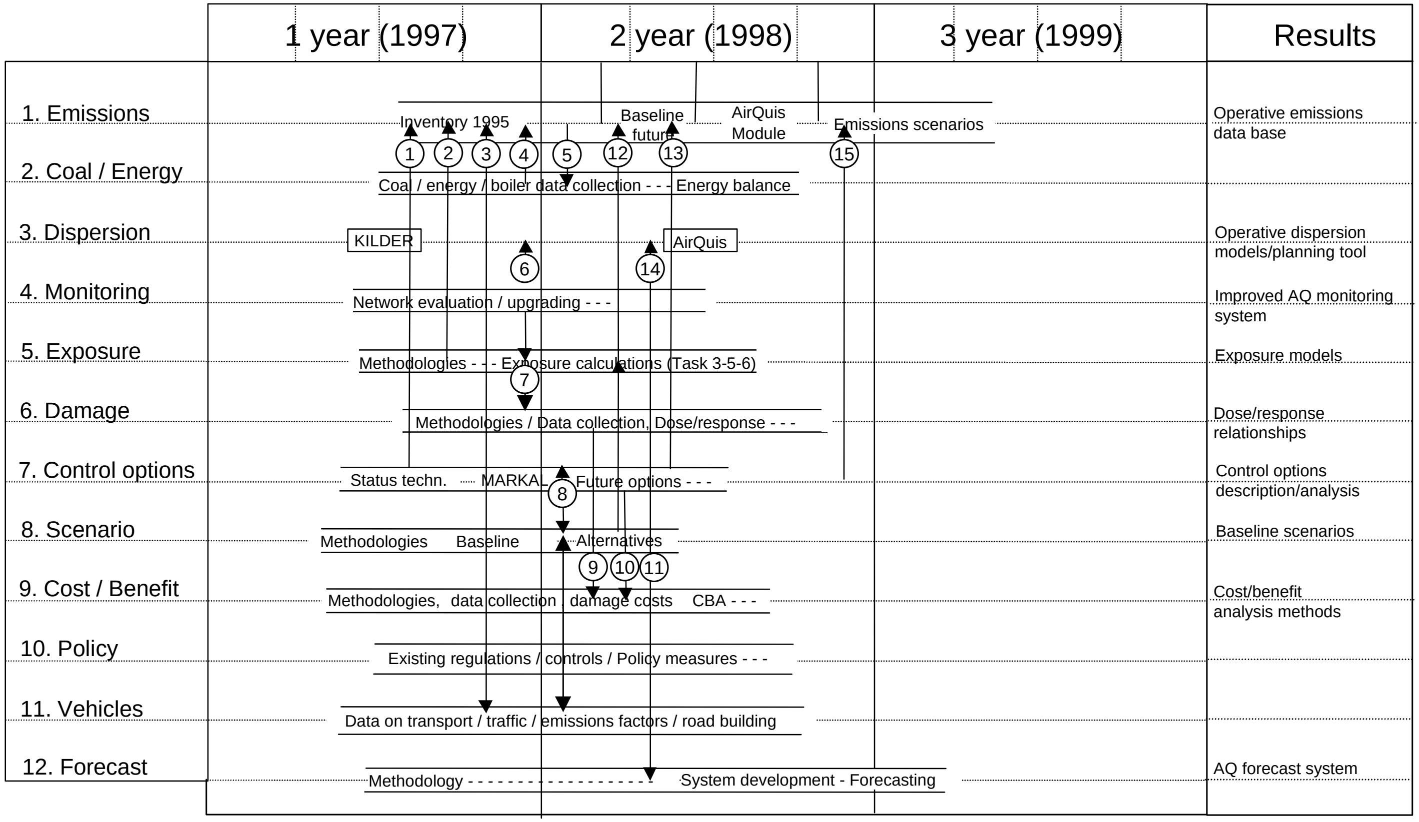
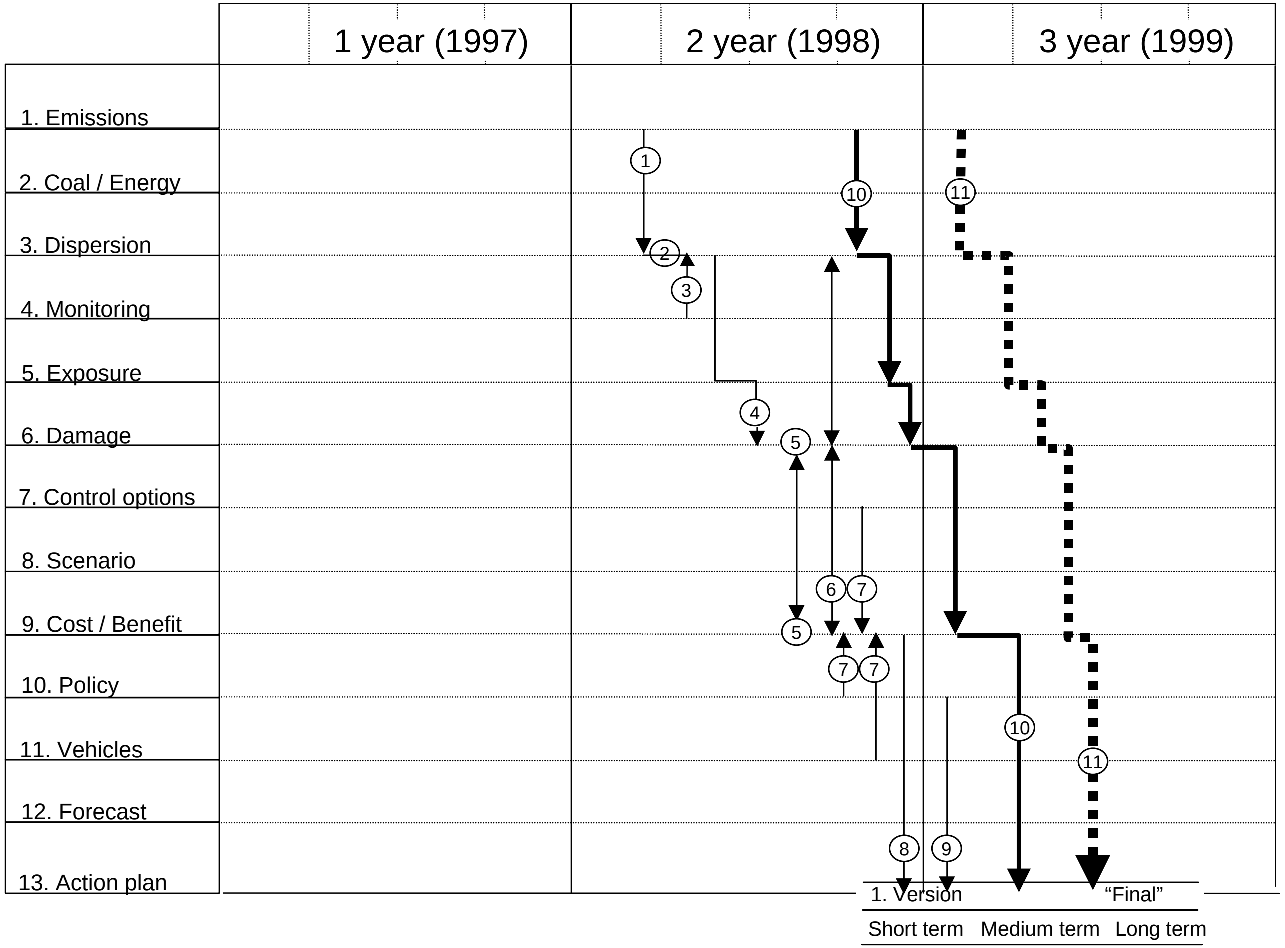


Figure 2

GZ AIR Quality Management & Planning System

Task / time schedule, development of abatement strategy and Action Plans



2.2 Status of 1998 Project Work. Summary

Based upon the Status reports presented at Workshop 2/98 in November 1998, the following is the overall project status:

Knowledge transfer, and training

- Much has been done as part of the task work, and the exchange program.
- Mrs. Li Zhiqin will go for training in Norway in 1999, and that will complete the exchange program.

The Exchange program in 1998 is described in section 2.4 in this report.

To enable a good completion of the knowledge transfer and training, the Task Status reports for 1998 contain an overview of what has been accomplished, and what should still be done (see Workshop Report 2/98).

Transfer of tools

The following tools have been transferred by now:

- Air pollution models (KILDER, ROADAIR, and EPISODE for forecasting);
- AirQUIS system (pre-release of version 2.0. Final version in February 1999);
- Materials' damage cost model (CorrCOST);
- MARKAL.

The Status reports contain an overview, and a completion plan (see Workshop Report 2/98).

Air Quality Management System

- Task work has been carried out according to the original Project Plan, towards establishing AQMS analysis capability in GZ, and a system/organisation in GZ to continue the work. This also includes the collection of necessary data, and establishment of groups that are familiar with the work, which can be continued after the project in finished;
- Emission inventory for GZ (1st version) has been made;
- 1995 air quality data and meteorological data (also 1990-1995 air quality data) have been collected;
- KILDER calculations/preparations for AirQUIS calculations have been performed;
- Damage assessment methods have been transferred (health and materials);
- Energy analysis carried out / fuel use analysed;
- Scenarios for future development has been made;
- Cost data on control options and health endpoints must be developed further, and very soon;

- Integration of tasks into a system of analysis, and team organisation: This must be developed further during 1999;

- 1st sequence of analysis: Carried out successfully and almost completely, according to plan (see Workshop Report 2/98). The main purpose was:
    - training in carrying out the AQMS analysis;
    - simulate cost-benefit of some actual measures.

  The 1st AQMS sequence was prepared with substantial guidance and leadership from NORCE. It is important that the GZ side go through the analysis on their own, and continue this work in 1999 as part of the Action Plan 2001 development.

- Organisation of AQMS work at GRIEP/in GZ must be well developed before the end of the project.

Action Plan development

- A 1st version has been proposed;
- This work shall be continued with high priority, according to the plans for this (see e.g. the task/time sequence Figures 1 and 2). This is one of the main topics of the work in 1999.

Monitoring System Improvement

- A large number of new instruments have been purchased, partly for funds available in this project, and put into operation.
- Evaluation of the present system is being carried out, and modification of the monitoring system will be implemented.
- Quality control and assessment work and guidance from NILU started in 1998.

Critical delays

Some delays may soon become critical, seen in relation to a successful completion of the project, if certain tasks are not carried out soon:

Task	
1	Emissions data to be input into AirQUIS. Must be completed before Spring festival (by the middle of February, 1999). Task 1 work.
3	AirQUIS: A fully operational version must be made available before the end of Spring festival (by end of February 1999 at the latest). NILU must deliver.
4	PM_{10} and O_3 data must be made available. Task 4 work.
5	Future population data (distribution in GZ) must be worked out. Task 1 work.
6.2	Building materials inventory must be finished early in 1999.
7	Data on costs of control measures must be developed and available early in 1999.
7, 1	Data on process emissions must be made available early in 1999.
9	Costs of health effects (for specific health “endpoints") must be developed for GZ and made available early in 1999.
11, 1	Data on Chinese emission factors for motor vehicles must be made

	available early in 1999.

2.3 Workshop Activities, 1998

Two workshops were carried out in 1998, according to plans. It is referred to the separate workshop reports for details.

Workshop 1/98, in Ulvik and Oslo, 11-15 May

- Participants from Guangzhou included the GZ project leader Mr. Wu Zhengqi, and 6 scientists/task leaders. 5 of the scientists stayed in Norway for 4-7 weeks after the workshop, for training. Also, a delegation of 7 representatives from GSTC and GEPB, including the Director of GSTC Dr. Zeng Shidu, participated in the workshop, and had a program visiting various institutions in Oslo.

- The activities of the workshop concentrated on:
  - discussing the work in each task, and modifying further plans where necessary;
  - preparing for carrying out the 1st Air Quality Management Analysis Sequence before the next workshop.

- Recommendations from the workshop included:
  - the need to start to develop candidate abatement measures for pollution control, to be analysed in the 1st AQMS sequence;
  - the need to co-ordinate this project and the UNDP project on NO_x emission control as well as possible;
  - recommendations re. the preparation and conduct of the next workshop.

Workshop 2/98, in Guangzhou and LongGui, 5-13 November

- Participants from Norway included the NORCE project leader, Mr. S. Larssen, and 8 scientists/task leaders.

- Before the workshop started, a team from NILU and NORGIT had installed the AirQUIS system, prerelease of the version 2, on computers at GRIEP, and training on use of the system had started.

- The activities of the workshop concentrated on
  - final preparation and the presentation of the results from the 1st AQMS analysis sequence;
  - discussion of status of task work;
  - development and discussion of Action Plans;
  - preparation and discussion of Detailed Work Plans for 1999.

- The main objectives of the work during 1999, as resulting from the proceedings of the workshop, are to:

- establish an Action Plan for 2001, and prioritize abatement measures based upon cost-effectiveness analysis;
- finalize all knowledge/tools transfer, incl. documentation in technical reports;
- finalize all data collection (the first "batch");
- develop Action Plan 2010;
- improve monitoring systems;
- finalize and report all task work.

2.4 Exchange Program, 1998

The Exchange Program for 1998 included the following training stays in Norway:

Name	Task	Host	Period
Jian Jianyang	1	NILU	13 May - 7 June
Fang Xingqin	3	NILU	13 May - 7 June
Cui Xia	2/7	IFE	13 May - 26 June
Fan Changzhong	8	ECON	13 May - 26 June
Yu Jican	9	ECON	13 May - 26 June

The reports from the participants are included as Annex 2.

The main topics of each participants' training were:

Jian Jianyang: Training in emissions inventory work and calculations with the KILDER program:

- Study with Mr. Gram of the emissions and other data brought from GZ;
- how to use the data as input to the KILDER program;
- how to run KILDER programs, and analyze the results;
- discussuin of emission factors re fuel use, especially to make use of Chinese factors, as summarized very well in a note by Mr. Jian;
- discussions on how to obtain harbour (ship) and airport (plane) emissions;
- the need to cover also industrial process emissions was discussed.

Fang Xingqin: The planned main topic was training on the AirQUIS system. Because of the delay in the development of the system, a full system could not be provided for the training, although some training (e.g. GIS) was done. Other topics that was covered during her stay at NILU:

- Mathews wind field model (a module in AirQUIS),
- Meteorological data and statistics for input to KILDER model;

- Development of wind field library, for dispersion calculations in GZ.

Cui Xia: Training/instruction on AirQUIS at NILU.
Training at IFE:

- The participants did some research to estimate emission factors based on the “point.xls” file. The suggestions were discussed with Task 1.
- To get a better knowledge of the energy system, the participants made some energy flow maps based on information from the Energy Balance. These maps are important to understand how the MARKAL system works.
- The instruction and training of MARKAL was continued. Since the information from GZ was not completed, the participants spent time using the model with some fictitious numbers (demo version).
- In co-operation with Task 9 some case studies were started. The participants selected 4 main industry sectors and started to collect more specific information of these sectors.
- A meeting at ABB Miljø in Oslo, to get information on the work by ABB in Schenzhen, China.

Fan Changzhong: Training at ECON on:

- Development of baseline scenario
- Sector distribution and activity indicators.
- Development of target scenario.

Yu Jican: Training at ECON on the principles of cost-benefit assessments, valuation of morbidity and mortality, designing a spread-sheet model of cost-benefit assessment of air pollution in Guangzhou, training on the spread-sheet model.

2.5 AirQUIS installation, training and demonstration

A prerelease version of AirQUIS, version 2.0 was installed on computers at GRIEP during the week before the workshop in November, by personnel from NILU and NORGIT. Details are given in Annex 3 to this report.

The installation process included commercial hardware and software, and the AirQUIS 2.0 package and also import of Guangzhou data into the system: Shape coordinates, map data, selected emissions and meteorology data for testing, and population data.

Training of personnel, mainly from GRIEP, but also from GEMC, was carried out vigorously during the entire workshop period.

The AirQUIS system was demonstrated to the entire project group during the last plenary session of the workshop, on 12 November. The demonstration was carried out by personnel from GRIEP, showing that the training had been successfully carried out.

3. Action Plans Development

3.1 Original Plan

The final version of the Project Plan (of February 1997) states that one of the main objectives is to:

"Develop an air quality action plan as part of a city Environmental Master plan to reduce the air pollution in Guangzhou. This priority list of actions may be part of the Government Agenda 21 for the Environment."

It was also stated that the action plan shall be developed by the Chinece counterpart, with the NORCE side assisting in this development, through the transfer of knowledge tools and experience.

It is also stated that:

"Possible short-term, obviously cost-effective control measures will be sought throughout the project. Any such measures will be given a brief description and presented for NORAD and other suitable organizations for evaluation."

The work on the action plan started in 1998, according to the objectives of the 1998 project activities, as described in the annual report for 1997 (see chapter 2.1 in this report). It was envisaged to develop action plans for short, medium and long terms. The long term plan should look at 2010 and beyond. The baseline scenarios developed in Task 8 looked at development scenarios towards 2010. According to the task/time schedule in Figure 2, we should

- develop a 1st version of an Action Plan as part of the 1st AQMS analysis sequence in 1998, and then continue the Action Plan work in 1999.

3.2 Action Plan Development Work in 1998

The work on Action Plans started after Workshop 1/1998 in May. NORCE proposed a short list of possible abatement measures to be analysed as part of the 1st AQMS sequence, and this was modified by the Chinese side. The following measures were to be analysed in the 1st sequence:

- Moving of factories out of central districts in GZ;
- Gasification of buses and taxis;
- Phasing-out of motor cycles;
- Gasification of 3rd industry (e.g. hotels and restaurants);
- Improving efficiency of burners.

The results of this analysis are given in the report from Workshop 2/98.

Before Workshop 2/1998 in November, the Guangzhou side had continued the work on Action Plans, and presented during the workshop a first draft of an Action Plan document.

During the workshop, the following activities took place:

- Presentation and discussion of the draft Action plan document.
- Presentation and discussion of a proposal from the NORCE side on candidate abatement measures that were considered to have substantial potential for reducing emissions and concentrations of air pollution in Guangzhou.
  In this selection, the results of the analysis in the 1st AQMS sequence was taken account of. Thus, not only the emission strength was considered, but also the actual contribution from sources to the air pollution concentrations, account taken of the dispersion effects.
- A plan for the further development of the 2001 Action Plan was made (see chapter 5 in this report).

These presentations and discussions are described in more detail in the report from Workshop 2/98.

In this discussion, it become clear that separate Action Plans had to be developed for the short term (2001) and for the medium-to-long term (2010).

Mr. Wu thus put strong emphasis on the goal of Guangzhou authorities that Guangzhou should strive to become an “Environmental Model City” (EMC) by 2001. There are certain (mainly 5) criteria which should be fulfilled to become an EMC in China, such as:

- Environmental management should be among the top 10 in China;
- It should be a sanitary model city;
- Env. Investment should be > 1.5 % of GDP;
- Ntl. Air quality guidelines must be met.

The goal of the GZ authorities is to make Guangzhou a model city within 3 years.

This goal now constitutes a major challenge for our project, particularly to develop a short term action plan that would assist GZ in reaching its goal.

3.3 Draft Action Plan 2001

After the workshop, during December 1998, the NORCE side continued the work on the 2001 Action Plan, in Norway. Several drafts have been worked out and sent to the Guangzhou side for comments.

The presently last draft of the 2001 Action Plan is given in Annex 4 to this report. The work continues into 1999.

4. Degree of Fulfilment of Overall Objectives

The main objectives of the project are listed in Ch. 1 of this report. The more specific objectives of the work in 1998 are given in Ch. 2.1.
The following is a quantitative evaluation of the status of the project relative to these objectives.

- *Develop and establish an air quality management and planning system (AQMS) for Guangzhou, based upon the URBAIR concept.*

This AQMS system development concerns most of the work in all the 12 defined tasks that has taken place during 1997 and 1998, and where task teams in Guangzhou and Norway are cooperating.

Also the Exchange program contributes towards this objective, which up until now has included 11 scientists staying in Norway for training for a total of 13 months.

The 1998 objectives concerning this, were to continue the work towards:

- improving the knowledge level within the Guangzhou task teams;
- completion of the training in the use of tools and methodologies;
- completion of the data collection necessary to fulfil the overall objectives of the project.

The general evaluation of the status on this objective is that the fulfilment is well underway, and will be completed before the end of the project, by end of 1999. The status reports for 1998 and the detailed work plans for 1999, for each task, shall reflect the remaining work, and plan for its completion.

One major part of the AQMS system development is the AirQUIS software system. The first (prerelease) version of this system was installed in Guangzhou in November 1998, and intensive training was provided. Preliminary instruction and training on the AirQUIS system has also been provided during the exchange program for 1998, during trainees’ stay in Norway. A complete version will be installed in Guangzhou early in 1999. This installation program represents a delay relative to the orginal plans. It should have been installed earlier in 1998. The reason for this delay is a similar delay in the development of the system, so an earlier installation in GZ has not been possible. Guangzhou is one of the first cities to get the system.

- *Transfer tools and knowledge to the extent necessary to enable the Guangzhou counterparts to continue the Air Quality Management Strategy work in a qualified fashion.*

This objective is closely linked to the previous one, through the task work, exchange program and transfer of tools, knowledge and methodologies.

One of the main objectives of the 1998 work is directly linked to this:

- To complete the first full sequence of analysis of costs and benefits (the URBAIR concept) of air pollution control in Guangzhou, based on some selected short-term abatement measures. This was a "trial" run, for the Guangzhou side to gain experience in this analysis sequence.

The 1st sequence was carried out successfully before and during Workshop 2/98 in November. There was substantial guidance from and involvement of the NORCE team during this work, but it provided very important training for the Guangzhou team.

It is necessary for the Guangzhou team to continue to work on analysis of control measures of air pollution based upon cost-benefit analysis. The plan for 1999 is to continue in this work during the whole of the year, and particularly the first half of the year, during the development of the 2001 Action Plan.

It is also important for the Guangzhou side to institutionalise the AQMS work, so that institutions and teams are designated to be responsible for the various parts of the AQMS work, and that the tasks and responsibilities related to this are described in detail.

- *Update and improve the monitoring system.*

This objective is to be met through the work in task 4: Monitoring.

Funds have been provided through this project, totally NOK 2,898,000, for purchase of instrumentation for air pollution monitoring and analysis. Equipment has already been purchased and put into operation for most of these funds, according to agreed purchase lists.

An evaluation of the existing monitoring system is being carried out, based upon a report on air quality in Guangzhou produced as part of the project. This evaluation will be part of the basis for improving the monitoring system. This task is delayed. The delay is not concidered critical, and will be finished before the end of the project.

- *Develop an Air Quality Action Plan as part of a city Environmental Master Plan.*

Action Plans may be developed for the short-, medium- and long term. It was envisaged to define, during the project, good short-term abatement measures with good potential for improvement of the air quality, but to concentrate on the more medium- and long term plans, towards 2010 and beyond.

The action plan work was planned to start during 1998. The 1998 work objective regarding this was:

- A first draft of an Action Plan for short-term control options shall be developed by the end of 1998.

Towards the end of 1998 it became clear that the Guangzhou authorities want to work towards the establishment of Guangzhou as an Environmental Model City in China, by 2001. For that, some goals need to be met, among them to comply with Chinese air quality guidelines. To be able to reach that goal, an Action Plan for 2001 has to be set up. Considerable efforts has to made in 1999 for the project to meet this requirement.

The work in 1998 has fulfilled the objectives:

- A first selection of potential abatement measures was made, and a cost-benefit analysis was attempted as part of the 1st AQMS analysis sequence;
- A draft Action Plan was developed, which includes specifically measures that have the potential to reduce the air pollution substantially by 2001;
- Plans have been detailed for the work in 1999 to complete the Action Plan development.

5. Objectives and Work Plan for 1999. Summary

1999 is the last year of the 3-year project. During the 2 first years there was a concentration on the following:

- transfer of methodologies, tools and instrumentation, and training through the exchange program and through the task work, where the GZ and NORCE teams work together.
- collection of the data needed for an objective air quality management process, and action plan development based upon cost-benefit analysis.

Most of this work has been finished, although some parts of it need to be completed.

In 1999 the work must concentrate on the development of the Action Plans.
The main objectives for the work in 1999 are shown below:

1999 WORK PLAN MAIN OBJECTIVES
<u>First priority:</u> • Develop action plan related to 2001. <u>Further objectives:</u> • Finalise all knowledge / tools transfer incl. documentation (in technical reports) • Finalise data collection, the first "batch" • Develop Action Plan related to 2010 • Improve the monitoring system • Finalise the all task work • Final reporting

Based upon this , the work plan for 1999 can be divided in several parts:

1. Make AirQUIS operative at GRIEP	:	by end of February, at the latest)
2. Completion of data collection	:	January - March
3. Action Plan 2001 development	:	January - May
4. Completion of training program	:	January - October
5. Completion of task work, incl. reporting	:	by October
6. Action Plan 2010 development	:	March - November
7. Final reporting to NORAD / MOST	:	by March 2000.

The two workshops in 1999 will be held in May and November, both in Guangzhou. This is described in the Agreement between the GZ and NORCE sides, about the 1999 work program (see Annex 5).

Detailed Work Plans (DWP) for each task are given in the Workshop 2/98 report.

Details regarding each of the above points are:

1. *Make AirQUIS operative at GRIEP*

A prerelease version of AirQUIS 2.0 was installed at GRIEP in November 1998, and selected persons given training. The prerelease version is suitable for the input of the necessary data (emissions, meteorology etc.) for the later model calculations. A final version of AirQUIS 2.0 will be installed before the end of February 1999.

2. Completion of data collection

In several of the tasks completion of data collection is necessary. This is detailed in each of the DWPs (see Workshop 2/98 report).

3. Action Plan 2001 development

The development process of the 2001 Action Plan as agreed at Workshop 2/98 in November 1998, is as follows:

1. The 1st selection proposed at the workshop 12 November 1998 to be evaluated By 15 December and amended, and sent to Guangzhou task 13.
2. GZ side to comment and completed, and send to NORCE side for final comments.By 10 January.
3. More commenting rounds may be necessary, but the final list of selected measures must be ready by end of January, at the latest.
4. GZ side will continue the work on the Action Plan document, By 31 January with a view to the contents list of the document proposed by NORCE side (updated draft, during the meeting at GRIEP on 11 November, background part).

   An updated version of the outline, and the background part of the document should be ready for commenting by NORCE side before the end of January. NORCE will be ready to assist in the writing of the updated draft, when requested by GZ side.

   The following chapters of the document will be written after January.

4. Completion of the training and exchange program:

This concerns several of the tasks. Details are given in the DWPs (see Workshop 2/1998 report).

The exchange program will be completed in 1999. Ms. Li Chiqin will stay in Norway for 4 weeks, related to task 6.1 training: health effects of air polution.

5. *Completion of task work, incl. reporting:*

Details are given in DWPs. Several reports are planned in each of the tasks. The present list of task reports is given in chapter 6 below.

6. *Action Plan 2010 development:*

This work should start during Spring 1999, by developing further the List of selected measures used as basis for the Action Plan 2001. The further detailed plan for the work on the 2010 Action Plan must be made by the Workshop in May 1999.

7. *Final reporting to NORAD / MOST:*

The final reports to NORAD / MOST shall be delivered before March 2000.
The contents of the final reporting, and the time schedule for this, will be discussed during the workshop in May 1999.

6. List of Reports and Publications

A list of planned reports is given below.

In addition, there are the following administrative reports:

- Kick-off seminar report, and Annual Reports for 1997 and 1998.
- Workshop reports from Workshop 1/97 and Workshop 1/98 and 2/98. (The Workshop 2/1997 report is contained in the Annual Report 1997).

Also, there are a number of mission reports. These reports will be organized in 4 report series:

Administrative reports (series A)
Technical reports (series B)
Scientific publications (series C)
Mission reports (series D).

Reports will be numbered chronologically within each series.

A proposal for a Report Front Page has been made, see Annex 6.

Overview, planned reports from tasks:

Task no.	Report	Authors	Report type			Status
			TR	SR	MR	
1	Air Pollution Emissions in Guangzhou 1995. Gridded emissions.	Huang Qingfeng, Jian Jianyang, Yang Shurou, Pan Nanming, Sun Qun and Frederick Gram	X			P
1	Air Quality Calculations for Guangzhou 1995.	Fang Xingqin and Frederick Gram	X			P
1	Air pollution Exposure in Guangzhou 1995.	Fang Xingqin and Frederick Gram	X			P
2						
3						
4	Air Quality in Guangzhou, 1990-1995.	Steinar Larssen and Guangzhou task 4 team	X			D
5						
6.1	Health effects of air pollution - methodology.	Li Zhiqin, Kristin Aunan and Jocelyne Clench-Aas	X			P
6.1	Health effects from air pollution in GZ - respiratory symptoms and diseases. Results from an interview study.	Li Zhiqin, Chen Yang, Jocelyne Clench-Aas and Alena Bartonova	X			P
6.1	Health effects from air pollution in GZ - mortality and hospital	Li Zhiqin, Xing Qi, Jocelyne Clench-Aas	X			P

	admissions.	and Alena Bartonova				
6.1	Reduced health damage from reducing air pollution in GZ - phase 1 calculations.	Li Zhiqin, Xing Qi and Kristin Aunan	X			P
6.1	Reduced health damage from reducing air pollution in GZ - phase 2 calculations	Li Zhiqin, Xing Qi, Chen Yang, Kristin Aunan, Jocelyne Clench-Aas and Alena Bartonova	X			P
6.2	Corrosion of steel and zinc in the Guangzhou area.	He Liangwan, Tian Kai and Jan Fr. Henriksen		X		P
6.2	Amount and distribution of materials, in Guangzhou area based on random inspection and statistical treatment.	He Liangwan and Tian Kai	X			P
6.2	Lifetime and maintenance cost of material in Guangzhou area.	He Liangwan, Tian Kai, Guri Krigsvoll and Jan Fr. Henriksen	X			P
6.3	Vegetation damage in GZ.	Su Xing and Thorbjørn Larssen	X			P
7						
8						
9						
10.1	Air pollution control in China. An overview of the main principles and the political-administrative framework.		X			F
10.2	Legal and administrative framework for pollution control in Guangzhou.		X			F
10.3	Plans and targets for economic development and emission trends in Guangzhou.[1]		X			D
10.3	Policy instruments for air pollution control - some successful international experiences.		X			D
10.4	Air pollution regulations: emissions from transport, industry and power plants.		X			F
11						
12	Establishment of an Air Pollution forecasting system for Guangzhou	D. Tønnesen, Liu Li	X			P
12	Evaluation of Air Pollution forecasts in Guangzhou	Liu Li, D. Tønnesen	X			P

TR: Technical report P: Planned
SR: Scientific report D: Draft
MR: Mission report F: Finished

[1] Will be integrated in report from task 8.

7. Budget and Costs Summaries

7.1 1998 Budgets and Costs

NORCE side

Table 1 shows the budget and costs for the NORCE side for the period January-November 1998. Since we were asked by NORAD to present the invoice for the 4th quarter 1998 by mid-December, only costs for October-November were included. The December costs are rather low. They will be included with the 1st quarter 1999 costs.

Notes to Table 1

1. The remaining funds from 1997 were included with the 1998 budget, and spent during 1998.
2. As of 1 December 1998 the 1998 budget was overspent slightly (by NOK 14,787).
3. On some of the tasks, the costs have exceeded the available funds and on other tasks, the costs so far are lower than the budget.

   For tasks 1, 3, 4, 5 (NILU tasks), this is corrected by reallocation of funds between tasks. This reallocation reflects the remaining work in each task.

4. Funds have been reallocated from Tasks 1-12 to the Exchange program, to cover the under-funding of the Exchange Program, as agreed previously between the GZ and NORCE partners. The reallocation amounts to 4.48% of the total personnel and travel funds on each task, all 3 years.

   The exchange budget for 1999 is sufficient to cover the costs of the training of Ms. Li Chiqin in Norway in 1999.

Cost of Guangzhou side for 1998 - Equal to 3179,000 NOK

Task	Name	Cost for 1998(unit:RMB)
1	Emission Inventory	117,510
2	Energy consumption and coal pollution	155,160
3	Dispersion modeling	127,600
4	Air quality monitoring	267,650
5	Air pollution exposure and impact assessment	63,030
6-1	Health damage assessment	93,390
6-2	Material deterioration assessment	50,820
6-3	Vegetation damage assessment	80,190
7	Pollution control option	162,960
8	Baseline scenario development	166,320
9	Cost/benefit analysis	99,600
10	Pollution control management and policy option	98,120
11	Motor vehicle pollution and photochemical smog	229,680
12	Pollution forecasting	150,540
13-A	Exchange, consulting	486,000
13-B	Management	300,000
13-C	Instrument	1289,000
13-D	Workshop	250,000
Total		4187,570

GZ AQMS Project (NORAD project CHN013) - Economic status from January including November 1998 (NOK)

Task	Remaining funds from 1997	1998 funds	Total funds 1998	Costs					Remaining funds	Reallocation re. exchange	Reallocation between tasks	Available funds for 1999 from 1998
				1st quarter	2nd quarter	3rd quarter	Oct.-Nov.	Total				
1. Emissions	50,148	150,000	200,148	70,200	21,484	44,915	146,025	282,624	-82,476	-25,760	110,000	1,764
2. Coal	-10,465	95,000	84,535	18,900	6,300	17,350	24,500	67,050	17,485	-10,530		6,955
3. Dispersion	443,365[2]	100,000	543,365	25,603	111,241	68,986	512,666	718,496	-175,131	-23,520	200,000	1,349
4. Monitoring	354,523[3]	170,000	524,523	22,750	21,450	131,736	43,896	219,832	304,691	-21,060	-240,000	43,631
5. Exposure	20,205	130,000	150,205	3,900	1,950		50,375	56,225	93,980	-10,750	-70,000	13,230
6. Damage	-203,152	485,000	281,848	100,235	109,029	31,370	47,105	287,739	-5,891	-44,800		-50,691
6.1 Health	(-92,272)	(346,000)	(253,728)									
6.2 Materials	(-67,920)	(88,000)[4]	(20,080)									
6.3 Vegetation	(-42,960)	(51,000)	(8,040)									
7. Control options	-27,105	520,000	492,895	56,700	164,471	70,560	186,350	478,081	14,814	-56,450		-41,636
8. Baseline scenario	-23,855	230,000	206,145	70,850	62,400	12,350	36,466	182,066	24,079	-20,160		3,919
9. Cost-benefit	-219,698	500,000	280,302	70,850	108,550	49,929	50,983	280,312	-0,010	-50,170		-50,180
10. Policy	233	245,000	245,233	7,800	48,100	100,100	82,520	238,520	6,713	-41,660		-34,947
11. Vehicles	14,480	65,000	79,480			3,150	11,500	14,65	64,830	-7,840		56,990
12. Forecasting	-41,505	75,000	33,495	4,225	4,875		20,890	29,990	3,505	-10,080		-6,575
13. Administration	-37,154	325,000	287,846	90,417	74,100	37,050	58,975	260,542	27,304			27,304
Workshops	71,683	500,000[5]	571,683	20,260	265,330	21,878	248,875	556,343	15,340			15,340
Exchange[6]	-96,047	70,000	-26,047		293,259	4,714		297,973	-324,020	322,780		-1,240
Total	295,656	3,660,000	3,955,656	562,690	1292,539,000	594,088	1521,126	3970,443,000	-3965,832	0	0	-3965,832

[1]Not including NOK 150,000 for computer server to be bought by GZ and transferred to Norway for configuration.
[2]Includes NOK 32,000 which is the rest of the instrument purchase funds, to be used by Guangzhou side.
[3]The funds planned for "materials inventory" in 1998, NOK 50,000, has been transferred from Task 5 to Task 6.2 where it belongs more suitably.
[4]50,000 NOK for Guangzhou side is included into 500,000 NOK for Workshop budget.
[5] Here, the NORCE and GZ parts of the exchange budget and costs are added together. The approximte costs of 4 air fare tickets, Hong Kong - Oslo round trip, paid by GZ in May for 4 trainees, approx. NOK 40,000 has been included..

7.2 Budget for 1999

NORCE side

NORCE budget for 1999 (1000 NOK)

Task	Remaining funds from 1998 (approximate)	Budget 1999	Available for use in 1999
1. Emissions	2	0	2
2. Coal	7	45	52
3. Dispersion	1	0	1
4. Monitoring	44[7]	0	44
5. Exposure	13	0	13
6. Damage	-51	265	214
7. Control options	-41	310	269
8. Baseline scenario	4	0	4
9. Cost-benefit	-50	560	510
10. Policy	-35	245	210
11. Vehicles	57	45	102
12. Forecasting	-6	100	94
Project admin.	27	325	352
Workshops	15	500	515
Exchange		65	65
Total	-13	2,460	2,447

Tasks 1, 3, 5 and 8 have no or little funding for 1999. According to the project plan, they were to be completed by the end of this year (1998). Some input of work from the NORCE side may still be needed to finish the work, including the reporting. NORCE will still provide assistance to finish the work.

GZ side

Guangzhou side budget for 1999 - Equal to 818,182 NOK

Task	Name	Budget for 1999 (unit:RMB)
1	Emission Inventory	30,000
2	Energy consumption and coal pollution	25,860
3	Dispersion modeling	31,900
4	Air quality monitoring	20,000
5	Air pollution exposure and impact assessment	20,000
6-1	Health damage assessment	20,000
6-2	Material deterioration assessment	20,000
6-3	Vegetation damage assessment	20,000
7	Pollution control option	65,000
8	Baseline scenario development	65,000
9	Cost/benefit analysis	50,000
10	Pollution control management and policy option	24,530
11	Motor vehicle pollution and photochemical smog	62,220
12	Pollution forecasting	25,490
13-A	Exchange, consulting	80,000
13-B	Management	100,000
13-C	Instrument	140,000
13-D	Workshop	100,000
Total		900,000

[7] This sum includes NOK 32,000 which is the rest of the instrument purchase funds, to be used by the Guangzhou side.

Annex 1
Workshops 1998 - Programs

Workshops 1998

Workshop 1, 1998, in Ulvik/Oslo, Norway, 11-15 May 1998

The program, which was proposed before the workshop, was modified somewhat during the course of the workshop. The main contents was as follows:

Date	Activities
Monday 11 May:	Opening Preparatory task work Presentation of task status reports (for Tasks 1-8)
Tuesday 12 May:	Continued presentation of task status reports (Tasks 9-12) Discussion Meeting in the Project leading group
Wednesday-Thursday 13-14 May:	Partly task work, partly visit to ECON and to other institutions in Oslo
Friday 15 May:	Visit to IFE and NILU Closing session, with presentation of updated task status, and discussion Evening: Workshop closing dinner

Workshop 2, 1998, in Guangzhou, 5-13 November 1998

The main objectives of this workshop were to:

- report on the 1st Air Quality Management Analysis sequence that had been carried out during the autumn;
- prepare detailed work plans (DWP) for 1999;
- demonstrate the AirQUIS 2.0 Air Quality Management System software tool;
- continue the Action Plan development.

The proposed program is shown in Annex 1. It was modified somewhat during the course of the workshop. The main content was as follows:

Date	Activities	
5 Nov. Thursday:	After short starting plenary, preparatory work, in groups, to finalize the analysis of the 1st AQMS sequence. Also other task work (e.g. Status report)	
6 Nov. Friday	As above	
8 Nov. Sunday	Evening:	Transfer to LongGui Ecological training centre
9 Nov. Monday	Plenary:	- Brief Task Status reports - Reporting of results from 1st AQMS sequence

	- Action plan: Presentation by GZ side. Discussion
10 Nov. Tuesday	Task work: - Prepare DWP 99 - Prepare for AirQUIS demonstration - - Action Plan discussion.
11 Nov. Wednesday	As above.
12 Nov. Thursday	Plenary: - Presentation of DWP 99, per task - AirQUIS demonstration - Action Plan proposal, presentation and discussion
13 Nov. Friday	Project Leading Group Meeting.

Annex 2

Exchange Program Reports from Participants

Collection of the reports regarding the training Guangzhou technicians carried out in Norway in 1998
1998.8

Introduction

Following the project proposal of the Sino-Norwegian Cooperation Project, Guangzhou Air Quality Management & Planning System, and the arrangements Norwegian and Chinese Side reached, the first workshop of 1998 has been held in Norway, and also five people from Guangzhou would carry out 6.5 person.month's training work in Norway. So, the project sent five key technicians to accept training in Norway from May 8 to June 28, 1998. The trainees are as the following:

Mr. Jian Jianyang,	Engineer, Guangzhou Environmental Supervising Administration
Mrs. Fang Xingqing,	Engineer, Guangzhou Research Institute of Environmental Protection(GRIEP)
Mr. Cui Xia,	Senior Engineer, Guangzhou Research Institute of Environmental Protection(GRIEP)
Mr. Fan Changzhong,	Engineer, Guangzhou Research Institute of Environmental Protection(GRIEP)
Mr. Yu Jichan,	Engineer, Guangzhou Research Institute of Environmental Protection(GRIEP) .

After they took part in the workshop they carried out the training work and now you will see that their training reports has been perfected and put together.

TRAINING REPORT

Jian Jianyang Task 1, Emission Inventory)
Guangzhou Environmental Supervising Administration

From May 9 to June 8, 1998, as the member of task group 1, *EMISSION INVENTORY,* I carried out the task work and accepted training in Norway, for the purpose of better achievement on the Sino-Norwegian cooperating subject "Air Quality Management and Planning System in Guangzhou". Four other trainees from Guangzhou Research Institute of Environmental Protection (GRIEP) were in my company. They were Ms. Fang Xingqin representing task 3, Mr. Cui Xia representing task 2 and 7, Mr. Fan Changzhong, task 8 and Mr. Yu Jican, task 9. According to the original plan, my work in Norway would be divided into 3 parts:

a. To attend the first workshop in 1998 for the subject.
b. To accept training on AirQUIS concerning task 1.
c. To discuss task work with Norwegian task member.

After a month's hard work, I thought I had done my job very well, and achieved the purpose basically. In the following I will give a detailed outline of my stay in Norway.

1 FIRST WORKSHOP IN 1998

The first workshop in 1998 of our subject was held respectively in Oslo and Ulvik, Norway, during May 11 to 15. The workshop was divided into two stages. From May 11 to 12, the task group representatives stated their status reports and plans of next 6 months, in Ulvik. From May 13 to 15, in Oslo, task members from both sides discussed problems raised during the first stage of the workshop. Necessary coordination between task groups were made. And finally, the workshop came to a conclusion.

During the meeting in Ulvik, Mr. Gram, who is the leader of task 1 for the Norwegian side, and I exchanged comments of ourselves about the status report. He gave his answer and explanation to the questions that had bothered the Guangzhou members of task 1. We combined the status reports of our own to make a complete one. Representing task 1, Mr. Gram made the statement concerning our report at the meeting, and we both answered questions raised by the workshop participants. After that, we listened to the reporters from the other tasks.

In the first stage of our workshop in Ulvik, task 1 was demanded to finish 2 jobs.

- Traffic emission factors for SO_2 and particles are necessary, they must be worked out.
- The plan of next 6 months was lack of the finishing time for every item, it should be decided through discussion during the second stage of our workshop.

Finally, Mr. Larsson, the project leader of NORCE side, said that task 1 was the key of the whole project, the progress of which would have a great effect on other tasks, or even on the whole project, and we must establish the preliminary emission inventory as soon as possible. Mr. Larsson made an introduction about the three sequences of the project. He said that our work now is still at the first sequence, and we have much to do afterwards. What we should do at the second stage of the workshop was that every task group should make clear what was its contribution in the three sequences, when was the date to supply input data and whether there would be any critical retard.

At the second stage of the workshop in Oslo, Mr. Gram and I mainly discussed the following questions: how to complete the emission factors for point sources and traffic sources, how to rearrange the emission data at hand and how to collect information on time variation, etc.

At the closure of the workshop, representing task 1, Mr. Gram made the statement about our discussion. According to Mr. Larsson's requirement, task 1 should supply the following data to other tasks during the first sequence.

Input/output	from	to	Time	Remark
Emission factors from fuel use	Task 1	Task 7	By May	
Emission factors for sectors	Task 1	Task 8	By May	Production/ production value
Emission factors from traffic	Task 11	Task 1	By May	SO_2, part. missing
Emission data of 1995 for KILDER	Task 1	Task 3 Task 12	By May	SO_2, NO_x, CO, part. Others?
Population distribution 95	Task 1	Task 5	By May	
Final emission data 95	Task 1	Task 3	By Aug.	
Baseline scenarios 2010 by sectors	Task 8	Task 1	By June	
Emission factors 2010 for scenarios	Task 7	Task 1	By Aug.	
Emission data 2010	Task 1	Task 3	By Sep.	
Population distribution 2010	Task 1	Task 5	By Sep.	
Point source technologies	Task 1	Task 2	By Aug.	
Emission 1996,1997,1998	Task 1	Task 3	By Sep.	Scaling of 1995
Time variation for point sources	Task 1	Task 3		

This workshop let me have a better understanding of the relationship between task 1 and the whole project and other tasks. That would help me a lot afterwards.

During the second stage of the workshop in Oslo, with the other trainees and the delegation, I paid a visit to the AirQUIS 1.0 system, which was installed somewhere at Grorud, suburb of Oslo City. We still received an introduction of the local air-pollution-control status by EPB of Oslo, and visited ECON, a partner of the project. This made a good foundation for our training that would be coming.

2 AirQUIS TRAINING

According to the pre-set plan, I would complete the following courses in NILU.

	Topic	Duration (days)
1	Talk/Introduction of the emission database and model, including an explanation of important concepts like Time Variation, Validity Period, Alternative and Temperature Dependence.	1
2	Presenting the system on the screen (using	1

	cannon), with focus on general functionality, including GIS, and on emission related data (which is almost everything, when you include measured meteorological data).	
3	Importing all necessary kinds of data.	1
4	Looking at the imported data in general, and at emission factors and traffic emission factors in particular.	0.5
5	Showing emission data on the map.	0.25
6	Exporting data and reporting.	0.25
7	Creating Emission Compositions.	0.5
8	Calculating total emission based on an Emission Composition in various result set types (point, line, grid, region) and view the results.	0.5
9	Creating Alternative data.	0.5
10	Calculating emission based on an Emission Composition that includes alternative data. View the result, and compare with "original" results.	0.25
11	Reporting the result and the sources that were used. Work out a good template for a "standard report".	2

After the closure of the workshop on May 15, we planed to take our training courses from May 18, Monday. Due to the unsatisfactory preparation of Norwegian side, we had to retard the beginning course to the next day. And I decided to continue the task work discussion with Mr. Gram.

As the AirQUIS 2.0 version was under examination and modification, there were many shortcomings in the system. Therefore, we failed to accomplish the training completely according to the plan. The actual duration was less than 5 days. There were many little problems like units and date in the import modular, this led to an unsuccessful data import trial. Still more, because the existent GIS of Guangzhou area had a different supporting interface with the AirQUIS 2.0 version, we failed to complete the GIS transforming. So, we could not show the emission data of Guangzhou on screen. During the whole training course, the demonstration was often come to an interruption, due to the necessary modification, which was done in Bulgaria. Because of the unsuccessful importing, necessary calculations became impossible, nor did the viewing of results and reporting.

At the beginning of the training on May 19, Mr. Riise gave every one of us a draft copy of ENSIS 2.0. From this copy, I learned that AirQUIS 2.0 was a part of ENSIS 2.0, which was rewritten from the 1.0 version. It needs support of Windows NT4.0 - or higher - version. As it was almost rewritten from the beginning, the new 2.0 version would have a stronger function. It can supply different services according to the privilege level. In this system, we can make various definitions if necessary, such as units, region border, validity periods, ID-groups, etc. According to Mr. Riise's introduction, there are many new concepts like time variation, validity and alternative in AirQUIS2.0. Since this system was not yet very perfect, Mr. Riise mainly focused on its general functionality. He showed us on GIS of Oslo some examples of road net, road nodes, coordinates and point emission.

Even if it was still not very perfect, I have such an impression on the AirQUIS 2.0. Indeed it is a modern, advanced management system. It has a stronger function than the Kilder, which almost is only a calculation model. In this system there is little rigid regulation to the data. We can import any concerning data if we believe it useful, as long as we set the proper import format to it. When we need some kind of data that is not at hand, we can use default data as replacement—of course the default is defined by experiences of long term accumulation. When equipped with detailed GIS, we can show on screen different kinds of calculation results clearly and conveniently. When we have enough data of pollution sources and meteorology for several years, we can use this system to do jobs of forecasting.

Regretfully we failed to transform the Guangzhou GIS in this new system. And further more, our GIS seemed not as detailed as that of Oslo. It was a great pity that our trainees could not do the whole practice on this system due to a series of little problems that were still unsolved. The NORCE side promised that the test would be finished in September of this year, and that they would do the installation in Guangzhou as soon as possible. We expected that the day would come soon.

3 Task Work Discussion

Thanks to the shortening of training course, I had more time to make discussion on task work in detail. During the stay in Norway, I had 5 Saturdays and 5 Sundays. In addition, May 21 and June 1 were public holidays. Mr. Gram went out of Oslo for meeting on June 3-4. Altogether I made discussions with Mr. Gram, Mr. Krogh and other task members for 7 working days.

Firstly, Mr. Gram and I exchanged opinions for the calculation of emission factors. We both agreed that cleaning devices must be taken into account. A new database of cleaning efficiency for 4 pollutants should be made, and the Guangzhou side was responsible for this work. In addition, through discussion with Mr. Krough from IFE, we agreed that the Guangzhou side would make out a note of emission factors for fuel use. As for emission factors for different sectors, we decided to go no far.

About the database made from the recovered questionnaires, the Norwegian side demanded an explanation report, and I agreed that I would complete it when I went home.

Mr. Gram explained the concept of time variation to me, and I learned its use. But about how to collect data and make out the curves, we both could tell no more.

As regard to the emission technologies, because the concerning task groups had not raised such demands when task 1 made and sent investigation questionnaire, we could not get useful information of that sort from the feedback. After coordination meeting, it seemed that we had to look for such data from the existent database. Task 1 would deliver the database, while he who wanted such data should do the extracting by himself.

Thank to lack of relating emission factors, process emissions would be left for further discussion in the future stage.

Mr. Gram was satisfactory with the population data and district maps that task 1 had delivered to him. He hoped that we should import the data as soon as possible when AirQUIS 2.0 was installed and GIS transformed successfully.

Mr. Gram believed that it was not enough that in the small grid net there were only 140 roads. And further more, in the big grid net, we had little information about traffic emission. Task 1 should do more on this aspect.

Examining the road data from task 1, Mr. Gram discovered some obvious mistakes. There were some grids whose total road length was 0, while on map it was not the case. He asked a reasonable explanation and necessary modification.

As for emission factors for traffic, data for SO_2 and particles were necessary. Task 1 should do its best to make them out. Meanwhile, the Norwegian side promised some help.

Other emission data such as plane emission, ship emission and railway emission were still demanded.

Through discussions of 7 days, I get a clear recognize of the present problems in task 1 work. Both sides came to a same start. That made a good foundation for our work of next stage.

4 Other Events

I started for Norway in the date of May 8, arrived in Oslo the day May 9 (local time). The mission ended on June 8 when I left for China. The duration was 31 days. During my stay in Norway, the Norwegian side, especially Mr. Larsson and Mr. Gram gave me great help. That enabled me to work and live in Norway smoothly.

When in Ulvik, I lived in a local hotel named Brakanes together with the other Chinese members. When in Oslo, with the other 4 trainees, I lived in an apartment located on Herslebsgate 7. From May 15, the bus drivers in Oslo were on strike (it did not end the day I left Norway). The way to NILU became time consuming. It took me 15 minutes by foot from apartment to Oslo Central Station; from there to Lillestrom by train, 30 minutes; and from Lillestrom to Kjeller, where NILU located, I must walk for 40 minutes. The everyday back way was the same. Wholeheartedly I thank Mr. and Mrs. Gram, as well as Mr. Riise and Mr. Tonnesen, very often they drove me from Lillestrom to NILU in the morning, or sent me to metro station in the afternoon. Thus I saved much time and felt less tired. Once again I thank the Grams for their cookers, which solved a big problem for me when I did the cooking everyday.

We must thank Mr. Larssen, who did a lot for our late baggage.

At the weekends I made sightseeing with the partners in Osa of Ulvik and a sculpture park in Oslo. In the national day of Norway, May 17, all of us watched the celebration march in front of the loyal palace. Sooner or later, I accepted invitation to visit homes of Mr. Yaeger from IFE, of Mrs. Zhao Xu from ECON and of Mr. Gram. Every time I felt happy. Here I give them my best whishes.

Schedule of Training in Norway

Date	Content	Remark
0509	Arrived in Oslo early morning, at Ulvik at 18:00.	Saturday
0510	Took rest and paid visit to Osa.	Sunday
0511	Made discussion with Gram and participated workshop in Ulvik.	
0512	Meeting ended, back to apartment at midnight.	
0513	Visited NILU. Workshop closure discussion.	
0514	Visited AirQUIS 1.0 and ECON. Listened to the introduction of Oslo air pollution control status.	
0515	Attended workshop closure and task group coordinating meeting in NILU.	Bus strike begins
0516	Sightseeing in Oslo City with the delegation.	Saturday
0517	Watched Norwegian national day celebration march, siad goodbye to the delegation at railway station.	Sunday
0518	NILU, task work discussion with Gram.	
0519	NILU, material study on AirQUIS 2.0.	
0520	NILU, general introduction of AirQUIS 2.0 by Riise.	
0521	Training material study in apartment.	Norwegian public holiday
0522	NILU, operation trial of AirQUIS 2.0, import experiment, GIS transforming not successful.	
0523	Spontaneous discussion on task work among trainees.	Saturday
0524	Visited Mr. Yeager's home.	Sunday
0525	NILU, no AirQUIS training. Discussion on concept of time variation and on traffic data with Gram.	GIS transform still unsuccessful
0526	NILU, discussion with Gram. IFE, discussion on calculation and use of emission factors with Mr. Krogh.	
0527	NILU, traffic emission discussion.	
0528	NILU, making clear the discussion results with Gram.	
0529	NILU, exercise on AirQUIS2.0.	
0530	Visited Zhao Xu's home.	Saturday
0531	Sightseeing and picnic around the suburb with Gram's, visiting their home near Lillestrom.	Sunday
0601	Studying materials in apartment and arranging thoughts from the early discussion.	Public holiday
0602	NILU, coordination meeting between concerning task groups, mainly involving emission factors, time variation and cleaning efficiency.	
0603	Reading materials in apartment. Seeking a good method for the work afterward.	Mr. Gram out for meeting
0604	NILU, Riise made a demonstration of AirQUIS 2.0 after some modification, but no better results.	Mr. Gram out for meeting
0605	NILU, final discussion on task 1 with Gram, reaching work direction and plan. Bye to him.	
0606	Training in Norway ended.	Saturday
0607	Visited botanical garden near the apartment.	Sunday
0608	Started to Fornebu at 10:00, took off for home via Copenhagen at 13:48.	

Training Report

Fang Xinqing (Task 3 Dispersion Modeling)
Guangzhou Research Institute of Environmental Protection(GRIEP)

Original Training Program

A Course in AirQUIS Emissions and Modelling

This course will be held for participants from Guangzhou. It will cover all topics related AirQUIS' functionality for emission inventory generation, emission modeling, wind modeling and dispersion modeling. It will also contain a general introduction to the AirQUIS functionality, including the GIS user interface.

The following must be regarded as preliminary plans for the course. Some changes may be introduced at a later stage.

The course is planned as starting on the 18th of Mai, 1998, and is to be held at NILU.

Emissions

The first topic to be discussed is the functionality immediately connected with the emission inventory. The various topics will be covered in the following order:

	Topic	Duration (days)
1	Talk/Introduction of the emission database and model, including an explanation of important concepts like Time Variation, Validity Period, Alternative and Temperature Dependence.	1
2	Presenting the system on the screen (using cannon), with focus on general functionality, including GIS, and on emission related data (which is almost everything, when you include measured meteorological data).	1
3	Importing all necessary kinds of data	1
4	Looking at the imported data in general, and at emission factors and traffic emission factors in particular.	0.5
5	Showing emission data on the map	0.25
6	Exporting data and reporting	0.25
7	Creating Emission Compositions	0.5
8	Calculating total emission based on an Emission Composition in various result set types (point, line, grid, region) and view the results	0.5
9	Creating Alternative data	0.5
10	Calculating emission based on an Emission Composition that includes alternative data. View the result, and compare with "original" results.	0.25
11	Report the result and the sources that were used. Work out a good template for a "standard report"	2
		7.75

Wind Modeling and Dispersion Modeling

The second part of the course will cover all topics regarding the AirQUIS wind and dispersion modeling functionality.
The various topics are covered in the following order:

	Topic	Duration (days)
1	Introduction to Wind and Dispersion Modelling	1
2	Introduction to the AirQUIS Modelling system, logic and implementation	0.5
3	Defining the modelling grids, and importing surface data (topography and possibly Z0)	1
4	Choosing measurement stations/time series in the Meteorological Composition	0.5
5	Generating a homogenous wind field based on a Meteorological Composition and viewing the result	0.25
6	Modelling a non-homogenous wind field based on a Meteorological Composition and viewing the result	0.5
7	Choosing/generating an Emission Composition as shown under the Emissions part.	0.5
8	Calculating total concentrations based on an Emission Composition and Meteorological Composition in various result set types (point, line, grid, region) and view the results	2
9	Calculating concentrations based on an Emission Composition that includes alternative data. View the result, and compare with “original” results.	0.5
10	Report the result and the sources and meteorology that were used. Work out a good template for a “standard report”	2
		7.25

The total duration of the course is set to three weeks, that is 15 working days. The suggested programme covers the same duration. Experience shows that during such visits, other tasks and practical problems will consume some time. We may therefore have to cut down on the proposed programme.

Real training situation

1. General situation

AirQUIS is the air part of ENSIS - Environmental Surveillance and Information System. It’s one of the main research tools in our project supported by NORCE side, the work of developing the government action plan in the second half of 1998 and in 1999 is just on the basis of this tool. The program editing and revision work of the new version –ENSIS v.2.0 is being done jointly in Bulgaria. The finishing of the developing work was delayed by several months compared with the expected time, so during the training period, NILU had just received the test version the ENSIS v2.0, and it was under test.

The real training of AirQUIS was affected to some extend because of the above situation, but because the general function frame of the system had been decided with direct visible demonstration, we could study the main function interfaces more deeply than from the document only, and the study results were encouraging.

I was also conducted how to establish the wind field library and the selection rules, as well as the MATHEW model, these theories will lay solid foundation of the real application work.

Additionally, I also ran the meteorological modules of the KILDER model together with NILU expert, and found some early problems of the provided executive modules. Finally, I discussed with NORCE experts of task 3, 5 and 6-1 about the relationships between tasks.

2. *Main training contents*

ENSIS v2.0

A. Operating environment : MS Windows NT4.0 or higher

B. Introduction of main functions

File
Login
Logout
New project
Open Project
Close Project
Delete Project
Import---import (text format)
---import (ENSIS format)
Export ---export (text format)
---export (ENSIS format)
Print
Exit
Geographic Areas
Map
Region ---Administrative region ---geography
---dataset
---Catchment ---geography
---dataset
---Treatment Area---geography
Grid ---geography
---dataset
River ---River system---river node
---river link
---river chain
---dataset
Lake --- geography

--- dataset

Measurements

Data series
Station ---stations
---Instruments at station
---Measurement position
Instruments

Pollution sources

Point data ---industry---air sources
---dataset
---water sources
---Municipal waste water---WW treatment plant
---treatment districts
---Building points---building points definition
---dataset
---Receptor points---receptor points definition
---dataset
Line distributed data---road node
---road link---definition
---dataset
---road chain
---net node
---traffic emission factors
Area distributed data---Air sources dataset
---spatial conversion

Models

Meteorology ---composition
---run model
Air emissions ---air source composition
---run model
Air dispersion ---Definition of background concentration
---run EPISODE
Effects ---run Population Exposure Module
Results

Calculations and graphics

Statistics ---descriptive statistics
---regression
---methodology ---rose
---stability frequency
---met. Frequency
Aggregation
Scaling
Graphics

Report

Report generator
Report template
Report

Address

Industry
Owners

Laboratory
WW treatment plant
Definition
Medium
Component
Parameter
Geographical area ---level
---river type
---bottom materials
---lake type
---area type
Measurements ---analysis
---quality flag
---instrument ---instruments
---instrument type
---measurement principle
---accessories
---quality assurance ---parameter limits
---sum of components
---surrounding area type
---site classification code
Pollution sources ---source category
---line of business
---emission factor
---products
---fuels
---vehicles class
---road classes
---road class default data
---temperature dependence function
---volume delay function
---raw materials
---activity category
---WW treatment method
---type of sludge treatment process
---type of sludge handling
Alternatives
Validity period
Time variations
Administer
Building frontage type
Data type
Unit type
Units
Calculation method
Quality classification system ---quality classification system description
---quality classification values
Help
ENSIS main help
Contents and index

About

The above mentioned course is mainly conducted by Mr. Atle Riise of NILU

3. Procedure for creating a Guangzhou wind field library

Goal:
To create a set of wind fields which will encompass all cases of data in the historical observations, and to establish a procedure for selecting one wind field from one real-time observation.

Tools:
(I): The historical meteorological data from 5 ground-level stations and one radiosonde station for a two year period.
(II):The topography data for the model grid.
(III): The MATHEW wind field model.

Procedure:
Analysis of the cases represented in the historical data.
For station 287 the observations should be divided into seasons, April-September and October-March. Observations made at hours 02,08,14 and 20 should then be used to create 8 matrixes of occurrences, each consisting of 16 wind-direction entries , 4 wind speed entries and two cloud cover entries. The wind speed entries are shown below.

Wind speeds:	< 1,5 m/s	1,6 m/s-3,0 m/s	3,1 m/s - 5,0 m/s	> 5,0 m/s

The cloud cover entries should be total cloud cover of 4 or less and of 5 or more. The number of occurrences matrixes will show the number of times a given combination of wind direction, wind speed and cloud cover have occurred for four different times of the day in two different seasons. The most frequent situations will have a high number in the matrixes, and many combinations will have zero number of occurrences.

Choosing contents of the library
Each occurring situation (as defined by a non-zero entry in the occurrence matrixes) should be represented by one generated wind field. Because radiosonde data only exist for hours 08 and 20, these must also be applied together with the observations made 6 hours later. The MATHEW model must be run for each occurring situation. When there are more several situations for one combination of speed, direction and cloud cover, **one** must be selected. This selection should be made based upon the following criteria:

- Completeness of data. The maximum number of observations from the four other ground level stations should be available, and they should have a defined wind direction.
- Representativeness of the cloud cover: For cloud cove less than 4 , minimum cloud cover should be chosen. For cloud cover of 5 or more, maximum cloud cover should be chosen .
- Most representative wind speed: For station 287 , the wind speed closest to 1 ; 1,8 ; 4,0 or 6,0 should be chosen.

If there are still more than one situation satisfying all the criteria, any of them can be used.

Generating the library

The wind field model should be run for each chosen situation. The output fields should be tested against the observation sites. This type of model will tend to underestimate the wind speed in the ground level.

The underestimation can be compensated by scaling up the wind speed in the whole field by the ratio between observed and calculated wind speed. This should be done for ratios of more than 1,25.

Choosing a wind field

The library will now consist of one field for each of 2 seasons, 4 hours of the day, and all observed combinations of up to 16 wind directions, 4 wind speed classes and 2 types of cloud cover. Any real-time observation that have occurred in the two year data observation period will have a corresponding wind field in the library. If the observed situation do not have a corresponding entry in the library, the "closest" corresponding field/observation should be chosen.

The "closest" corresponding field/observation should be found using the following search-criteria:

1) Disregard the cloud-cover, look in the other cloud cover class.
2) Disregard the time of the day, look in the other hour-classes.
3) Disregard the season, look in the other season-class.

If still no corresponding field/observation is found, look in the correct cloud cover - hour -season class for observation/fields within the two closest wind-direction classes. Next, look within the next higher wind speed class and eventually the next lower wind speed class. Then disregard cloud cover, hour and season. If there is still no observation/field present, look in the two next wind direction classes.

If there is still no corresponding entry in the library, use the last previously chosen wind field.

When this last choice have been made, the wind field library should be expanded to cover the :on-matched case" by running the mathew wind field model with all available information for the hour that did not have a corresponding entry in the library.

The above mentioned contents was conducted by Mr. Dag Tonnesen of NILU

4. The use guidance of MATHEW wind model

A. Preparation of topography data file , the file name can be gzdixing.top
Its format is as:

dummy,Nx,Ny A20:2I3
i, j,height(m) Free format

B:Editing top.run(the batch running file of topog.exe):the name of file is fixed, and should be in the same directory as topog.exe.

c mathew original DX(km) DY(km) DZ(m) IM JM KB flat terrain option
0.0 0.0 1.0 1.0 60.0 52 56 30 0

‘..\dat\gzdixing.top’ ! input filename
‘..\res\gzdixing.res’ ! output filename
‘..\res\laygz.top’ ! high level filename
c 0 there is topography, 1 it is flat terrain

C: Run topog.exe

D:Preparation of meteorological data files
The filenames are as:
..\met\287.dat ..\met\279.dat ..\met\284.dat ..\met\294.dat ..\met\480.dat
..\met\287up.dat
the data format of ground observation file for the central station:

```
 year  month  date  hour  wind speed  wind direction(degree)  stability
 95  1  1 23   1.23   3.19     5    4I3,2f7.2,I7
 95  3  1 23   1.23   3.19     2
 95  7 23  0   2.23 353.18     4
```

the data format of ground observation file for other surrounding stations:

```
year  month  date  hour  wind speed  wind direction (degree)
 95  1  1 23   1.53  43.19   4I3,2f7.2
 95  3  1 23   1.63  73.19
 95  7 23  0   2.73  53.18
```

the data format of radiosonde observation file for the central station:

```
year  month  data  hour  wind speed  wind direction(degree)
 95  1  1 23 112.23   5.10   35.5    4I3,3f7.2
 95  1  1 23 845.00   6.80  289.5
 95  1  1 231546.89   7.60  356.8
 95  3  1 23 101.23   4.10  240.2
 95  3  1 23 834.53   6.50  345.2
 95  3  1 231481.26   8.40   34.8
 95  7 23  0 122.56   5.00  353.1
 95  7 23  0 122.56   5.00  353.1
 95  7 23  0 122.56   5.00  353.1
```

note : the time solution of the meteorological data files should be consistent with each other

E. Editing mathew.inp (the batch running file of mathew.exe)

```
0.4                                 ! Minimum allowed observed windspeed.
0.4                                 ! Minimum allowed calculated windsp.
'..\res\gzdixing.res'                ! Filename for topography 1000m.
'..\res\gzoutput.fld'     ! Resulting output filename (it is a binary file).
0          ! 1= average from 4 to 1 grid-cells   0= no averaging.
0          ! Number of km in x direction to Episode origo
0          ! Number of km in y direction to Episode origo
0          ! Number of km to cut in x-direction from eastern border.
0          ! Number of km to cut in y-direction from North border.
210         ! IHOUR  Number of hours.
5          ! (Number of surface met. stations)
'..\met\287.dat'    ! Met. observation file name.
'guangzhou'   27.50  28.4  10.0  ! Stname xpos(km) ypos(km) Hwind
'..\met\284.dat'    ! Met. observation file name.
'huadu'   17.2  55.9  10.0        ! Stname xpos(km) ypos(km) Hwind
'..\met\480.dat'    ! Met. observation file name.
'shunde'   20.3  0.1  10.00       ! Stname xpos(km) ypos(km) Hwind
'..\met\279.dat'    ! Met. observation file name.
'shanshui'   0.1  32.8  10.00     ! Stname xpos(km) ypos(km) Hwind
'..\met\294.dat'    ! Met. observation file name.
'zengcheng'   51.9  47.4  10.00  ! Stname xpos(km) ypos(km) Hwind
1                       ! (0=no SODAR measurements, 1=SODAR meas. available)
'..\met\287up.dat'        ! SODAR observation file name.
27.50  28.4   3       !For SODAR meas:xpos ypos n. of levels
```

```
     0.4  10.0  ! (average surface roughness for the area)(Most common wind meas.
height)
3          ! Number of layers for Episode.
20.        ! Thickness of first layer (m) of Episode (dispersion model).
30.        ! Thickness of 2nd layer (m) of Episode (dispersion model).
150.       ! Thickness of 3rd layer (m) of Episode (dispersion model).
```

F. run MATHEW

Mathew < ..\dat\mathew.inp

G. conversion between ASC code and binary code with ..\tools\convta.exe and ..\tools\convtb.exe

The above mentioned content was mainly conducted by Ms. Christina Guerreiro and Mr. Dag Tønnesen

4. Running the meteorological modules of KILDER model together with NILU expert

During the running , we found the following problems:

A. The time solution of the input file guided by the user manual is hour 0-23 daily, but the model itself dealt with the data by hour 1-24, so the result file had some strange output;
B. The statistical sum of the percentage was not 100%, so there may be some calculation errors in the program itself.

The NILU expert promised to revise the original codes of the corresponding modules:WINDFREC:STABFREC:METFREC, and email to Guangzhou.

The above mentioned content was conducted by Mr. Frederick Gram of NILU.

5. Discussing with NORE task leaders of task3, 5, 6-1about the relationships between tasks

NORCE experts inclued Leiv Haavard Slørdal(new task leader of task 3 and 5) Atle Riise(former task leader of task 3 and 5) K.Aunan and J. Clench-Aas.(task 6-1)

Training Report

Cui Xia (Task 7, control option)
Guangzhou Research Institute of Environmental Protection(GRIEP)

Following the arrangement of the work plan of Sino-Norwegian cooperation project “Guangzhou Air Quality Management and Planning System”, I studied and worked in Norway during May/June 1998. In this paper, I will report my training and work in Norway.

1. Time
   The time of exchange was from 8th May to 26th June, 1998.
2. Place
   The training place was at NILU and at IFE, the main trainers were Mr. Riise, Mr. Yager and Mr. Krogh.
3. Trainee
   The trainee from Guangzhou was Mr. Cui Xia. Gz task leader of Task7 and task team of Task 3 of CHN013 Project.
4. Objective
   The objective of the exchange program was to learn the air quality information system, AirQUIS, represents the air pollution part of a modern ENvironmental Surveillance and Information System, ENSIS. The other objectives of the exchange program were to learn a multi-period, linear-programming model for energy system , MARKAL ,which can be applied to scenarios or cases that embody a variety of assumptions or restrictions; and identifying and discussing the possible control options.
5. Contents
   (1) In NILU
   I had got training in NILU for AirQUIS from May 18th to Jun. 5th, 1998. I had learned a lot of knowledge of AirQUIS:

   The Air Quality Information System, AirQUIS, represents the air pollution part of a modern ENvironmental Surveillance and Information System, ENSIS. AirQUIS was installed in Oslo in 1996 and has since then been used to describe and forecast the air pollution situation in the capitol of Norway.

   In addition to presenting on line measurements of meteorology and air pollution, the system calculates the pollution concentration distribution and the public’s exposure to air pollution. It also predicts the air pollution situation based on the predicted weather conditions.

   The context of the AirQUIS system:

   The episodes of high impact of air pollution in Norway occur in the winter season during calm, cold periods with unfavorable meteorological conditions. The problems are mainly linked to emissions from traffic, especially particle pollution related to the use of studded tires. Daily average values of PM_{10} of 100 - 150 ug/m^3 can occur along the major streets during these winter episodes.

The measurements are available for the publican Internet and automatic presentation in the Town Hall.

The authorities also use the system as a planning and decision tool, by evaluating the effect of reduced air pollution related to different planned measures. The effects of changing the road network or new establishment of industry can be evaluated by changing the input in the emission module and calculate the concentration distribution by using the air quality dispersion model established for the Oslo city.

An automatic management system for the environment:
The development of computer software and hardware, on line monitors and telemetric systems have opened the possibility to make environmental data available to planners, authorities and to the public. In line with awareness and strong focus on our common environment, the key features of the modern environmental management system is the integrated approach that enables the user to access and use the data directly in the assessment and in the planning of actions. The demand of integrated systems to enable monitoring, forecasting and warning of pollution situations has been and will be increasing in the future.
To fulfill the needs for modern air quality management, the followingmodules are included in the AirQUIS system:

* on line sensors with data loggers,
* automatic and manual data acquisition system,
* measurement data base and graphical presentation,
* emission inventory database,
* emission models,
* atmospheric dispersion models,
* exposure models for public health
* air quality indicators,
* statistical evaluation tools
* data import and export
* wizards for reports

All functionality between the modules is integrated by a user friendly map oriented interface with self explainable menus to enable the user cooperate the system without advanced knowledge of computer systems.

Data acquisition and quality control:
Modification and development of new sensors and data loggers are necessary to meet the requirements of a modern environmental management system. Special designed flexible data loggers are developed to collect and store data from different types of monitors. An automatic data acquisition system has been developed for collection of data directly from the monitors and into the AirQUIS Measurement Database. Quality control is performed at the stations during automatic and manual calibrations and in the central database following ISO quality assurance routines.

The emission inventory database:

A modern data base for emissions to air has been developed. The emission module is a flexible system containing a map oriented interface to treat the sources for emissions to air such as industry, traffic, airport and harbor activities and domestic energy consumption. The sources can be selected either by activities or area distribution. The traffic module is the most complex part of the emission module, taking into account variables such as road type, facades, vehicle type, driving speed and traffic time variation.

Atmospheric dispersion models:
The dispersion models in AirQUIS covers air pollution on all scales in the urban environment; street traffic, industrial emissions and emissions from household. The NILU developed model EPISODE calculates spatial distribution
of hourly concentrations of the main air pollution components in the urban atmosphere. The NILU model CONTILINK is used to estimate sub grid concentrations close to roads within the square grid. A puff-trajectory model is used to calculate the impact from point sources.

Air Quality Indicators:
Many national and international authorities are presently working with selection of environmental indicators. The aim is that the indicators can form a basis for evaluating the impact on humans and the environment as a whole. At the moment, most of the indicators are related to air pollutants for which air quality guidelines are available.

A set of indicators based on combination of measurements and models results can be established in the AirQUIS system. These indicators may be a single parameter or derived from a set of independent variables, both modeled and measured, to reflect the status of the environment.

The platform:
The AirQUIS system version 2.0 is a Client-Server system, developed for the Windows NT platform, and running on IBM compatible Pentium or Pentium Pro PCs. The preferred data base system is Oracle, but other relational databases can be used. The integrated geographical information system is based on Map Objects from ESRI and implements a map oriented platform directly linked to all modules. This gives a user friendly, fast response and menu based user interface.

Installations:
The AirQUIS system has been installed in the major cities in Norway. In addition, installation in three cities in China will be performed next year. In Egypt and Botswana, the authorities has decided to use AirQUIS as the national air quality system for both measurements and emissions to air from traffic, industry and household. Several other clients have contacted NILU to discuss further the implementation of AirQUIS.

According as ENSIS and AirQIUS system construct and characteristic , I studied the contents in NILU:

- How to log on to the ENSIS system;

- Project definition;
- Geographical Information System (GIS) functionality;
- Import/Export functionality;
- Area Distributed Data;
- Point Distributed Data;
- Line Distributed Data_Road Traffic;
- The Air Emission model;
- The Meteorology model;
- Explanation of some important concepts;
- Exchanging Map Data of Guangzhou;

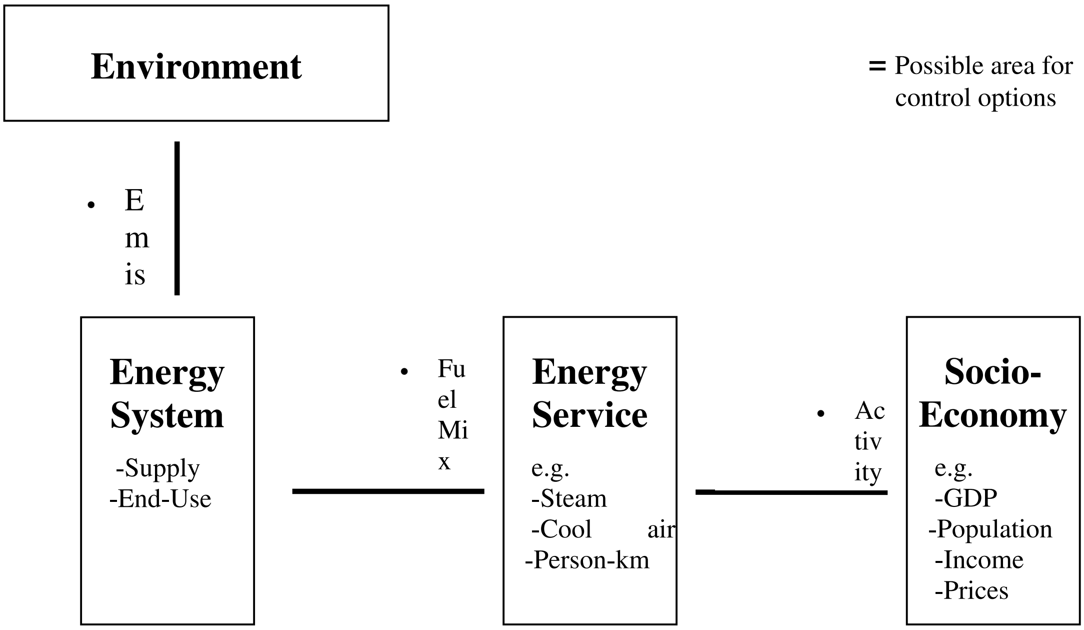
(2) In IFE

I trained for the MARKAL Model and prepared for running the model with the NORCE experts from June 9th-26th in 1998 in IFE .We discussed the workplan of Task 7 in later several months.

Energy is a necessary element of everyday life in all modern societies. We need energy to cook our food, heat our water, transport ourselves and the goods we buy. For producing the goods industry enterprises need energy, for some products lots of energy, and the buildings we buy our goods and services in are often air conditioned or heated. And as the societies grow they require more and more energy. How much more and what kind of energy is certainly dependent on the rate of growth of the economy, but also on the stage of development a society is at. E.g. in some very developed countries the growth rate in energy use seems to be stagnating (families do not buy 4 refrigerators or use 5 cars), but in a society where very few people have cars or advanced electric appliances like air conditioners, energy use is likely to grow rapidly as income rises. On the other hand, as countries or societies get richer they may use energy more efficient in producing the goods they need, e.g. they can afford buying more efficient boilers and machines, or they change their production towards producing good that require less energy, e.g. producing electronics instead of steel.

In most cases people and enterprises are not interested in energy itself, but rather the service that the energy can provide. What they are interested in is producing goods, cool buildings where the goods are sold, driving to work, transport to visit relatives out of town, hot water in the shower, etc., etc. Hence, in assessing how energy use may evolve over the next years or decades, it is very important to seek an understanding of the development of the various activities in a society that eventually results in the use of energy.

The figure below illustrates how the society and the economic activity of the society (called socio-economy in the figure) is linked to individuals and enterprises' demand for energy service, how this is linked to an energy system supplying these services, and finally the environmental impacts of the energy system activities. Demand for energy services is generated from the activity levels and the structure within the sectors that we can divide the society into. By structure we mean for example the type of production within the industry, e.g. how much steel is produced compared to other products, what kind of transport modes (e.g. cars, buses, train) we use to transport people and goods in. Driving factors behind the activity and structure development are GDP, population, income distribution, prices, etc. Calculated at end-use level energy intensity is representing the delivered, or final energy needed per unit of activity (a measure of end-use energy efficiency). Including supply side losses for each energy carrier (e.g. losses in production and distribution of electricity and city gas) we can measure the primary energy requirements per unit of activity, and finally by multiplying all fuels by its emission factor we calculate the emissions resulting from each of the activities in the various sectors.



This figure attempt to illustrate the principal elements that shape energy and emission developments, and thus to the areas where control options can be applied, indicated by arrows. Broadly speaking this includes;

- control options directed towards energy supply and end-use (reduce energy intensity and change to less polluting fuels),
- control options directed towards reducing emissions coefficients through introducing "end-of-pipe" technologies (e.g. scrubbers, catalyzers), or improved combustion (e.g. increased temperature, better tuned engines),
- control options can also be governmental programs and interventions directed towards reducing activities that are heavy polluters (e.g. closing of steel mills) and changing the structure of energy use (e.g. improving public transportation to reduce car use).

The MARKAL model is an integrated energy system least cost optimization model that determines the least cost means of satisfying the demand for energy services. MARKAL was developed in the early 1980's by the International Energy Agency's (IEA) Energy System Analysis Project. MARKAL is used by a wide range of agencies and institutions, in both developed and developing countries, which have energy sector planning and policy analysis functions. MARKAL modellers can also access a world-wide users support network established under the auspices of the IEA Energy Technology and Systems Analysis Project (ETSAP).

MARKAL (MARKet ALlocation model) is a highly flexible, multi-time period, linear programming model of a generalized energy system. It was developed in the early 1980s by the International Energy Agency (IEA) under the Energy Technology Systems Analysis Programme (ETSAP). MARKAL Model which is popularly used in the general energy system is a linear programing model with several time intervals. The model is established for estimating the application possibility of new energy technology in locality and nation.

MARKAL is ‘demand driven’, in that feasible solutions are obtained only if all the specified end-use demands for energy services are satisfied for every time period.It allows for the specification of energy supply, demand for energy services, transformation and demand technologies, and any limits or policy assumptions that may be set on the energy system, such as limited capital for investment, restricted petroleum imports, or limits on CO_2 emissions.

With these parameters specified, MARKAL then determines the configuration of technologies and fuels that represent the least cost means of satisfying the demand for energy services over the forecast time period.

Because MARKAL models a generalized energy system, it is capable of analyzing energy systems at a local, regional or national level.

MARKAL assists policy analysts and decision makers to track the complex interactions and feedback systems in their energy system, and assists them to quantify the effects of policy changes. Examples of policy applications of MARKAL include:

- least cost strategies to limit greenhouse gas emissions and other waste emissions from the energy sector
- assessing the impact of demand side management programs
- ·assessing the economic merits of inter-connecting national and international gas pipelines and electricity grids
- identifying the potential impacts of the introduction or removal of taxes and subsidies on energy production, energy consumption, and energy using technology
- ·identifying the potential role of improved technologies, such as clean coal technologies, renewable technologies, and more energy efficient technologies.

To determine the least cost configuration of the energy system, the user must detail in MARKAL both the items that constitute the energy system and the parameters that characterize each item.

Parameters include all possible constraints on the system and items within that system, such as availability of fuels, emission limits, and load constraints. MARKAL, like other optimization models, requires comprehensive and detailed data on the energy system in order to deliver useful results. To be an effective analytical tool users must be aware that considerable time and effort is required to develop a comprehensive database of the energy system to be modeled.

ANSWER is the Windows 95 interface to the MARKAL model, developed over 1996-1997 by the Australian Bureau for Agricultural and Resource Economics (ABARE), using:

·MS Visual Basic v.4

·MS Access v.7
·MS Excel v.7
·and GAMS.

It is mouse driven, visual, intuitive, and interactive. It provides the energy analyst with

·data entry/edit/browse
·model run
·results handling
·and charting facility.

ANSWER was developed to provide a modern Windows-based interface for MARKAL modelers.

ANSWER represents another step forward from the original and technically complex main frame version of the model, through the significant enhancement achieved by the PC based MARKAL Users Support System (MUSS), to this modern Windows-based PC version. These ongoing enhancements have enabled the MARKAL model to become more readily accessible and usable to the energy policy and systems analyst.

ANSWER MARKAL is PC based and is installed as an executable file. It requires the following:

·1.44 MB FDD (for installation)
·32 MB RAM or greater
·133 MHz Pentium processor or greater
·6 MB free HDD space
·SVGA monitor, set at 800 x 600 or greater
·MS Windows 95
·MS Excel v.7
·MS Word v.7

MARKAL model training in IFE:

- the interface and database of MARKAL Model
- the energy flow chart of Guangzhou (preparing for running MARKAL Model)
- estimating the treatment efficiency of industry , such as food , making paper , chemical industry and black metal
- classifying the industrial boiler according to the fuel (coal or oil) consumption
- installing MARKAL Model demo on portable computer.

6. Discussion with Task 1 and Task 2:

- Task 1 should provide the explanation of exiting emission factors and the future emission factors which are concerned with treatments,
- Task 1 and Task 2 should replenish boiler index , such as service life , capacity and price,
- Task 1 and Task 2 should replenish the price , installation and running cost of boilers and industrial kiln and furnace,
- Task 7 provide the future emission factors ,
- Task 7 and Task 2 provide the combustion rate of boiler and industrial kiln and furnace,
- Task 7 and Task 2 provide energy price especially for coal and oil,

- Task 2 provide capacity and loading curve of power plant boilers,
- Task 7 and Task 2 provide investment and running cost , by-product types and amount of desulfurizing installation in the power plant and other industries.

7. Discussion between Task 7 and Task 8
    - Task 7 provide the future emission factor to Task 8,
    - Task 8 calculate the total emission amount,
    - Task 8 provide the report to Task 7.

8. Discussion between Task 7 and Task 2, Task 8,Task 9, Task 11
    - Task 7 should provide investment and running cost to Task 9, include as follows:
        1. the scenario of new boiler replacing old one
        2. high-grade coal replacing low-grade one
        3. the power plant desulfurizing scenario
    - Task 11 should provide the scenario about 4ccMC replacing 2cc MC,
    - Task 2 provide the data about energy (especially for coal) and power plant,
    - Task 7 provide the boiler alternative scenario , include as follow:
        1. To improve boiler combustion system
        2. the replacement of power plant boiler
        3. To replace grates
        4. To replace valve gas outlet
        5. To improve compress air character
        6. To replace heat exchange system

9. Problem and suggestion
    - Since Task 7 is an important subtask , it is concerned with engineering and energy technology , model and computer knowledge. As time and professional knowledge are limited , I'm not able to master the engineer and energy technology in such a short time . I hope Task 13 to give me assistance.
    - As the NORCE didn't raise all the demand of data from the beginning , it is still a far way to finish the data collection. Such large number of data collection require a heavy outlay and it seems the funds aren't enough to finish the work.
    - The NORCE still don't promise to install MARKAL Model in Guangzhou and the train was very simple. I hope Task 13 can resolve this problem.
    - Some Functionality of the AirQUIS system were not clear because AirQUIS was delaied

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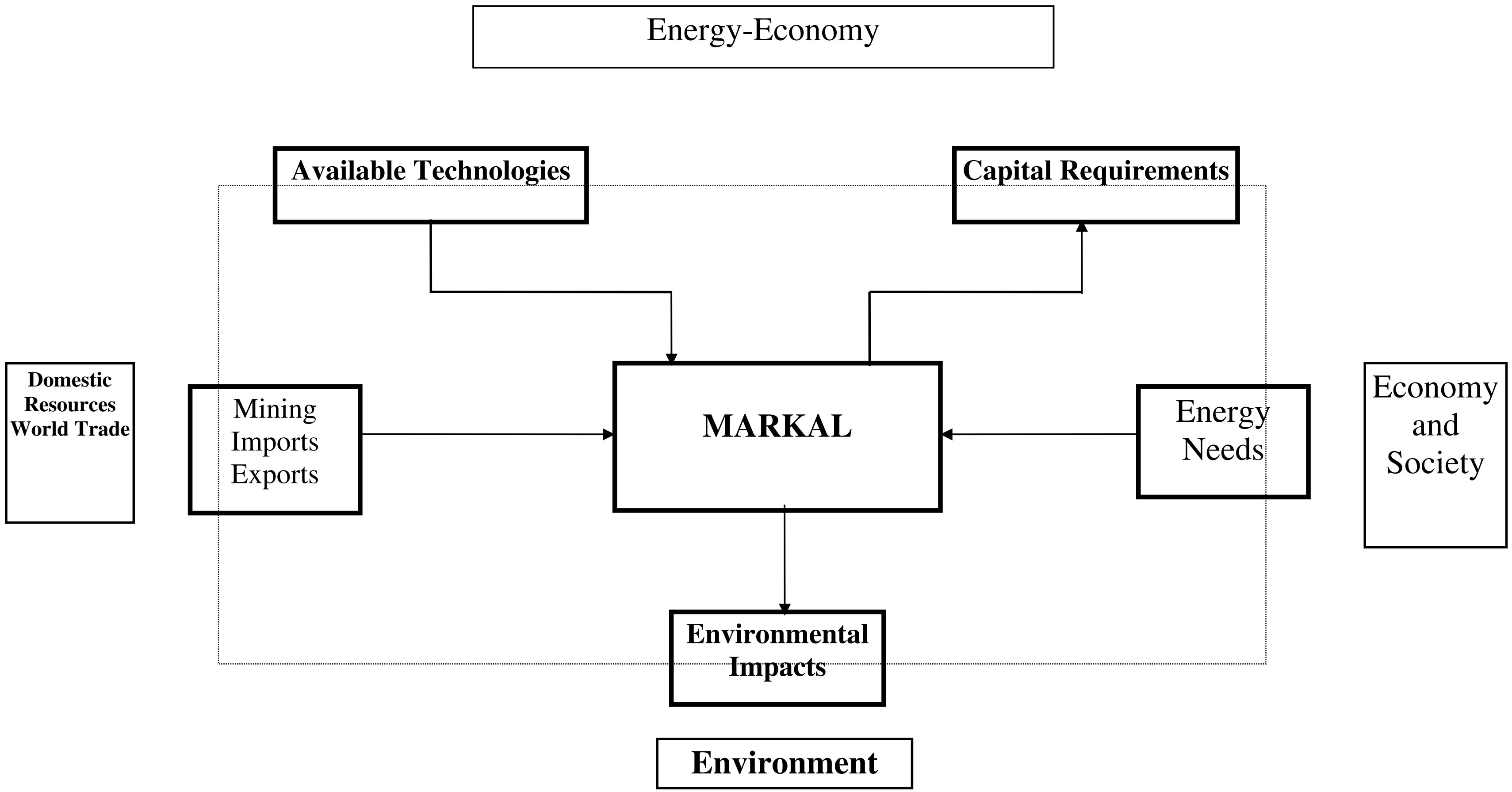
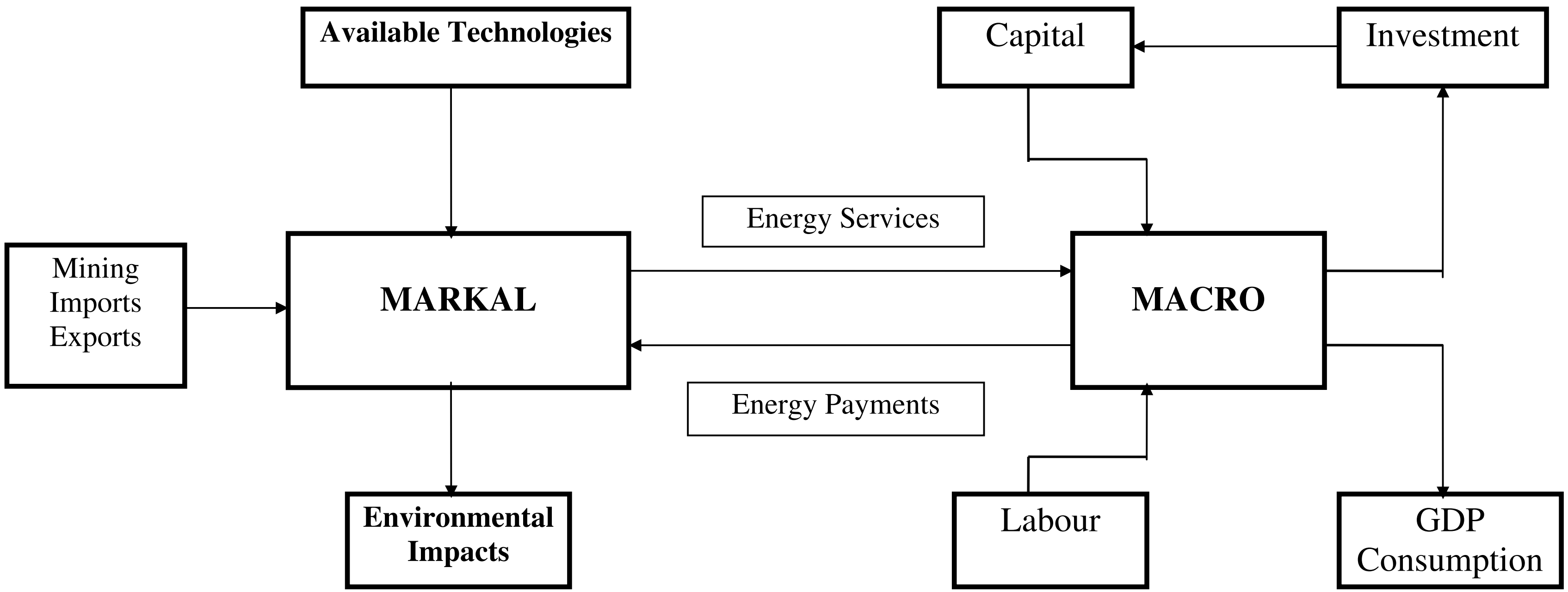
MARKAL and Economy/Environment



MARKAL:MACRO



The Training Report

Fan Changzhong (task 7, control option)
Guangzhou Research Institute of Environmental Protection (GRIEP)

1. The participants involving in the training

GZ side: Mr. Cuixia and Mr. Fan Changzhong

Norwegian side: Dr. Andrew Yager and Mr. Thomas Krogh

2.Training time

The training was carried out from the 16th of May of 1998 to the 26th of June of 1998 and it took 11 days.

3. The place where the training carried out

The training was carried out at the Energy Technology Research Institute(ife).

4.The targets of training

- Learn MARKAL model
- Begin to work on control options

5. The detailed works

- Calculate the emission factors

Based on the emission inventory task 1 provided, the emission factors of Nox, TSP,SO2 and CO were calculated by task 7 and task 8 collaboratively. The detailed results are summarized in the training report of task 8.

- **Perfect the tentative GZ energy balance flow chart**

Before the training task 7 had constructed a tentative energy balance flow chart for GZ. But it can't meet the requirements for running MARKAL model. So, during the training we improve it a lot and make it roughly meet the requirements for running the MAKAL model .

- **Analyze the in-use boilers**

As we know, the industrial air pollutants mainly come from the fuels burning in boilers and the air pollutants emission quite closely connected with the technological level of boilers. And also, if we want to control the pollutants' emission generated by industry sectors firstly it is essential for us to clearly understand the weakness and strength of boilers currently used in industry sectors and then we are able to easily apply a series of practicable control measures to tackle the weakness of the in-use boilers or even replace them with other type of boilers. So, in order to put forward very feasible control measures to control the fuel-burned emissions in boilers during the training task 7 employed the emission inventory task 1 provided to analyze and sort out the technological level of the boilers currently used in the industry sectors of GZ and roughly understand the weakness and strength of the boilers.

- **Analyze the control measures currently used in GZ**

Based on the emission inventory provided by task 1, task 7 analyzed the control measures currently used in GZ and got to know that the control measures currently used in the industry sector of GZ are mostly the dust scrubbing measures.

- **Discuss how to work on the control options**

During the training Norwegian experts and Chinese researchers agreed on that when we work on control options in our cooperating project we not only should pay much attention to the end-pipe control measures, but also we should direct our energy to other possible measures, such as the fuel switch, improve the combustion efficiency of boilers, improve the energy utilization efficiency and etc., with which the pollutants emission will be indirectly reduced.

- **Learn MARKAL model**

What is MARKAL?

MARKAL (MARKet Allocation model) was developed in the early 1980s by the international Energy Agency(IEA) under the Energy Systems Analysis Project(ETSAP). It is a highly flexible, multi-time period, linear programming model of a generalized energy system. MARKAL is demand driven, i.e.,feasible solutions are obtained only if all the specified end-use demands for energy are satisfied for every time period. It allows for the specification of energy supply, end-use demand, the transformation and demand technologies, and any limits or policy assumptions that may be set on the energy economy, such as limited capital for investment, restricted petroleum imports, or limits on SO2 emission. With these specified, MARKAL then determines the optimum configuration of technologies and fuels that represent the least cost means of satisfying the demand for energy services over the forecast time period.

How does MARKAL do it?

MARKAL is similar to an input-output accounting system, in that for any given sets of input conditions it will provide a solution or output. The model consists of a series of mathematical equations that govern the relationships between the components of the energy system, namely energy supply, demand for energy services, the transformation and demand technologies, and any limits.

What is MARKAL's role on the policy front?

MARKAL assists policy analysts and decision makers to track the complex interactions and feedback systems in their energy economy, and assists them to quantify the effects of policy changes. Examples of policy applications of MARKAL include:

Though the history of MARKAL model is quite short, it is widely used in many countries. In November 1997 Norwegian experts has provided the DOS version MARKAL model and Chinese researchers have learned it. But at present the Window version MARKAL model has be put in use and its interface is more friendly than the DOS version and it is more easily learned. During the training Norwegian experts introduced and taught the Window version MARKAL model. But I think the training time is too short to learn such a complicated big model. Hence, I hope I have opportunity to learn it further.

- **Learn some control measures currently used in abroad and China**

ABB company is great international energy technology company. And the ABB environmental company, one of ABB subsidiaries, is located in Oslo. The ABB environmental company has a lot of advanced air pollution abatement technologies. During the training we visited this company and payed much attention to the FLAKT-HYDRO PROCESS technology which use seawater to remove sulfur from flue gases and discharge it into the sea. When we visited this company the experts coming from this company told us that the FLAKT-HYDRO PROCESS technology would be put into use in Shengzhen, P.R.China and we have discussed the possibility that this technology would be put into use in GZ.

During my training in ife I also read a book issued by the World Bank recently and through it I learned some control measures that are currently used in China.

In general, I have got to know the technological level of air pollution control measures currently used in abroad and in China. And I believe that it will be helpful for me to understand for the control measures currently used in abroad and China when we work on the control options in our cooperating project.

- Construct a workplan for the next several months

In order to meet the progress and requirements of some relevant tasks during the training Norwegian experts and Chinese researchers have constructed a detailed workplan for the next several months. And in the next several months task 7 will pay attention to work not only on MARKAL model but also on the control options of industry sectors .

- The coordination between tasks

In order to clarify the work division and clarify the data input and output between tasks during the training task 7, task 1 ,task 9, task 8 and other relevant tasks have held several coordination meetings. And also, we believe that the coordination meetings are successful and it would be beneficial for the work progress of the relevant tasks. In the future task 7 will pay much attention to coordinate with task 9.

6. Impression for the training

Though I have just studied and worked at ife for only 11 days, I successfully fulfill the training targets. And also, I believe that the training will be quite useful for our cooperating project and for myself. In general, I have achieved following results:

- Understand the methodology of task 7 further
- Get a deeper understanding for the overall projects and task 7
- Achieve some tentative research results
- Strengthen the cooperation and the friendship between Norwegian and Chinese researchers
- Broaden my outlook and improve my research ability a lot
- Read and collect many overseas latest research materials

Finally, I wish express to my thanks to ife, which provided me a wonderful working and studying environment. Special heartfelt gratitude goes to Dr. Andrew Yager, Mr. Thomas Krogh and other Norwegian friends, who have provided a lot of invaluable helps for me when I studied and worked in Norway.

The Training Report

Fan Changzhong (task 8, Scenario Developemnt)
Guangzhou Research Institute of Environmental Protection (GRIEP)

1. The participants involving in the training

GZ side: Mr. Fan Changzhong
Norwegian side: Dr. Haakon Vennemo and Ms. Xu Zhao

2. Training time

The training was carried out from the 14th of May of 1998 to the 15th of June of 1998 and it took 31 days.

3. The place where the training carried out

The training was carried out at the Center for Economic Analysis (ECON).

4. The targets of training

- Perfect the Reports completed before
- Work on Emission Factors
- Calculate Baseline Emission Scenario
- Determine the Emission Control Targets of some air pollutants, such as SO2
- Plan to construct the target scenarios
- Plan to construct the trend scenarios
- Discuss other works of task 8 as needed
- Get to know ECON

5. Training work Planing

Week 1 (18:24, May)

- Get to know ECON
- Perfect the reports completed before
- Work on Emission Factors

Week 2 (25:31, May)

- Calculate Baseline Emission Scenarios
- Report Baseline Emission Scenarios
  ---discuss weakness and strengths of the approach used to construct baseline emission scenarios

Week 3 (1:7, June)

- Finish Baseline Emission Scenarios
- Work on Target scenarios

Week 4 (8:15, June)

- Finish target scenarios
- Begin trend scenarios

6. The detailed works

6.1 Get to know ECON

At the beginning of the training, Dr. Haakkon Vennemo and Ms. Xu Zhao introduced me to ECON and introduced ECON to me. Through their introduction I got to know that the ECON was founded in 1986 and it's a private shareholder economic analysis center. At present, it has 56 employees and it has a headquarters located in Oslo, and two branch research centers located in Stockholm and Paris.

ECON has many customers coming from different areas, such as government departments, Norwegian domestic companies, international companies, international organization, and so on. Though ECON has very short history, in the sharp competition its development is very fast. Why is it able to achieve current great success? Its experiences are mainly as the following:

- Expanded its service area with excellent services
- Directed its development with definite targets
- Employed a good management system--- Shareholder system

6.2 Agree on how to construct baseline, target and trend scenarios

In order to successfully construct the baseline, target and trend scenarios, during the training based on the availability of data task 8 is able to get Norwegian and Chinese researchers improved the methodologies agreed on before.

6.2.1 Agree on how to construct the development scenario of activities

Through the scientific and reasonable forecast for the development of activities of GZ, some official plans, such as Toward a Modern International Metropolis—five year plan and 2010 prospective targets of GZ, Urban Master Plan of GZ and Transportation Plan of GZ, have published the development scenarios for the activities of GZ, such as farming, manufacturing, service & commercial and transportation. At the same time, the plans also published the development scenarios of GDP, population, per capita income, and so on. Therefore, for the activities whose future development scenarios have been quantitatively published by the plans we directly apply their quantitative development size to indicate their development scenarios. But for the activities whose future development scenarios have not been quantitatively published by the plans we have to adopt some other available and reasonable methods to quantitatively predict its future development scenarios.

6.2.1.1 For motor vehicle

At present, in GZ the motor vehicles often are categorized into 5 types of motor vehicles that are light-duty gasoline vehicle, medium-duty gasoline truck, heavy-duty gasoline truck & caterpillar tractor, heavy-duty diesel vehicle and motor cycle. Their development scenarios might be indicated with their ownership and their running mileage in the future years.

- Running mileage
  Some official plans, such as the Urban Master plan and the Environment protection master plan, etc., point out that the annual growth rate of the built-up area of GZ will reach 3.4% from 1995 to 2010, and that indicates the daily activity range of people will possibly increase with the same growth rate. And also, the increase of the daily activity range of people might let a person drive longer distance go to work and then go home. That means the running mileage of motor vehicle will increase with the expansion of the built-up area. However, how can we estimate the quantitative relationship between the

increase rate of the running mileage and the expansion rate of the built-up area? As we know there are no available methods up to now. Nevertheless, we might be able to roughly assume the running mileage per motor vehicle will keep on the same growth rate with the built-up area expansion.

- Motor vehicle ownership
  In order to control the rapid increase of motor cycle ownership, GZ municipal government will not license the any new motor cycle and the motor cycle whose service life reach 13 years old must stop running. That means the motor cycle ownership will reduce year by year. And also, based on the historical statistical data of motor cycle we can predict its population in 2000 and 2010. In order to predict the ownership of the other types of motor vehicles, at first we assume their growth rate during 1995-2000 and 2001-2010 are same as their growth rate during 1990-1995 during 1985-1995 respectively and then we are able to calculate the ownership of these types of motor vehicles in 2000 and 2010 with following equation:
  $P = P_{1995} * (1+\beta_t)^t$
  Where:
  P = Population of motor vehicle in 2000 or 2010
  P_{1995} = Population of motor vehicle in 1995
  β = Growth rate of motor vehicle population from 1995 to 2000 or 2010
  t = Years between 1995 and target year

6.2.1.2 For some subsectors of manufacturing industry

In our project, we split the manufacturing industry into 21 subsectors, and the plans published by government have issued the quantitative development scenarios for some manufacturing sectors. However, for most of the manufacturing sectors, the plans haven't published their quantitative development scenarios. How can we estimate their development scenarios? At first, based on the total development scenario of 21 subsectors (i.e., the activity of manufacturing industry) and the activity of some susectors, we can calculate the average growth rate of activity development generated by all of the other sectors, whose activity has not quantitatively published by government. And then, we assume the activity development of all of these subsectors will develop with the same growth rate calculated just now. The detailed calculation equations are as the following:

$$\beta_t = \sqrt[T]{\frac{ACT_{mt} - \sum_{j=1}^{n} ACT_{jt}}{ACT_{m95} - \sum_{j=1}^{n} ACT_{j95}}} - 1 \qquad (1)$$

$$ACT_{it} = ACT_{it} * (1+\beta_t)^T \qquad (2)$$

Where: β_t = The growth rate of the subsectors whose activity size has not quantitatively published by government.
ACT_{mt} = The activity size of 21 subsectors(i.e., manufacturing industry) in year t,
ACT_{jt} = The activity size of subsector j in year t,
ACT_{m95} = The activity size of 21 subsectors(i.e., manufacturing industry) in 1995,
ACT_{j95} = The activity size of subsector j in 1995,

T = Years between 1995 and target year.
n = Total number of the subsectors whose activity size has quantitatively published by government,

6.2.1.3 For other activities

For some activities, such as GDP, farming, manufacturing, population , commercial & service, transportation capacity of vehicle, and so on, their development scenarios can be directly employed from relevant plans.

6.2.2 Agree on how to construct the baseline scenarios

6.2.2.1 For Motor vehicle

Calculation equation:

$$EMG'(i,j,t) = AC(i,t) * EF'(i,j,1995) = N(i,t) * D(i,t) * EF'(i,j,1995) \qquad (3)$$

Where:
EMG'(i,j,t) = Emission amount of pollutant j generated by type i vehicle in year t in GZ citywide;
AC(i,t) = Activity of type i vehicle in year t in GZ citywide;
N(i,t) = Population of type i vehicle in year t in GZ citywide;
D(i,t) = Running mileage of type i vehicle in year t in GZ citywide;
EF'(i,j,1995) = Emission factor, emission amount of pollutant j generated by type i vehicles running per unit of distance in 1995 in GZ citywide.

6.2.2.2 For other sectors

Calculation equation(Omit the processing emissions)

$$EMG(i,j,t) = ACG(i,t) * \sum_{k=1}^{n} \left(\frac{FCG(i,k,1995)}{ACG(i,1995)} * \frac{Em1(i,j,k,1995)}{FC1(i,k,1995)} \right) \qquad (4)$$

Where:
EMG(i,j,t) = Total emission amount of pollutant j generated by all of the factories of type i sector in year t in GZ citywide;
ACG(i,t) = Activity of all of the factories of type i sector in year t in GZ citywide, for example, industrial production measured in monetary units, yuan;
ACG(i,1995) = Activity of type i sector in 1995 in GZ citywide;
FCG(i,k,1995) = Consumption amount of type k fuel consumed by all of the factories of type i sector in 1995 in GZ citywide;
FC1(i,k,1995) = Consumption amount of type k fuel consumed by the type i sector's factories included in inventory in 1995 ;
Em1(i,j,k,1995) = Emission amount of pollutant j generated by the type i sector's factories included in inventory during consuming type k fuel in 1995;
n = Total number of fuel types included in inventory

6.2.2.3 Total emission amount of each pollutant in GZ citywide

Calculation equation:

$$TEMG(j,t) = \sum_{i=1}^{m} EMG(i,j,t) + \sum_{i=1}^{T} EMG'(i,j,t) \qquad (5)$$

Where:
TEMG(j,t) = Total emission amount of pollutant j in year t in GZ citywide;

T = Total number of vehicle types
m = Total number of the other sectors
The others are similar to those introduced previously.

6.2.3 Agree on how to construct the target scenarios

6.2.3.1 Determine the emission control targets of some air pollutants

In order to efficiently protect and improve ambient air quality governments often stipulate a lot of air pollution control targets. The emission scenarios meeting the requirements of targets are called the target scenario. To achieve the targets many control measures will have to be adopted to reduce the emission amount of air pollutants in the future years. In fact, the emission amount of air pollutants is determined by the activity of each sector and the emission factors of each air pollutant generated by each sector. While, as we know, the baseline emission scenario will just consider the effects of activity on the future emission scenario and will not consider the effects of emission factors of each air pollutant on the emission scenarios. So, if we know the pollutants' control emission targets governments issued and their baseline emission scenarios there is a method which can be adopted to construct the target emission scenario. At first, based on the baseline emission scenarios of pollutants and their control emission targets issued by governments we calculate their necessary reduction to meet the targets. And then, we estimate the essential reduction of their emission factors and the essential emission reduction amount of each air pollutant generated by each sector. If possible, we even are able to estimate the essential emission reduction of each air pollutant generated by each source. Finally, we are able to construct the target scenarios for the whole area , or each sector, or even each source.

At present, in GZ there are three main programs, the atmospheric environment protection planning of GZ (planning 1), the environmental master planning of GZ (planning 2) and the ninth-five year planning & the far-viewing targets of GZ in 2010---toward a modern international metropolis (planning 3), which have stipulated the atmospheric environmental protection targets. In general, the targets mainly consist of 1)the protection targets of ambient air quality of GZ, 2)the emission control targets of some air pollutants, 3)the air pollution sources' control targets and 4) the targets of the infrastructure constructions contributed to air pollution control. Based on our tentative analysis it is easy to find that almost all of the detailed targets stipulated by the three programmes directly or indirectly affect the total emission amount of air pollutants. For example, the targets of gas popularizing rate will affect the energy consumption structure; furthermore, the variation of the energy consumption structure will affect the emission factors of air pollutants, and finally the variation of emission factors will bring out the variation of total emission amount of air pollutants.

When task 8 construct the target emission scenarios it is very important that the effects of each target on the emissions of air pollutants should be correctly taken into account in the future years. Nevertheless, sometimes it is not easy to estimate the effects of some targets on the emission of air pollutants, especially for those targets, such as ambient air quality targets, infrastructure construction targets and pollution sources' control targets, which are indirectly determine the emission amount of air pollutants. Why? The main reasons are the relationship between the targets and the emission of air pollutants is complicated and usually we are unable to find enough data and available tools to simulate the effects generated by the targets on the emission of air pollutants. Comparatively, the emission targets are directly related to the emission of air pollutants and they are easily adapted to construct the target emission scenarios.

For the emission control targets of pollutants, the planning 1 and planning 2 plan to reduce the total emission amount of some air pollutants in 2000 and make their emission amount approach their total emission amount in 1995 , and also control the total emission amount of some main air pollutants in 2010 and make their emission amount in 2010 lower than their emission amount in 1995. And furthermore, the two planning clearly plan to reduce the emission amount of SO_2 in 2000 in GZ citywide and make its emission amount in 2000 approach the emission amount of SO_2 in 1994. At the same time, they have just quantitatively published the specific emission control targets of SO_2. However, they didn't clearly clarify what the other main air pollutants mentioned by them are and didn't quantitatively publish the emission control targets of the other air pollutants, such as NOx, CO and etc. So, In our project, GZ Air Quality Management & Planning System, task 8 just plan to construct the target emission scenarios of SO2 and industrial dust.

6.2.3.2 Agree on how to construct the target scenarios

Based on the baseline scenarios and the emission control targets of each air pollutant, we are able to calculate the essential total reduction amount of each air pollutant in order to meet the emission control targets and the overall reduction of emission factors with the Top-Down method. Possibly, if there are enough data and available tools we are still able to estimate the emission reduction amount of air pollutants generated by each sector, or even the emission reduction amount of the air pollutants generated by each source.

6.2.4 Agree on how to Construct the trend emission scenarios

When we construct the baseline emission scenarios we just consider the effects of activity change of each sector on the emission amount of each air pollutant generated by each sector, and don't consider the effects of emission factor change of each sector on the emission amount of each air pollutant generated by each sector. But actually the emission factor of each air pollutant generated by each sector always change with the improvement of air pollution control technologies and it will affect emission amount of each air pollutant generated by each sector. So, if we want to estimate the actual emission scenarios (or called it trend emission scenario) we not only should take the effects of activity change of each sector and also the effects of emission factor of each air pollutant generated by each sector on the emission amount of each air pollutant into account.

According to the work division between task 7 and task 8, task 7 will be responsible for estimating the possibly adopted control options and then estimate the effects of the control options on the emission factors. That means that task 7 will publish a or a series of possible emission factors (or called it trend emission factors) corresponding to a or a series of control options. And finally, taking both the effects of activity change of each sector and the effects of the trend emission factors of each air pollutant generated by each sector on the emission amount of each air pollutant into account, task 8 calculate the emission amount of each air pollutant generated by each sector in the future years. That means task 8 will take charge of constructing the trend emission scenarios.

6.3 Perfect the reports written before the training

Before the training task 8 has written 5 draft research reports. During the training under the direction of Dr. Haakkon Vennemo I perfect the reports and check some data in the reports. And finally task 8 publish a tentative activity development scenario. Its detailed results are summarized in Table 1.

Table 1: Activity development scenario in GZ citywide

Sectors	Activity	Development						Energy Consumption:: in 1995					
	Indexes	Units				Growth : Rate %		Coal	Coke	Heavy oil	Kerosene	LPG	Coal gas
			1995	2000	2010	1995-2000	2001-2010	ton/a					m^3/a
GDP		0.1bill.yuan/a	790.17	1707	4846	16.65	11.0	--	--	--	--	--	--
Farming	Gross Prod.	0.1bill.yuan/a	64.56	88	173	15.53	14.16	458000	100		50200		
Industry	Gross Prod.	0.1bill.yuan/a	1387.2652	3162	11415	17.913	13.698	--	--	--	--	--	--
Mining	Production	10000yuan/a	187247	385345	1085484	11.68	4.84	6746	3	10			
Foodstuff, Drinks and tobacco manufacturing	Production	10000yuan/a	1266305	2200000	3530000	11.68	4.84	1382023			9111		
Textile	Production	10000yuan/a	624518	1285227	3620375	15.53	14.16	159939		75180	11889		
Clothing, leather and fur product	Production	10000yuan/a	1824631	3755001	10577514	15.53	14.16	8515		6420	15185		
Papermaking and paper product	Production	10000yuan/a	375221	772186	2175283	15.53	14.16	530109	78	2000	2213		
Printing	Production	10000yuan/a	211238	434717	1224562	15.53	14.16	10	4		363		
Power,steam,hot water production and supply	Production	10000yuan/a	151349	311469	877381	15.53	14.16	4655312	200	1289505	42692		
Oil-processing	Production	10000yuan/a	414238	852481	2401367	15.53	14.16	649271		69506	756		
Coking,gas and coal product manufacturing	Production	10000yuan/a	10427	21458	60446	15.53	14.16						
Chemistry industry	Production	10000yuan/a	1141458	2349064	6617112	15.53	14.16	551970	11907	91799	7067		
Medicine manufacturing	Production	10000yuan/a	370880	800000	3000000	16.62	14.13	68577		130	3579		
Chemical fibber manufacturing	Production	10000yuan/a	63727	131147	369430	15.53	14.16	67461		738	334		
Rubber manufacturing	Production	10000yuan/a	324311	667416	1880054	15.53	14.16	73614		22633	2834		
Plastic industry	Production	10000yuan/a	505881	1041078	2932628	15.53	14.16	13976		6335	40804		
Nonmetal mineral and building material	Production	10000yuan/a	592623	1219589	3435477	15.53	14.16						
Ferrous metal smelting & processing	Production	10000yuan/a	267286	550061	1549476	15.53	14.16	425957	388681	93179	4209		
Non-ferrous metal smelting & processing	Production	10000yuan/a	260054	535178	1507551	15.53	14.16	7762	720	8636	6064		
Metal product manufacturing	Production	10000yuan/a	715460	1472381	4147572	15.53	14.16	9792	4880	1286	2508		
Mechnism,electric communication and electric device industry	Production	10000yuan/a	2332119	4799386	13519458	15.53	14.16						
Vehicle manufacturing	Production	10000yuan/a	1059348	5620000	15831058	39.62	14.16						
Others	Production	10000yuan/a	1174331	2416715	6807679	15.53	14.16	84741	1238	9860	5759		
Inhabitants	population	10000yuan/a	647	705	785	1.73	1.08	184000				102800	6200
Commercial and service	Production	10000yuan/a	4400440	10417442	32937426	18.81	12.20	164100		500	24100		
Light-duty gasoline vehicle	ownership	vehicle	91224	221595	956132	19.42	15.74						
	Mileage	km/vehicle.a	50000	50000	50000	0.0	0.0						
Medium-duty gasoline vehicle	ownership	vehicle	85875	208602	9000069	19.42	15.74						
	Mileage	km/vehicle.a	40000	40000	40000	0	0.0						
Heavy-duty gasoline vehicle	ownership	vehicle	67557	139323	396289	15.58	11.02						
	Mileage	km/vehicle.a	25000	25000	25000	0	0.0						
Heavy-duty diesel vehicle	ownership	vehicle	12840	8560	7688	-7.79	-1.07						
	Mileage	km/vehicle.a	25000	25000	25000	0	0.0						
Motor cycle	ownership	vehicle	613655	425994	0	-16.68							
	Mileage	km/vehicle.a	10000	10000	10000	0.0	0.0						

6.4 Calculate the emission factors

Based on the inventory provided by task 1, task 7and task 8 calculated the emission factors of each pollutant generated by each sector in 1995. The detailed results are summarized in Table 2.

Table 2: The emission factors of each air pollutant generated by each activity in 1995(units:Coal gas: kg/m^3,the others: kg/ton)

Activity	Coal				Cok				Diese				Heav Oil				LPG				Coal gas			
	SO2	NOx	CO	TSP	SO2	NOx	CO	TSP	SO2	NOx	CO	TSP	SO2	NOx	CO	TSP	SO	NOx	CO	TSP	SO2	NOx	CO	TSP
Farming																								
Mining																								
Foodstuff, Drinks and tobacco manufacturing	16.420	4.120	6.860	36.100																				
Textile	32.956	3.900	5.011	2.751					1.030	0.550	0.010	0.100	8.033			11.155								
Clothing, leather and fur product																								
Papermaking and paper product	54.001	19.817	3.629	21.53																				
Printing																								
Power,steam,hot water production and supply	12.689	2.980	3.496	4.636					38.619	20.293	0.887		15.106	5.0157	20.186	0.640					2.720			2.278
Oil-processing													12.666			4.0263								
Coking,gas and coal product manufacturing	20.510	2.210	0.750	0.840					28.730	2.430	37.560	16.820												
Chemistry industry	7.915	3.039	4.287	4.049					2.134	7.227		0.884	104.660	6.7212	11.378	10.335								
Medicine manufacturing	15.361	1.459	8.954	4.650																				
Chemical fibber manufacturing																								
Rubber manufacturing	13.834	1.936	3.657	2.032																				
Plastic industry																								
Nonmetal mineral and building material	6.098	0.498	19.831	7.192									111.940	42.146	69.651	34.407								
Ferrous metal smelting & processing	8.913	1.7125	15.043	8.583	17.210			4.750				0.606	56.630	15.615	51.842	10.313								
Non-ferrous metal smelting & processing	7.523	1.281	147.17 2	2.873				2.170	1.723	1.903	5.606	1.672	2.559	0.818	0.843	21.61								
Metal product manufacturing				2.889																				
Mechnism,electric communication and electric device industry	12.661	2.741	27.713	4.413					0.511			3.752	1.322	5.288	50.239	1.403								
Vehicle manufacturing																								
Others	15.09	2.742	1.656	2.430	0.330	0.190	0.270	1.290	2.832	0.213	0.0711	2.437	17.324	10.677	2.264	12.918								
Inhabitants																	.0386	.0236	2.9195	.0565	.017	.0102	1.260	.0240
Commercial and service																								
Light-duty gasoline vehicle		2.148	51.529																					
Medium-duty gasoline vehicle		3.779	57.620																					
Heavy-duty gasoline vehicle		4.649	69.988																					
Heavy-duty diesel vehicle		18.595	12.498																					
Motor cycle		0.168	48.067																					

6.5 Construct the tentative baseline emission scenarios

Based on the activity size and the consumption amount of each type of energy used by each activity listed in table 1, and the emission factors of SO_2:NOx:CO and TSP generated by each activity in 1995, employing the methods introduced previously on how to construct the baseline emission scenarios task 8 calculated the emission amount of SO_2:NOx:CO and TSP generated by each activity in 1995, 2000 and 2010 respectively. And also, task 8 calculated the total emission amount of SO_2:NOx:CO and TSP generated by all of the activities in GZ citywide in 1995, 2000, 2010 respectively. The detailed calculation results are summarized in table 3. In table 3 you might find task 8 didn't calculate the emission of pollutants generated by farming, commercial & service, water transportation, air transportation and railway transportation, and didn't calculated the processing emission of air pollutants generated by each sector. Why did task 8 do that? The main reason was task 1 and task 7 were not able to provide their emission factors up to the time the training was being carried on

Table 3: The tentative emission scenarios of each activity(unit:tones per year)

	SO2			NOx			CO			TSP		
Activity	1995	2000	2010	1995	2000	2010	1995	2000	2010	1995.	2000	2010
Farming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mining	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Foodstuff, Drinks and tobacco manufacturing	22692.8	39425.1	63259.4	5693.9	9892.3	15872.6	9480.7	16471.1	26428.7	49891.0	86677.6	139078.1
Textile	5874.9	12090.2	34057.1	623.7	1283.5	3615.5	801.5	1649.4	4646.3	1278.6	2631.3	7412.1
Clothing, leather and fur product	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Papermaking and paper product	28626.7	58912.2	165950.7	10505.1	21619.0	60898.8	1923.5	3958.5	11150.7	11414.3	23490.0	66169.3
Printing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Power,steam,hot water production and supply	78549.7	161651.5	455358.3	20338.4	41855.5	117903.4	42305.8	87063.3	245249.8	22405.4	46109.1	129885.5
Oil-processing	880.4	1811.8	5103.6	0.0	0.0	0.0	0.0	0.0	0.0	279.9	575.9	1622.3
Coking,gas and coal product manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemistry industry	13976.8	28763.5	81024.3	2294.4	4721.7	13300.5	3410.9	7019.4	19773.0	3183.9	6552.3	18457.2
Medicine manufacturing	1053.4	2272.2	8520.8	100.1	215.9	809.5	614.1	1324.6	4967.1	318.9	687.8	2579.3
Chemical fibber manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rubber manufacturing	1018.4	2095.7	5903.5	142.5	293.3	826.2	269.2	554.0	1560.6	149.6	307.9	867.3
Plastic industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonmetal mineral and building material	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ferrous metal smelting & processing	18837.4	38766.5	109202.0	2184.5	4495.5	12663.4	11238.3	23127.9	65149.2	6463.1	13300.8	37467.2
Non-ferrous metal smelting & processing	80.5	165.7	466.6	17.0	35.0	98.6	1149.6	2365.9	6664.5	210.4	433.0	1219.8
Metal product manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.3	58.2	164.0
Mechnism,electric communication and electric device industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vehicle manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Others	1450.3	2984.7	8407.5	337.9	695.3	1958.6	163.0	335.5	945.0	334.9	689.2	1941.4
Inhabitants	1.7	1.9	2.1	10.5	11.4	12.7	129.5	141.1	157.2	2.5	2.7	3.0
Commercial and												
Light-duty gasoline vehicle	0.0	0.0	0.0	11029.0	26790.9	115596.4	235034.1	570929.6	2463427.1	0.0	0.0	0.0
Medium-duty gasoline vehicle	0.0	0.0	0.0	12980.9	31532.3	136054.4	197924.7	480785.9	2074478.2	0.0	0.0	0.0
Heavy-duty gasoline vehicle	0.0	0.0	0.0	7851.8	16192.9	46058.7	118204.5	243774.1	693386.6	0.0	0.0	0.0
Heavy-duty diesel vehicle	0.0	0.0	0.0	5969.0	3979.3	3574.0	4011.9	2674.6	2402.1	0.0	0.0	0.0
Motor cycle	0.0	0.0	0.0	1030.9	715.7	0.0	294965.5	204762.5	0.0	0.0	0.0	0.0
Total	***17.3***	***34.89***	***93.73***	**8.11**	**16.43**	**52.92**	***92.16***	***164.69***	***562.04***	**9.60**	**18.15**	**40.69**

Shown in Table 3, the emission amount of SO_2 and TSP generated by all of the activities in GZ citywide is 17.3 and 9.60 ten thousand tones per year respectively. And in 1994 the actual emission amount of SO_2 and TSP published by government is 16.53 and 10.85 ten thousand tones per year respectively. So, if we compare the calculation emission amount of the emission amount of SO_2 and TSP generated by all of the activities in GZ citywide and the actual emission amount of SO_2 and TSP generated by all of the activities in GZ citywide we will find that the calculation value might be reasonable in some sense. The tentative emission scenarios of SO_2:NO_x:CO and TSP in GZ citywide can also be demonstrated in Figure 3.

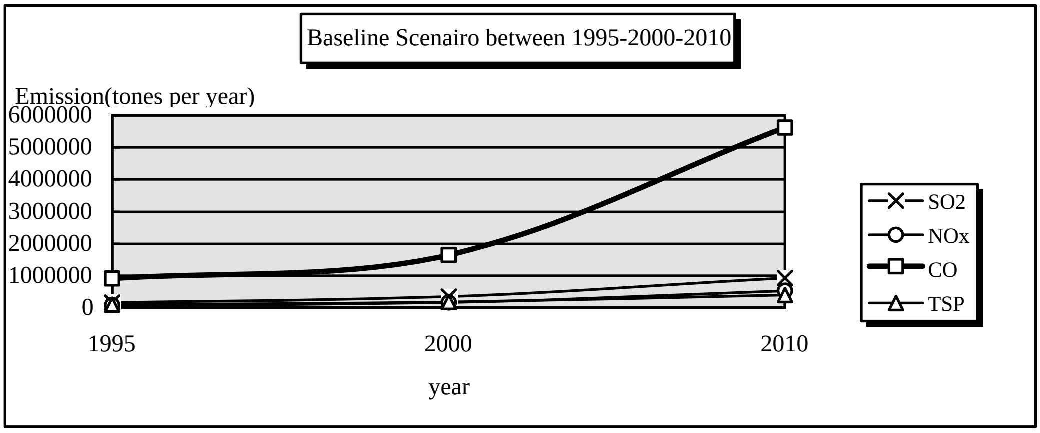


Figure 3: The tentative emission scenarios of SO_2,NO_x, CO and TSP in 1995, 2000 and 2010.

6.6 Begin to think how to construct the target scenarios

During the training Norwegian and Chinese researchers agreed on how to construct the target emission scenarios of SO_2 and TSP with TOP-DOWN methods.

6.7 Begin to think how to construct the trend emission scenarios

During the training Norwegian and Chinese researchers have discussed the methods on how to construct the trend scenarios. All the participants agreed that it would be necessary that task 7 should provide the trend emission factors corresponding to each control option to task 8 to construct the trend emission scenarios.

6.8 The coordination between tasks

In order to clarify the work division and clarify the data input and output between tasks during the training task 8 , task 1 ,task 7 and other relevant tasks have held several coordination meetings. And also we believe that the coordination meetings are successful and it will be beneficial for the work progress of other relevant tasks

7 Impression for the training

Though I have just studied and worked at ECON for only four weeks, I successfully fulfill the training targets and the training program. And also, I believe that the training will be quite useful for our cooperating project and for myself. In general, I have achieved following results:

- Understand the research methodology of task 8 further
- Get a deeper understanding for the overall projects and task 8
- Achieve some tentative research results
- Strengthen the cooperation and the friendship between Norwegian and Chinese researchers
- Broaden my outlook and improve my research ability
- Read and collect many overseas latest research materials

Finally, I wish express to my thanks to ECON-Center for economic analysis, which provided me a wonderful working and studying environment. Special heartfelt gratitude goes to Dr. Haakon Vennmo, Ms. Zhao, Mr. Haugland, Mr. Larssen and other Norwegian friends, who have provided a lot of invaluable helps for me when I studied and worked in Norway.

Annex 3
AirQUIS installation and Training Report

AirQUIS installation and Training Report

Installation of ENSIS 2.0 (AirQUIS) in Norway

Hardware Installation

The following equipment was shipped from China National Scientific Instruments and Materials Import/Export Corporation (CSIMC) to NILU for installation and testing purposes.

HP NetServer LH II:

- The Network card was replaced. The reason for this replacement was that the server contained a network card without any drivers.
- During installation and testing of the server, a problem with the SCSI-controller (type: IBM, installed in China) was detected. The problem was detected during booting with the following warning message:
  "
  IBM RAID Adapter BIOS Version 1.29 – 21 Dec 95

  RAID Firmware Version 2.43
  WARNING: 1 logical drive is critical
  WARNING: SCSI drive at channel 1 bay 1 is defunct
  "
  Despite this warning, the server functioned stably with no apparent problems during the two weeks period of installation and testing in Norway.

HP kayak:

- No apparent problems were detected with this computer during the installation and testing period in Norway. The response time of the login procedure and the opening of new projects were not particularly long.

Software Installation

HP NetServer LH II:

- Microsoft Windows NT Server version 4.0
- **Demo** version of ORACLE 7.3 Server
- INTERSOLVE 2.11 32-BIT Oracle 7 ODBC-driver
- ENSIS 2.0 (modules: Basic, AirQUIS)

HP kayak:

- Microsoft Windows NT Workstation version 4.0
- **Demo** version of ORACLE 7.3 Client
- INTERSOLVE 2.11 32-BIT Oracle 7 ODBC-driver
- ENSIS 2.0 (modules: Basic, AirQUIS)

Import of Guangzhou Data and Setup of Project Specifications

- ***Converting of shape co-ordinates***
- ***Map Data (Railroads, Rivers, Roads)***
- ENSIS Themes (Geographical data like: Adm. Regions, Stacks, Road Network, Met. Stations, Grid Definitions)
- Traffic Emission Data
- Industry Emission Data (only some illustrative examples have been imported so far).
- Met. Data for the period of January 1995.
- Topography Data (1 km x 1 km, large and small model grid)
- Population Data (2 km x 2 km large model grid and 1 km x 1 km small model grid)

Testing the AirQUIS 2.0 application for the Guangzhou Project

- Important concepts and modules were tested.

Installation of ENSIS 2.0 (AirQUIS) at GRIEP

The ENSIS system is installed in a separate network at GRIEP in Guangzhou. The network consists of one server and three clients. All clients run Windows NT 4.0 operating system, ORACLE 7.3 client software and AirQuis system. The ORACLE software is a demo version and must be upgraded.

HP NetServer LH II,project computerServer
HP-kayak,project computer Client
EPIC, GRIEP computerClient
EPIC_1, GRIEP computerClient

All software is installed and the ENSIS database is running correctly on the server and clients.

<u>HP NetServer LH II :</u>

During installation the server was unstable. A local HP representative examined the server and a memory configuration problem was fixed. The HP representative also found that one of the disks was damaged, and he recommended that this disk should be replaced. Despite this disk problem the server is now stable.

HP kayak.

ORACLE client and AirQUIS software were installed.
Problems: Long response time on login to AirQUIS and on opening of new projects. However, the computer showed no apparent slowness as soon as a project was opened. The local HP representative should have a look at the computer to sort out the problems regarding login- and opening of new projects.

EPIC: OK

Runs Chines version of Windows NT 4.0. This NT version sometimes outputs a mixture of English and Chines characters.

The computer should be upgraded to 64 Mb memory.
ORACLE client and Airquis software were installed.

EPIC_1: OK
Identical comment as for the EPIC computer.

Met. Data from GEMC

GEMC has received the import format specification, and will deliver data on that format. However their database is not running for the moment so it could take some time before the data are sent. The data will be delivered as Excel files on diskette.

Training

Training of computer staff.

The following topics where covered:

Installation of ORACLE client.
Installation of ENSIS client.
Import / export of ORACLE users with data.
ENSIS User Database Administrator.
Create users
Edit user profile (privileges/datasets/projects)
Edit data sets

Training of task personnel

Day 1: Introduction to the system. General concepts and the map system (GIS).

Day 2: Measurement database, Statistics on time series and introduction to the Import functionality.

Day 3: Introduction to the dataset (line, point and area) concept.

Day 4: Introduction to the different models. Running the emission- and the wind model. Description of the population exposure model.

Day 5: A general description of the wind- and the dispersion model. Running the dispersion model.

Day 6: Import functionality concerning traffic-, industry- and area data. Advanced use of the emission model.

Day 7: Advanced use of the wind-, dispersion- and exposure model.

Day 8: Import functionality, how to create new templates. Export functionality, with emphasise on receptor point data set.

Day 9: The User Database Administrator Tool: create new user and edit existing users; how to add / replace shape themes. Import and Export AirQUIS projects applying the ORACLE tools.

Preparation and Demonstration

1. Advanced use of the map system (GIS)
2. Advanced use of the measurement database
3. The Wind Rose
4. The Wind Field model
5. The Emission model
6. The Dispersion model
7. The Exposure model
8. Displaying the results from the model runs, both in table format and geographical presentation applying the map system
9. Brief introduction to the Report Generator

Annex 4
Draft Action Plan for Guangzhou, from 2001
(Version of 5 February 1999)

Selected abatement measures for Action Plan 2001/2010 (5/2)

Measure	Policy/regulation	Effects (expressed as reductions unless otherwise stated)	Costs	Other comments	2001	2010	Potential
SO_2 (mg/m^3) Target: 0.06 (ann) 0.15 (24h) Status: 0.075 (ann) 0.2-0.3 (24h)							
A. Pre combustion: fuel switch or improved fuel quality							
1. Imported low sulphur coal in all power plants and industry (<0.5% sulfur)	If mandatory, how to control supplies from informal or semiformal coal producers? This option may be difficult for political and economic reasons if power plants are tied to local coal suppliers. However, liberalisation of coal market should have removed this barrier? Possible instruments: mandatory requirement for large sources, differentiated charge/tax on coal/fuels. Emphasis on enforcement.	Andy/NILU: compared to present situation/data on s-content of present coal consumption	Price difference? Chongqing estimate: abatement cost assumed to be equal to washed coal (RMB 1400 per ton)		X		A
2. Sulphur fixed briquettes in power plants and industry	Production can take place at the boiler site	MIT: Coal saving = 20-30%; Chongqing estimate: SO2: 40-50%; PM: up 33% if no filter	MIT Coal costs increase: 10-30% (assuming 20% coal cost increase and 2% S-content: $700/ton SO2) Chongqing estimate: RMB 10.500 per ton SO2 **Case study from Shanghai/ Henan:$150/ton SO2 reduced in industrial sectors** increased waste disposal costs	Suitable for all boilers. Many industries located in densely populated areas.	X		B
3. Fuel switch in 3rd industry: from coal/oil products to gas (affects TSP as well)	Large number of sources (16.000). If mandatory, substantial costs for effective supervision and control (could be reduced with high cost, i.e. fine, for non-compliance) Favourable relative price for gas, or alternatively reform of pollution charge (for SO2) will reduce need for control. Differential charge on input factors (coal, oil and gas) will reduce administrative challenges for charge collection.	SO2: 90% or more TSP: 90% or more Emissions at low height, important for concentrations. However, SO2 emissions from 3rd industry ccount for only 2% of total.	Changing burners (low cost) Fuel costs difference Infrastructure costs ?	Already decided in Guangzhou (?) Most sources situated in densely populated areas	(X)	X	C

4. Coal sorting - power plants and industry (Coal treatment at site, which can seperate coal into different sizes so as to optimize boiler combustion. Suitable boilers: 2-35 t/h.	Could be undertaken as mandatory requirement. Suitability depending on total number of affected units. A more general instrument such as stricter SO2 emission limit would leave units with more options to reduce emissions and increase cost-efficiency of SO2 abatement.	Boiler efficiency improvement: 5-10% $\Rightarrow$ SO2 and TSP: 5-10%	RMB 70,000 + installation= 20,000. Life: 3-5 years (MIT) additional dust control necessary?	Suitable for boilers 2-35 t/h	X		C
5. Use low sulfur oil in industry (<1% S) through sulfur removal	Availability? How to regulate possible suppliers/refineries outside Guangzhou?	Probably limited effect on exposure since large share is used in one source with high stack			X		C
B. Combustion technology and energy efficiency							
1. Furnace sorbent injection (FSI) - charged dry sorbent injection, power plants and selected industries.	Technology demonstrated and certified in China (Shangdong, Guangdong). FSI, like spray dryer FGD, produces dry powder waste, which must be disposed of.	IEA 1988: 60-75% WB 1997: 30-70%	Low capital costs, low maintenance costs, but higher operation costs than wet FGD. Requires filter (electrostatic precipitators, fabric, cyclone) if increase in particles emission is to be avoided. WB 1997: $500-750 per ton SO2 abated. Unclear whether this includes waste disposal costs. Reported to be more cost effective than FGD (Energy Policy) Price of ESP?	Easy retrofit. Very small area requirements. Construction time:3-6 weeks if space available. Proven technology. Low parasitic power consumption (0-0,5%). Easy to upgrade to higher efficiency (hybrid). Particularly suitable for old boilers with short remaining life or for use as peak capacity.	X		A
2. Atmospheric Fluidised Bed Combustion (AFBC). Reduces NOX, particulates & ash.as well.	Currently under development in China - and increase in their utilisation is planned. AFBC is particularly suitable in developing countries, because it can burn local coal and qualifies to replace old pulverised coal fired boilers.	70-95% (IEA/OECD 1994). An old pulverised coal boiler site can be used to install an AFBC boiler with 15% more output (IEA/OECD 1994)	Generating costs are similar to state of the art P.F.-fired plants with flue-gas-desulpurisation. WB Shanghai estimate: $163 per ton SO2 removed		X		A
3. Energy efficiency improvements in paper, ferrous metal, chemical and food/beverages industries. Priority measures are: improved boiler maintenance, burner replacement, steam system, compressed air, variable speed motors, waste heat recovery. Affects TSP as well. Applies to 30 factories (50 burners). Details given in separate note	Possible barrier: lack of financial autonomy (firms do not enjoy saved operating costs)	SO2 and TSP: 10-30%	Energy cost savings: 10-30% Other costs: ?	Many located in densely populated areas	X		C (B)

4. Upgrading of boiler efficiency through *replacement* of low efficiency boilers in old power plants/industry with new boilers. Thermal efficiency requirement: 75%. Affects NOx and TSP as well.	Financial barrier depending on magnitude of capital costs. Will firms enjoy savings from reduced fuel costs? If not, centralised program for boiler replacement backed by public funds.	SO2 and TSP: 15-30%	Fuel cost savings High capital costs		X	X	C/B
5. Upgrading boiler efficiency through appropriate instrumentation and controls (efficiency improvement = 10%)	Substantive savings possible if cost estimates are realistic. Limited funds necessary, suitable for targeted information campaigns. Possible barrier: lack of financial autonomy.	Boiler efficiency improvement = 10% $\Rightarrow$ SO2 and TSP: 10%. Reduction of NOx and CO as well.	Chongqing estimate: RMB +1730 per ton SO2 abated (industry boilers); RMB minus 2441 per ton SO2 abated (power plants); RMB minus 1890 per ton SO2 abated (meaning savings). A positive side-effect over 20% reduction of waste with 10% efficiency improvement	Easy retrofit of instrumentation	X		C
6. Cogeneration in industrial boilers. Affects NOx and TSP as well.	Too costly to realistically be funded by Chinese sources. Could be candidate for joint implementation projects cofunded by foreign sources and industrial companies in GZ	SO2:10-30% NOx: same TSP: same	High capital costs?			X	
C. Post combustion							
1. Flue Gas Desulphurisation (FGD) **-** Wet scrubbers in power plants and selected industries: refineries, chemicals, metals, (+ cement?) Affects TSP as well.	Few units responsible for large share of total emissions. This facilitates effective administration and enforcement. Some power plants not under city jurisdiction. Lack of financial resources could prevent measures to be carried out. Electricity prices regulated, not much room for passing over costs to consumers. Ability to pass over costs even less for some industries. Barrier may be lowered by soft loan arrangements or subsidy.	SO2: 90% (Power plants, IEA 1988) Other more recent sources: 90-100% (WB 1997)	High capital costs, but these are declining and expected to decrease further next decade IEA 1988 estimate - new plants: Increases generation costs by 9%. Not clear if this refers to wet or dry scrubbers. Retrofit capital costs: 10-40% more than new. WB - Shanghai estimate: $144 per ton SO2 removed. Not clear if estimate refers to wet or dry scrubbers. Refers to PP burning coal with 2% S or more. WB 1997 estimate: from $280/t SO2 (600 MW PP burning high-S coal) to $500-600/t (300 MW PP burning medium-S coal), including waste product disposal Chongqing estimate: RMB 1300/t SO2 (industry boiler); RMB 2000/t SO2 (power plant)	Disadvantage: large quantities of waste product (gypsum) This market is saturated in China. Relatively high parasitic power consumption (1-1,5%). Construction period: 3-6 weeks (retrofit) Large area requirement	(X) ?	X	A

2. FGD - Spray dry scrubber	Same as for wet scrubbers. No reference project in China. No licensed production in China. Technology must be imported	70-90% (WB 1997)	See comments for wet scrubbers WB 1997: relatively high capital costs, but lower than wet scrubbers	Medium parasitic power consumption (0,5-1%). Construction period: 3-6 weeks (retrofit). Waste product unusable (at present)	(X) ?	X	A
D. Industry structure							
1. Shut down of small power plants (or alternatively: restricted use as reserve capacity or peak load production only) Affects NOx and TSP as well.	Resistance from local authorities in charge of small and dirty power plants. (If kept as reserve capacity: Tempting to put them back in operation even for base load production after some time when demand has increased further). Shut down better than upgrading if incentive to upgrade reamins weak (due to price structure) (Ingo Puhl/IEA)	Power plants < 100MW responsible for 30-35,000 tons SO2/year (1995) = 30% of emissions from PP: NOx and TSP: data incomplete, but one small plant (Dianhuaqiye) responsible for large part of TSP from power plants Power plants of 50 MW or less: SO2 emissions = 20,000 tons/year, or 20% of SO2 from power plants.	No cost (?) Task 9/10		X		? needs to be studied further
2. Shut down small power plants on days with high pollution	Same as above, although less resistance	See above	No cost (?). Task 9/10		X		Same as above
3. Moving 68 factories (of which 20 relevant for air emissions?) Affects NOx and TSP as well.	Difficult financial situation of 68 factories, if ordered to move: close-down likely, could result in unemployment. Resistance from workers due to longer work travels.	SO2:? NOx:? TSP:?	ECON note 23/11	Already decided in Guangzhou.	X	X	C

NOx

Target: 0.1 (ann) 0.15 (24h)
Status: 0.134-0.240 (ann) 0.3-0.8 (24 h) GEMC: 1.6

A. Fuel switch and improved fuel quality							
1. Fuel switch to LPG for all new and existing diesel buses. Affects TSP (and VOC) as well. NORCE proposes this option of fuel switch to be extended to *heavy trucks* as well in order to get closer to target.	Enforcement of a possible mandatory requirement facilitated by existing annual test program. Investment costs (assuming no subsidy) could reduce number of taxis, availability of taxis and consequently lead to more private cars.	NOx-concentration: Negligible. 50% less per bus? NOx reduction per vehicle much higher if fuel switch to LPG is accompanied by 3-way catalytic converter TSP:	Buses: RMB 8000 (?) x 5000 buses = 40 mill. + fuel cost difference (according to "WB Clean Fuels for Asia" LPG wholesale price is 30% less than for diesel) + infrastructure investments (40 LPG fuelling stations) RMB 1 mill per station (Chinese demo project)	Fuel switch for buses already decided in Guangzhou. Fuel switch for heavy trucks could yield large effect. Fuel switch for buses makes more sense for TSP than for NOx?	X		B/C

2. Fuel switch to LPG for taxis. Affects TSP (and VOC) as well	Enforcement facilitated by annual test program. Financial viability of taxi cooperatives?	WB (Walsh et.al): NOx-emission from LPG-vehicles roughly equal to gasoline vehicles TSP	Investments taxi: RMB7000x15000 taxis= 105 mill + fuel cost difference? According to "WB Clean Fuels for Asia" LPG wholesale price is approximately the same as for gasoline. + infrastructure investments: see above	Fuel switch for taxis already decided in Guangzhou. Fuel switch more sensible for TSP and other emissions than for NOx?	X		C
3. Improved diesel fuel quality (reducing aromatic content). Will reduce TSP and HC as well.	Suppliers outside Guangzhou could be unwilling to change formulae for diesel to be sold in Guangzhou. General product standard for diesel sold in Guangzhou.	NOx: reducing aromatic content from 35% to 20% would produce a NOx reduction of 5-10% for existing diesel engines and 10-15% "transient" particulate emission reduction					C
B. Combustion technology							
1. Low-NOx burners (LNB) in industry and power plants	Resistance from industry will depend on degree of exposure to competition from industries not required to replace burners (outside Guangzhou). Low costs may reduce this problem. Limited number of units should facilitate control and supervision. Individual emission permits most practical and effective? Alternatively, higher emissions charge.	30-55% (WB 1997) 30-50% (IEA 1988)	WB 1997: Very low capital cost for new boilers ($1-3/kW). Retrofit: $10-40 per kW. $175-250 per ton NOx in boilers with high uncontrolled emissions. $540-700 per ton NOx in tangential fired boilers; i.e. boilers with lower NOx emissions. WB Shanghai: retrofit in power plants: $100/ton NOx	Easy retrofit. Outage for retrofit: 3-5 weeks. Already commercial in China No waste product. Suits all plant sizes	X		B
2. Improved combustion in existing facilities through improved operational routines (monitoring of combustion parameters such as CO, O2 and temp.)		15-25% (low excess air)	No or little extra cost (WB 1997) WB Shanghai: $20/ton NO_2	Recommended as first option to be undertaken in several sources	X		C/B
3. Over fire air (OFA) - air staging in power plants and large industrial boilers. Description: part of the combustion air is withdrawn from combustion zone and added higher up in furnace so as to complete combustion		10-25% (WB 1997)	WB 1997: Capital costs $7-9/kW (<300MW); $30-40/kW (>300MW). Levelized costs: approx. US cents 0.10/kWh. $440 per ton NOx abated (tangential fired,) WB Shanghai: retrofit capital costs: $10-20/kW	Construction (retrofit) time: outage 4-9 weeks - assuming both LNB and OFA.	X		C/B

C. Post combustion/flue gas cleaning							
1. Selective catalytic reduction - SCR in power plants and selected industries	As this technology is not yet applied (or tested) in China, it is probably not realistic for the 2001 targets	70-90% (WB 1997) 70-80% (retrofit, Germany, IEA 1988)	WB 1997: Capital costs, new plants: $50-90 per kW; retrofit: 90-150 per kW. Operating and maintenance costs: 0.2-0.4 US cents/kWh. Levelised costs (assuming 80% NOx reduction): approximately UScents 0.4 - 0.6/kWh. WB Shanghai: $1,200/ton	Most often used in small boilers/fluidised bed boilers. Construction time: 3 weeks - 3 months. Some area requirements. Proven technology. No previous Chinese experience		X	B
2. Selective non-catalytic reduction – SNCR in industry and/or power plants	Same as above. Requires imported technology. Need for import and high costs pose administrative and financing problems. However, as SNCR is being researched and evaluated in China, it could possibly be part of 2001 action plan	30-50% (IEA); 60% (Swedish waste incinerators); 30-70% (WB, 1997)	Capital costs: $10-25 per kW Levelised costs (50% NOx reduction): $900 per ton NOx (500 MW); $1,100 per ton NOx (100MW) WB 1997 Generation costs increase: 9% (IEA 1988)	Construction if retrofit: 2-5 weeks. Proven technology. No previous Chinese experience, but SNCR is being researched in China.	X		B
3. Flue gas re-circulation in industry and/or power plants		20% (Swedish data) 15-20% (WB 1997) 50-70% (USA, IEA)	Low cost		X		C/B
D. Vehicle emission technology							
1. Gasoline cars and light duty trucks: 3-way catalytic converters on *new* cars/trucks	May be difficult to introduce mandatory requirement for Guangzhou, although not impossible (Shanghai has it, Beijing will have it). Price difference could stimulate sales of cars without 3-way converters. Effective annual test could reduce this problem.	90% reduction per car 12% of total NOx-exposure	WB Henan: $7600 per ton NOx when 3-way catalyst applied to "transportation sector"; WB (Walsh et.al.) US$ 630 per vehicle (gasoline-fuelled passenger car or a light-duty truck), including converter, air injection system and crankcase + evaporative controls)	Reduces HC as well	X		B
2. Replace taxis with new vehicles with three way catalytic converters, or alternatively: retrofit all taxis with 3-way catalytic converters	Mandatory? Tax incentives have proven successful in Germany.	90% less NOx-emission per vehicle	RMB 10-15,000 per ton NOx ? Retrofit: USD 630/RMB 5000 per vehicle		X		B?
3. Catalytic converters on new MCs	Same as for new cars (see above). Has not been adopted on four stroke MCs in any other country (Walsh et.al)		WB (Walsh et.al): US$80-100 per vehicle	Probably not suitable if most MCs in Guangzhou are 4-stroke.	X		C
4. Ban on new MCs and increased phase out of old MCs	How to effectively control out-of-city registered MCs circulating inside city?	MC-NOx = 0,7% of vehicle-NOx, i.e. negligable effect	ECON note 30/10	Already decided policy in Guangzhou	X		C
5. 100% enforcement of scrapping of diesel buses above maximum age/mileage	Difficult financial situation of many bus companies (of which many owned by city government)	Bus-NOx = 5% of total NOx, this option would yield limited effect			X		C

6. Catalytic converters on all new LPG buses		NOx-emission from LPG bus with catalytic converter is approx. 90% lower than without converter	The cost in larger vehicles is expected to be 50-100% higher than passenger cars because larger equipment required (approximately $1200-1600 per vehicle)			X	
E. Traffic & demand management							
1. Reduce future traffic significantly - stabilize total vehicle kilometres at 1998 level. Means needs to be specified (fleet reduction through taxes or quotas, less use of vehicles through taxes/charges, road pricing system or other schemes, ban of private mototorized transport in the centre of GZ - combined with free bike rent scheme)		Traffic-NOx = 50% of total NOx	Difficult to estimate costs without specifying means for achieving traffic reduction	Main point: Traffic is projected to grow significantly. This will make it even more difficult to reach NOx-targets. Thus, a slow-down of traffic growth is needed if other options are to achieve target.	X		?
2. Toll road ring around a defined city area					X		C
TSP Target: 0.3 mg/m^3 Status: 0.6-1.4 mg/m^3							
A. Fuel quality							
1. Use low ash content coal in power plants and industry	Availability of low ash content coal, would necessitate coal washing. How to control informal and semi-formal coal-supplies?		Washed coal: $720 per ton TSP removed (WB)		X		B
B. Post combustion							
1. High-efficiency electrostatic precipitators (ESP) in power plants and selected industries	Well proven technology. In China there are at least 3 ESP manufacturers for plants up to 600 MW. As there are relatively few units in question, individual permits/licenses would be most suitable for quick implementation. Increased emission charge for dust could be alternative, but could be less effective in practice. Permit + subsidy to ensure quick implementation?	TSP: 99% or more ESP efficiency is above 99,5%, but can be sized for efficiencies up to 99,99% with dust emissions as low as 5 mg/m3. ESP in smaller plants (<200 MW) has typically lower efficiencies around 99,1%. Example: A reduction from 24.0 to 0.1 t dust per hour from a 200 MW power plant equipped with ESP compared to a plant with no dust control.	**Chongqing estimate: Upgrade to ESP from water membrane. Total costs: RMB 4,798 per ton abated** WB (Shanghai): 25 MW units: $100-240 per t. removed; 100-125 MW units: $300-500 per ton removed. WB 1997: Capital costs for new ESP: 30-80 US$/kW (depending on coal quality); Costs of ESP-improvements: 1-20 US$/kW Operation and maintenance: low cost: 5 US$/kW per year. The by product "fly ash" can be used.	Probably installed in most power plants in China, but upgrade may be a cost effective option – and is also needed when clean technologies are used (spray dryers, sorbent injection, and FBC) Installing new ESP:2-3 months Increasing the size of existing ESP: 2-3 months Retrofit: 2-6 weeks	X		B
2. Baghouse fabric filters in power	Relatively few units: individual	Very high (99% of initial	**Pulse-jet fabric filter are a newer**	Only few installed in	X?	X ?	B

plants and selected industries	permits. Same comment as above	emissions)	**kind of baghouse filters with lower capital costs than the traditional reverse air fabric filters. Are more cost-effective than ESP and not depend as much on coal quality.** Capital costs 50 US$/kW . Total O&M is 6-7 US$ per year	power plants. An advantage with baghouse is that it can increase SO2 capture in combination with sorbent injection and dry scrubbers			
C. Traffic management							
1. Traffic flow management measures (reserved lanes for buses and bicycles, improved conditions for pedestrians, extended and synchronised traffic lights system, more traffic police officers posted in junctions, other)		Reduction potential highest for diesel vehicles. Increased traffic flow may cause higher exposure due to higher oppvirvling					
D. Other							
1. Cleaning of streets		Difficult to estimate, could be significant	How many kilometres of main roads? Speed: 20/km/h. 8 hours a day. Cost of vehicle and manpower		X		B?
2. Clean transport of building materials (Steinar)?	Mandatory (backed by effective enforcement: personnel and sanctions)				X		
3. Clean construction (physical measures to reduce dust from construction sites)					X		
4. Elimination of refuse burning	Difficult to enforce a mandatory requirement, lack of alternative disposal methods for refuse?		Cost of centralised waste incinerators with abatement equipment				?

Explanatory notes for filling in the table:

It is very important for this exercise that *control options or measures* are distinguished from *policy instruments* (virkemidler). Measures are technical measures and other forms of changed behaviour which are instigated by the application of policy tools or instruments. Flue gas cleaning through installation of some filter or scrubber or application of 3-way catalytic converters on cars are control options/measures. An emission standard or a pollution charge are policy tools whose aim is that people actually install scrubbers or buy cars with catalytic converters. In some instances the line is not so easy to draw: the ban on motorcycle could be said to both a policy instrument and a measure. Instead one could define the MC *measure* as 50% less MC kilometres driven per year, and that the *policy instrument* for achieving this is a ban on all new MCs.

"Effects" should give a rough indication of how much emissions (and if possible: concentration levels) will be reduced as a consequence of measure, preferably expressed as percent (emission reduction), or alternatively using the values "large", "some" and "insignificant".

"Costs" should give an idea of whether abatement measure should be classified as a low-cost measure, medium cost measure or high cost-measure. If possible: give an estimate of unit cost, meaning cost per ton reduced emission or (if possible) mg/m3 reduced concentration.

"Policy/regulation" should list main problems and challenges for the actual realisation of the measure and how such problems could be reduced or challenges overcome.

"Why?" should list other arguments and justification for including or not including the measure.

"2001/2010" should indicate whether option could be included in 2001 action plan or whether 2010 is more realistic.

"Potential" should indicate whether option have the potential to reduce total exposure by up to 5% (C), between 5-25% (B) or more than 25% (A).

Annex 5
Agreement between GZ and NORCE, of Nov. '98

Agreement between the Guangzhou and NORCE partners on some items under the 1999 program

During the meetings in the Technical Leading Group (TLG) on 6 and 13 November 1998 at GRIEP, the Guangzhou and NORCE partners agreed on the following topics related to the work plan for 1999:

1. Workshops 1999

<u>Workshop 1, 1999:</u>

Place: Guangzhou/LongGui
Period: 1st week of May.
Participants

- from NORCE side	:	On the workshop budget: Project Leader, and 3 task leaders (from NILU, IFE and ECON, according to the Project plan). On task budget: It is anticipated that more task leaders will participate.
- from Guangzhou side	:	Project Leader, Task leaders, and all other involved task groups members, as necessary. Representatives of GSTC, GEPB and Municipal government.

Program: To concentrate on Action Plan, as well as status and problems on all relevant tasks.

<u>Workshop 2, 1999</u>
Place: Guangzhou/LongGui
Time: Early in November, to be held together with the planned workshop on the UNDP project on NOx control in Guangzhou.

Participants:

- from NORCE side	:	On workshop budget: Project Leader, and 5 task leaders (from IFE, ECON and CICERO, according to the Project plan).
- from Guangzhou side	:	As for the May workshop.

Program: Concentrate on Final version of the Action Plan, as well as the finalization of the project.

The participation in the workshops from NORCE may change according to need, but keeping the total number of participants on the workshop budget the same, namely 10.

2. Exchange, 1999

To complete the Exchange program, Mrs. Li Chiqin, GZ Leader of Task 6.1, will have training in Norway for 6 weeks. Hosts will be CICERO (main host) and NILU.

The period of the stay will be decided within Task 6.1, in cooperation with the project leadership on the Guangzhou side.

The rest of the funds for exchange and training that has been transferred to Guangzhou side from the 1997 and 1998 project budgets (total funds were NOK 90,000) should be used to cover her expenses for travel to Norway and back, and for her subsistence in Norway. According to the Economic status overview of the Exchange program (which was sent to the Guangzhou side together with the invoice for 2nd quarter 1998), there is still approximately NOK 40,000 left of the training funds transferred to the Chinese side. Expenses for Li Chiqin which exceeds the NOK 40,000 amount, will be covered by NORCE side, according to the same rates for subsistence as used for the other trainees.

3. AirQUIS and EPISODE model transfer

AirQUIS: The complete AirQUIS version 2 will be transferred as soon as testing of the model is finished, and all known shortcomings ("bugs") corrected. The current estimate of when it will be available is February.

EPISODE: The EPISODE model delivered as part of AirQUIS, and for forecasting purposes to task 12, is delivered as a PC version to suit the available computer equipment at GRIEP and GEMC. The PCs are not powerful enough to do calculations on urban scale of photochemical pollutants. Also, dry deposition is not included in the present version, because it is not important on urban scale for pollutants like SO_2, NO_x and combustion particles. A version of EPISODE which includes photochemistry and dry deposition can in principle be delivered by NILU to be run on a UNIX platform. NILU will discuss the possibility of transferring such a model version (exe-version) to GRIEP and the requirements for such a delivery, and send a note about this to GRIEP before 30 January 1999.

4. Budget for 1999

The 1999 budget is stated in the Project Plan (Final Version of February 1997, page 35). This is shown below.

In addition to this, the rest of the 1998 budget which might not be used in 1998, will be available for use also in 1999.

Also in addition, the rest of the funds for equipment purchase (NOK 32,000) must be used in 1999.

Task	NORCE side	Guangzhou, from NORAD	Guangzhou side
1999 Budget			
1 Emissions	0		
2 Energy/Coal	45		
3 Dispersion	0		
4 Monitoring	0		
5 Exposure	0		
6 Damage	265		100
7 Control options	310		200
8 Scenarios	0		200
9 Cost-benefit	560		200
10 Policy instruments	245		150
11 Motor vehicles	45		100
12 Forecasting	100		300
13 Project administration	325		100
Workshops	500	50	50
Exchange	65		
Total	2,460	50	1,400

The distribution of funds between the different tasks may change, dependent upon the agreed contents of the Detailed Work Plans for 1999.

As has already been agreed, there will be a redistribution of funds, from all tasks to the Exchange task, because of overexpenditure of that task during 1997 and 1998. The redistribution will amount to about 4.25% of the total funds for all 3years for each task separately.

GRIEP, Guangzhou, 13 November, 1998

Mr. Wu Zhengqi
(Signature, for GZ side)

Mr. Steinar Larssen
(Signature, NORCE side)

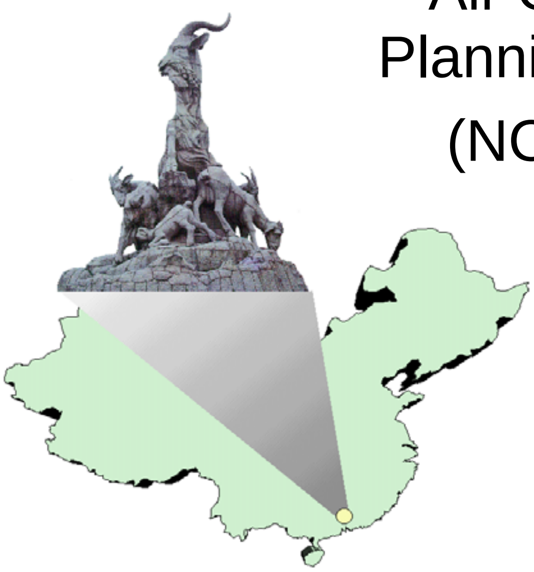
Annex 6
Proposed Report Front Page

Report Series: Technical/Task reports (B)
Report no.: B1
Date: July 1998

Air Quality in Guangzhou, 1990 - 1995

Steinar Larssen and
Guangzhou task 4 team

Air Quality Management and Planning System for Guangzhou
(NORAD Project CHN 013)



Participating Institutions:

P.R. China: GMSTC, GEPB, GRIEP, GEMC
Norway: NILU, IFE, CICERO, ECON

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ABSTRACT (in Norwegian)			

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