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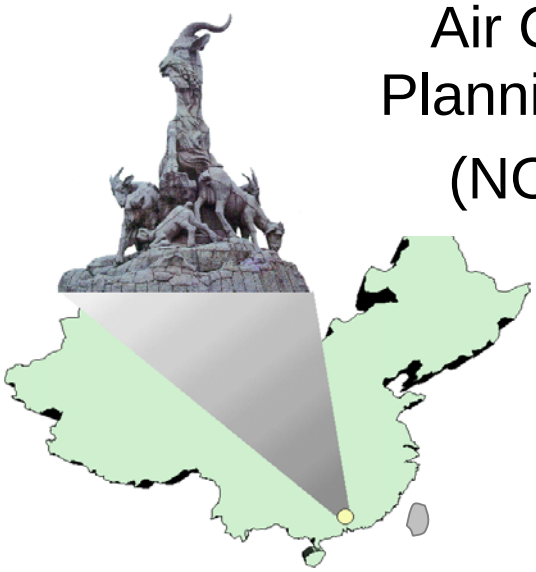
Report from Workshop 2, 1999

LongGui, Guangzhou, Nov. 29 - Dec. 3, 1999



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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Guangzhou Air Quality Management and Planning System

Steinar Larssen

Contents

LongGui, Guangzhou, Nov. 29~Dec. 3, 1999

Guangzhou Air Quality Management and Planning System

1 Introduction

The Sino-Norwegian cooperation project "Guangzhou Air Quality Management and Planning System" holds two workshop per year. The 2nd workshop in 1999 was held in Guangzhou during Nov. 28~Dec.3, 1998. It was arranged according to the agreement about this made between the partners, at the 1st workshop in 1999 in Guangzhou.

The workshop was attended by the full Guangzhou team, and from NORCE by 5 NORCE Task Leaders and by the project leader Mr. Steinar Larssen.

This workshop is the last workshop of whole project. The main objectives of this workshop were to finalize and report the main research results of whole project, and explore the further cooperation studies in Guangzhou or other cities of China.

The task teams had been asked to prepare Final Task Reports, to be available at this last workshop. The Final Task Reports were to summarise in brief statements the activities within and results from each task over the 3-year project period. These reports are included in Chapter 5 of the present workshop report.

2 Program and participants

The workshop program is shown in Appendix A. The main content was as follows:

Date	Activities
29 Nov. Monday:	Preparatory work in task groups.
30 Nov. Tuesday	Plenary Final project seminar (Report the research results from this project)
1 Dec. Wednesday	• Mini-workshop on Control on Mobile Sources • Task work • to prepare for the final workshop onThursday, and to complete task work and reporting (Final Task Reports, and Technical Reports).
3 Dec. Thursday	Morning • Project Leading Group meeting Afternoon: Plenary: • Final Project Plenary Meeting

The presentations at the Final project seminar on Tuesday included

- report on Action Plan 2001 and Action Plan 2010;
- report on Air Pollution Effects studies in Guangzhou;
- report on Improvement of Monitoring System in Guangzhou, as a result of the project;
- report on Air pollution forecasting system for Guangzhou ;
- report on Transfer of knowledge and tools. Summary of Project activities;
- report on The establishment of an integrated Air Quality Management and Planning System in Guangzhou.

The guidance note for the preparation of these presentations is copied in Appendix B.

List of participants:

	Guangzhou Team	NORCE Team
Invited Guests from Guangzhou and Guangdong	• Mrs. Cheng Ming (Dty. Director, Guangdong EPB) • Mr. Li Zhisheng (Chief Engineer, Guangdong EPB) • Mr. Liu Qihang (Div. Director, Guangdong EPB) • Mr. Ling Yuanhe(Vice Mayor of Guangzhou city) • Mr. Li Xing hua(Dty. Director, GSTC) • Mr. Liu Zheng yong(Div. Director, GSTC) • Mr. Zhang Nangfeng(Div. Director, GSTC) • Mr. Luo Yukuang(Div. Director, GSTC) • Mr. Gan Hai zhang (Director, Guangzhou EPB) • Mrs. Zheng Zhuoying(Dty. Director, EPB) • Mrs. Hu Shangyu (Div. Director, EPB) • Mr. Hao Enhe(Div. Director, GZ Planning Comm.)	
Media	• Guangzhou Environmental Education Centre • Guangzhou newspapers • Guangzhou TV stations	
Project Leaders	Wu Zhengqi	Steinar Larssen
Tasks		
1	Huang Qing Feng Jian Jianyang Pan Nan Ming Wang Dao Ming Kuang Jun Xia	
2	Zhong Jieqing Li Kangmin	Andrew Yager
3	Wan Daoming Fu Chun	
4	Dong Tianming Sun Daoyong Song Weiping	Steinar Larssen
5	Weng Shifa Zhang Jinghong	
6	Li Chiqin (6.1) He Liangwan (6.2) Yang Dangqing (6.3)	Kristin Aunan
7	Cui Xia Huang Qiangde Ye Ling	Andrew Yager
8	Fan Changzhong Huang Yingyu	Haakon Vennemo
9	Yu Jican Huang Xiaoshang	Haakon Vennemo
10	Ge Yi Liao Yundong	Knut Aarhus
11	Yu Kaiheng Zhu Changjian Wang Boguang Sun Qun	Andrew Yager
12	Fu Chun	Dag Tonnesen

3 Report from the Final Project seminar, 30 November

Opening statements

Mr. Wu welcomed all the participants and invited Mr. Ling Yuanhe, vice mayor of Guangzhou, to deliver an opening speech. Mr. Ling gave good comments for this cooperation project. Mr. Steinar Larssen delivered his opening speech and introduced the time schedule of the workshop.

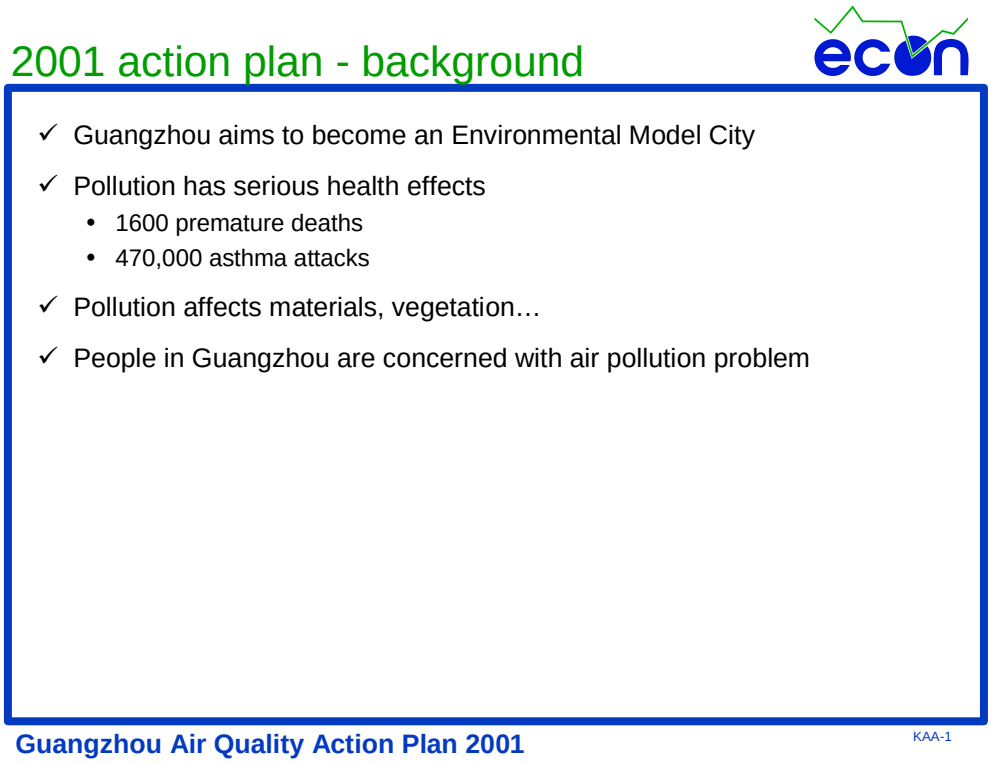
Presentations

The experts from Guangzhou and NORCE sides gave presentations on the Summary of Main Results, and fulfilment of objectives of the Guangzhou AQMS Project:

3.1 Action Plan 2001 Mr. Knut Aarhus, NORCE/ECON

The 2001 Action Plan exists as a separate report from the project. The action plan is summarised and main results are high-lighted in the Final Report from the project.

The transparencies from the presentation are shown below on the following pages.



Action plan 2001

- ✓ Objective: reach air quality targets for SO_2, NOx and TSP
  - basis for maximizing the impact of environmental expenditure
- ✓ Identify a least-cost package of control options
- ✓ Focus on concentrations rather than emissions
- ✓ Cost effectiveness analysis:
  - rank alternative options in terms of their cost
  - units used: costs per unit reduction of SO_2, NOx concentration

Guangzhou Air Quality Action Plan 2001 KAA-2

Methodology - analytical steps

- ✓ Estimate how large reductions - in concentrations - are required
- ✓ Identify sources, calculate emissions and contributions to concentrations
- ✓ Identify set of control options,
  - 1st screening: reduction potential, costs, maturity
  - "scoping": which individual sources
- ✓ Calculate cost and emission reduction potential of each control option
- ✓ Compare and rank options in terms of costs per unit SO_2 and NOx concentrations reduction
- ✓ Consider all options together - adjust reduction potentials and costs
- ✓ Select set of least cost options required to meet target

Guangzhou Air Quality Action Plan 2001 KAA-3

Targets

- ✓ Air quality concentrations: How large reductions are required?
- ✓ Comparing observed levels (1995) and targets:
- ✓ SO_2 annual average: 0 - **20%**
  - (max 24 h: 11% - 52%)
- ✓ NOx annual average: 23 - **62%**
  - max 24 h: 70-87%
- ✓ TSP annual average: 8 - **50%**
  - max 24 h: 48 - 78%

Guangzhou Air Quality Action Plan 2001 KAA-4

Main causes of air pollution levels

- ✓ Identify set of control options - 1st screening
- ✓ Contributions from different categories of sources (excl. backround):
- ✓ SO_2: Point sources, particularly large point sources (95% and 70%)
- ✓ NOx: Traffic (50%) and large point sources (30%)
- ✓ Particles: Large point sources (70%)
- ✓ SO_2 and particles: A few sources account for large share of contributions to concentrations
  - e.g. 15-20 sources responsible for 50% of calculated contributions to SO2 concentrations.

Guangzhou Air Quality Action Plan 2001 KAA-5

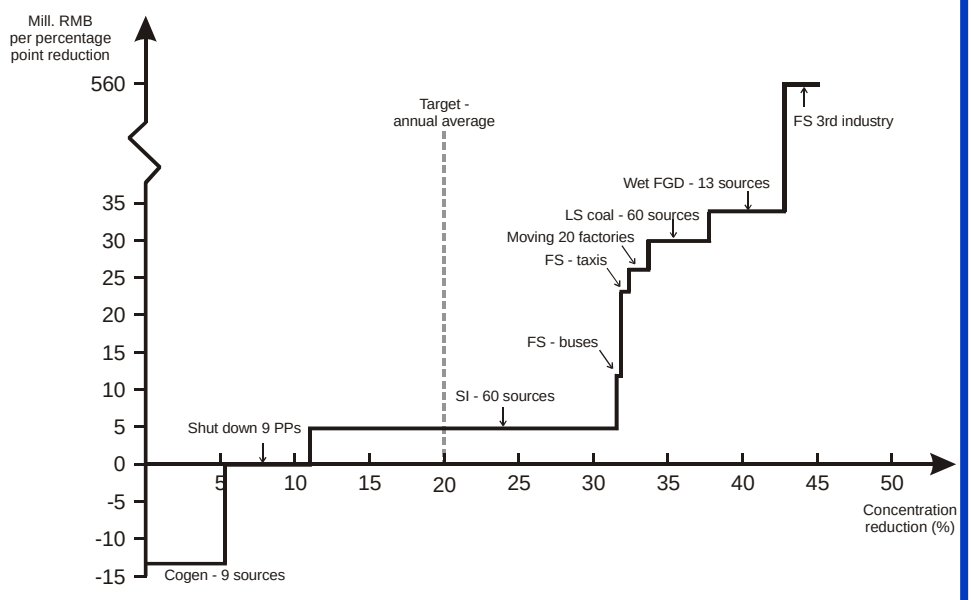
List of control options - SO_2

- ✓ Cogeneration - 9 industrial sources
- ✓ Shut down small power plants
  - increase capacity utilization in big plants
- ✓ Sorbent injection (60 sources)
- ✓ Shift to low sulphur coal (60 sources)
- ✓ Wet flue gas desulfurization - 17 sources
- ✓ Fuel switch taxis (LPG)
- ✓ Fuel switch buses (LPG)
- ✓ Moving 20 factories
- ✓ Fuel switch 3rd industry (LPG/city gas)

Guangzhou Air Quality Action Plan 2001

KAA-6

Results SO_2



Guangzhou Air Quality Action Plan 2001

KAA-7

Priorities and feasibility - SO_2 options

- ✓ Least cost package: Cogeneration, shut down and sorbent injection
- ✓ Target for annual average well within reach, small total costs (net costs ⇗ RMB 30 mill., or RMB 5 per person)
- ✓ Max 24 h target = 52%
- ✓ Technical feasibility: well known, no/low risk
- ✓ Institutional/political feasibility: may be a problem for shut down PP

Guangzhou Air Quality Action Plan 2001 KAA-8

Policy instruments - SO_2

- ✓ Cogeneration: a profitable option
  - what is the main barrier? credit? information? bureaucracy?
  - loan arrangement, information, sector co-ordination of public regulations
- ✓ Shut down PP
  - Direct regulation: new emission standards for existing PPs and strict implementation of TWAPT
  - possibly some compensation scheme for local authorities
- ✓ Sorbent injection
  - Direct regulation - stricter emission standards for major industrial sources, combined with TWAPT

Guangzhou Air Quality Action Plan 2001 KAA-9

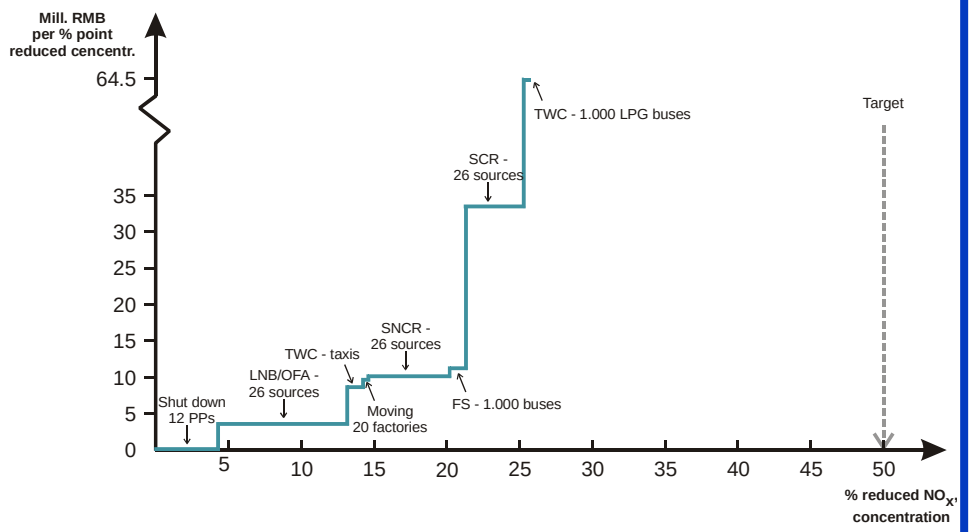
List of control options NOx

- ✓ Some options related to SO2
  - Shut down PPs, fuel switch buses, moving 20 factories
- ✓ Low NO_x burners/OFA in large point sources
- ✓ Selective non-catalytic reduction (SNCR) in 26 large point sources
- ✓ Selective catalytic reduction (SCR) in 26 large point sources
- ✓ Retrofit of three way catalytic converters (TWC) on taxis
- ✓ Retrofit of three way catalytic converters (TWC) on LPG buses

Guangzhou Air Quality Action Plan 2001

KAA-10

Results NOx



Guangzhou Air Quality Action Plan 2001

KAA-11

Priorities, feasibility and policy - NOx

- ✓ Difficult to achieve target for annual average:
  - traffic and background represent large share of contributions
  - target for max 24 hours average even more difficult
- ✓ DeNOx-technologies should be applied on all large point sources
- ✓ Well known technologies, though some new in China
- ✓ Total annual costs ⇗ RMB 100 mill. (20%); RMB 260 mill (25%)
- ✓ Policy instruments: direct regulation aimed at large sources
  - introduce emission standards for NOx, existing sources
  - in combination with soft loans/subsidies to finance initial investment costs equipment
- ✓ More drastic and effective traffic options needed
- ✓ Revise target - focus on NO_2 rather than NOx?
  - NOx China stricter than NO_2 WHO

Guangzhou Air Quality Action Plan 2001 KAA-12

Control options - particles

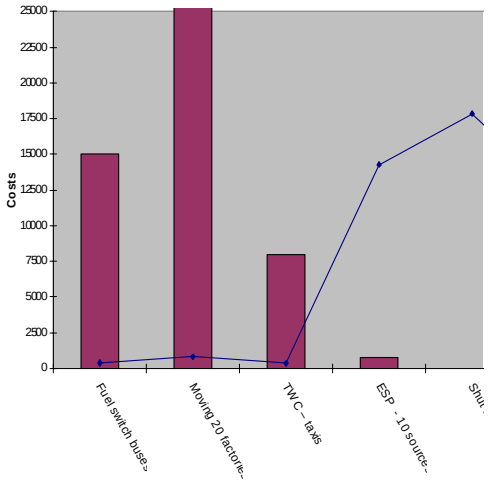
- ✓ SO_2-related options
- ✓ Low ash coal - large point sources
- ✓ High effective electrostatic precipitators (ESP) - 11 sources

Guangzhou Air Quality Action Plan 2001 KAA-13

Results - particles

	Costs per ton	Reduction potential - tons pr year
✓ Cogeneration, 9 sources	< 0	16,500
✓ Shut down 13 PPs	0	26-39,000
✓ ESP, 11 sources	500-1,000	20,000
✓ TWCs - taxis	8,000	500
✓ Fuel switch buses	12,500	120
✓ Low ash coal	10-20,000	32,000
✓ Moving 20 factories	72,000	1,150

Results particles



Priorities, feasibility and policy - PM

- ✓ Emissions decreases significantly through cogeneration, shut down and ESP
  - 40-50,000 tons or 35-40% of total calculated emissions (combustion particles)
- ✓ Total costs of three least cost options should be very moderate
- ✓ Mature technologies, already in use in Guangzhou
- ✓ Policy instruments:
  - cogeneration and shut down: as above
  - high effective ESP: emission standards or technology standards,
    - sector-wise or individual permits

Guangzhou Air Quality Action Plan 2001 KAA-16

Results SO_2

- ✓ Each option analysed independent of other options:

	Reduction potential	Total costs	Cost per %-point
✓ Cogeneration 9 srcs	5.5%	- 73 mill.	- 13.2 mill.
✓ Shut down 13 PPs	8%*	0*	0*
✓ Sorbent injection	26%	124 mill.	4.8 mill
✓ Low sulfur coal	12%	112 mill	9.3 mill.
✓ Wet FGD 17 sources	24%	225 mill	9.4 mill.
✓ FS – buses	0.15%	1.75 mill	11.7 mill
✓ FS – taxis	0.5%	11.5 mill	23 mill.
✓ Moving 20 factories	1.4%	36.2 mill	26 mill.
✓ FS 3rd industry	2.4%	1350 mill	560 mill.

Guangzhou Air Quality Action Plan 2001 KAA-17

Results NOx

- ✓ Each option analysed independent of other options:

	Reduction	Costs per %-point reduction
✓ Shut down 13 PP	4%	0
✓ LNB/OFA , 26 sources	11%	3.6 mill.
✓ SNCR, 26 sources	12%	5.4 mill.
✓ TWC - taxis	1.5%	8.4 mill
✓ SCR 26 sources	20%	9.0 mill.
✓ Fuel switch, buses	0.7%	11.4 mill.
✓ TWC, LPG buses	0.2%	64.5 mill.
✓ Moving 20 industries	0.1%	9.8 mill.

Guangzhou Air Quality Action Plan 2001

KAA-18

3.2 Action Plan 2010 Mr. Luo Jiahai, GRIEP

The 2010 Action Plan was presented as a draft document, which at the time of the workshop was not quite complete. It was based upon the baseline scenario for 2010, and control options for all major source categories were investigated in terms of their costs per reduced ton of emissions. The resulting improvements in air quality and exposure had not yet been calculated, since the AirQUIS calculations had not been completed fully. Thus, a calculation of cost-effectiveness had not yet been made, in terms of relations between control costs and reduced air pollution concentrations. It was agreed that the NORCE side would give detailed comment s to the 2010 Action Plan by the end of 1999.

3.3 Air Pollution Effects Studies in Guangzhou Mrs. Kristin Aunan, NORCE/CICERO

The content and the main findings in the studies related to damage on health, building materials and vegetation from air pollution in Guangzhou was presented. Calculations of the estimated reductions of health effects and material damage in Guangzhou due to air pollution abatement, as this was outlined in the Action Plan 2001, were presented. Tentative estimates for reduced agricultural crop damage was also presented.

Copies of the transparencies presented are found below on the following pages.

EFFECTS OF AIR POLLUTION IN GUANGZHOU

- **human health**
- **materials (buildings)**
- **vegetation**

Goal: **Assess the present level of damage due to air pollution and provide tools and knowledge so that the Guangzhou counterparts can continue the Air Quality Management work in a qualified fashion**

NUMBER OF PEOPLE IN GUANGZHOU EXPOSED TO SO_2 LEVELS ABOVE CHINESE AIR QUALITY STANDARDS (1995)

Class I (20 µg/m^3): **5.4 mill. people**

Class II (60 µg/m^3): **2.0 mill. people**

Class III (100 µg/m^3): **0.1 mill. people**

(World Health Organisation (50 g/m^3): 3.0 mill. people)

A) Respiratory symptoms and diseases among people living in Guangzhou - an interview study:

- **4000 adults**
- **2000 children**

4 areas:

- **Control area,**
- **Traffic area**
- **New industrial area**
- **Old industrial area**

- **Prevalence rates for several respiratory symptoms**
- **Prevalence rates for other health conditions (e.g. eczema and allergy)**
- **Medication (type, amount)**
- **Sources of indoor air pollution**
- **Pets at home**
- **Smoking habits**
- **Perceptions of the air pollution situation**
- **Willingness to pay for reduced pollution**

Examples of results:

- **~4% of both adults and children are often bothered with upper respiratory symptoms (e.g. sore throat, coughing, runny nose)**
- **~8% of the adults are bothered with lower respiratory symptoms (wheezing and shortness of breath)**
- **~6% of the children have chronic bronchitis**
- **On average ~6 sick-leave days per adult per year (⇒ ~35 mill. sick-leave days in Guangzhou annually)**

How much of the health effects may be attributed to air pollution?

- Differences between the four study areas?

Cross-sectional analysis to find dose-response relationship between air pollutants and effect frequencies….

B) Daily number of hospital admission at four hospitals in central Guangzhou:

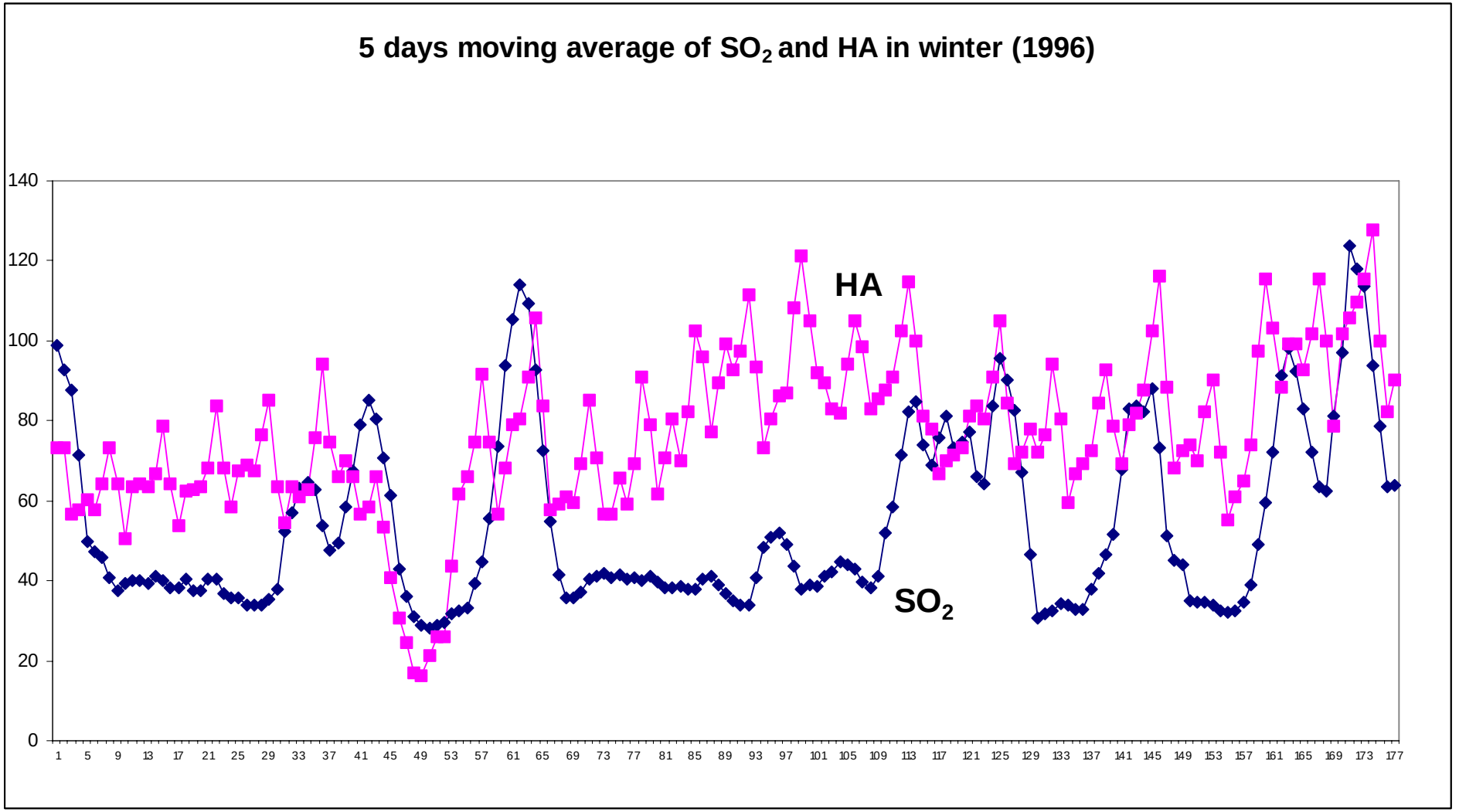
1) Zhongshan 3rd hospital (in Tianhe)

2) Honghui hospital (in Haizhu)

3) Guangzhou medical college 1st affiliated hospital (in Yuexiu)

4) Guangzhou medical college 2nd affiliated hospital (in Haizhu)

- **Malignant neoplasma in respiratory system**
- **Respiratory diseases**
- **Cardiovascular diseases**
- **Cerebrovascular diseases**
- **Hypertensive disease**


5 days moving average of SO2 and HA in winter (1996)
HA
SO2
140
120
100
80
60
40
20
0
1
5
9
13
17
21
25
29
33
37
41
45
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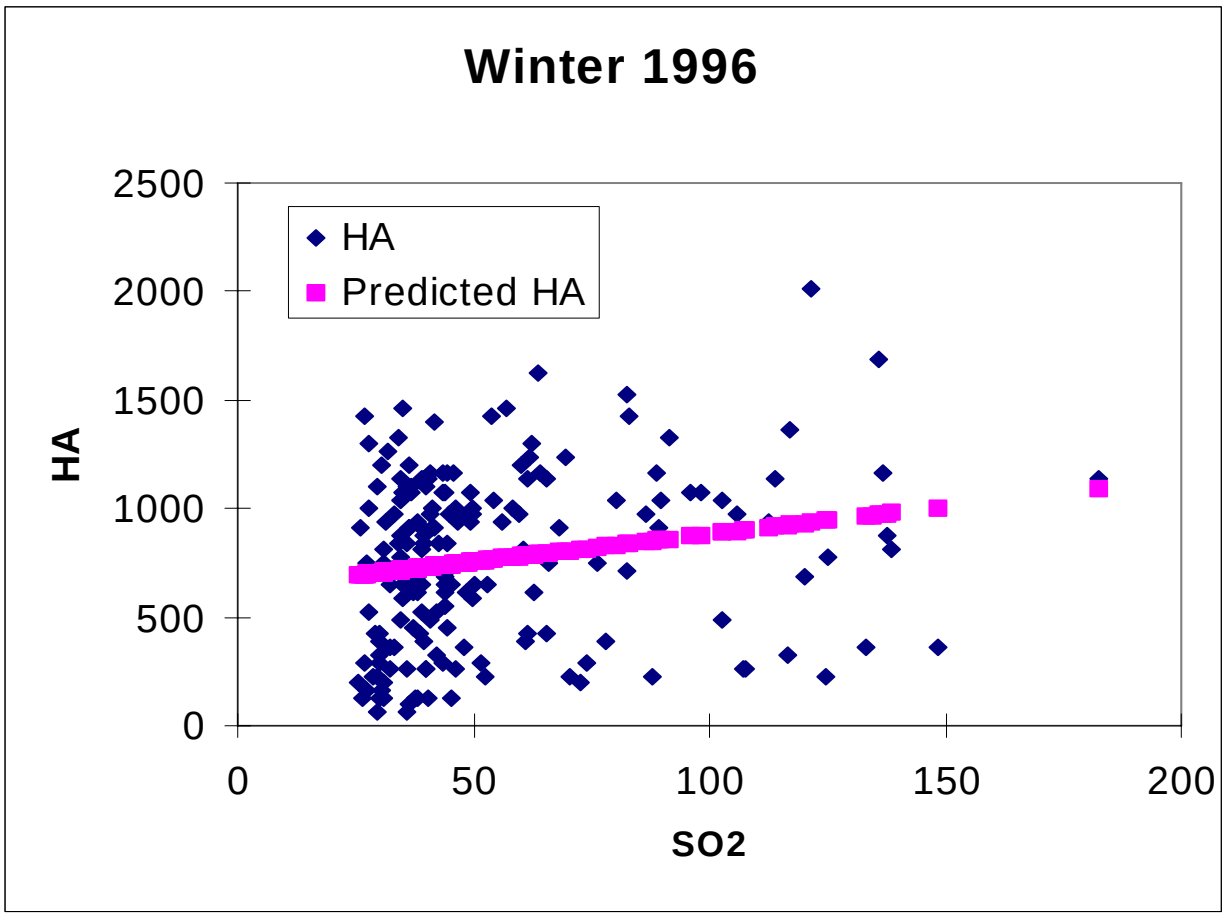


% increase in HA per µg/m^3 SO_2 : 0.28 (±1SE 0.15-0.40)
(Simple linear regression)

Numerous studies have reported a coherent association between air pollution and various health end-points, including:

- **Increased mortality rate, especially cardiovascular and respiratory mortality**
- **Increased incidence rate and duration of acute respiratory symptoms**
- **Exacerbation of asthma**
- **Decline in lung function**
- **Increased hospitalisation, especially for respiratory and cardiovascular diseases**
- **Increased prevalence of chronic diseases, e.g. chronic bronchitis**
- **Increased number of lung cancer cases**

Annual total number of cases estimated for the 8 central districts in Guangzhou, and estimated percentage reduction in cases obtainable from implementation of nine control options in Action Plan 2001.

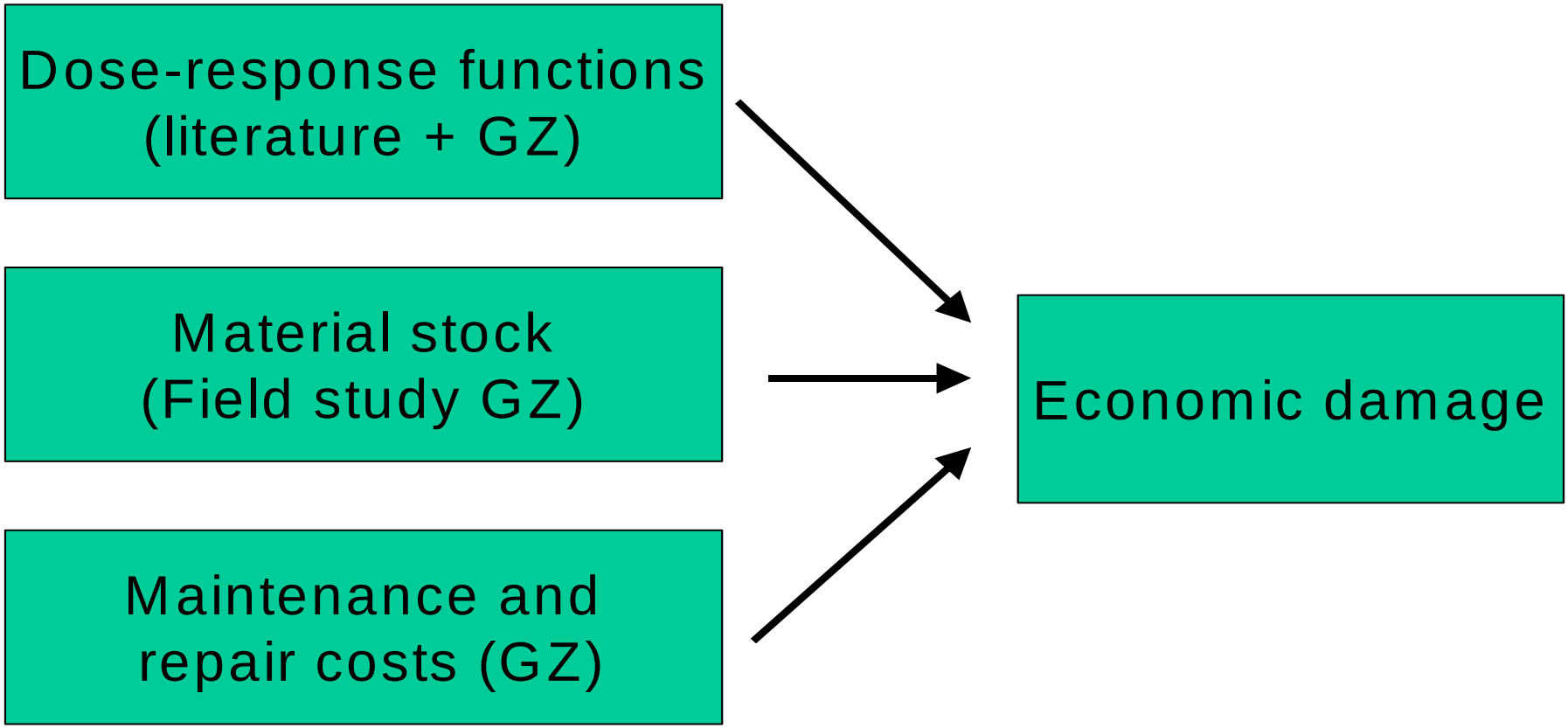
	Annual no. of cases	% reduction
Deaths	22,513	2.7
Infant deaths	463	2.2
Outpatient visits (mill.)	30.1	0.3
Emergency room visits (mill.)	1.9	0.5
Hospital admissions (mill.)	0.34	2.8
Respiratory symptoms in children (mill. symptom days)	14.9	1.0
Respiratory symptoms in adults (mill. symptom days)	40.2	1.0
Chronic respiratory disease in adults (cases)	138,000	0.5

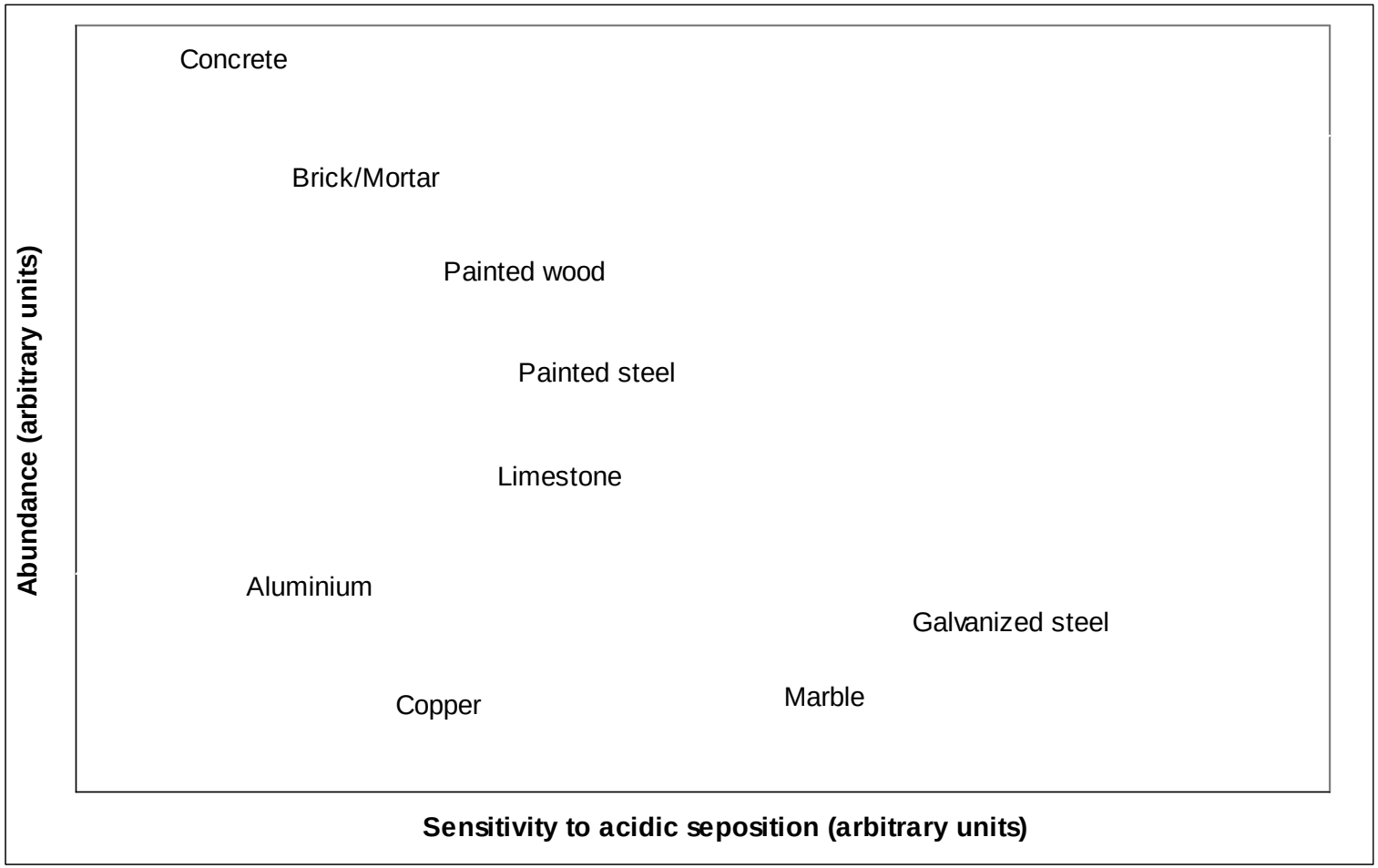
Estimated reduced number of cases obtained for each control option in Action Plan 2001, estimated for the 8 central districts in Guangzhou. OPV:Outpatient visists; ERV: Emergency room visits; HA: Hospital admissions; ARS-Ch: Acute respiratory symptoms in children; ARS-Ad: Acute respiratory symptoms in adults; CRD-Ad: Chronic respiratory disease in adults.

Control option	**Deaths**			**Infant deaths**			**OPV (10^3)**			**ERV (10^3)**			**HA (10^3)**			**ARS-Ch (10^3)**			**ARS-Ad (10^3)**			**CRD-Ad[1]**		
	Mean	low	high	Mean	low	high	Mean	low	high	Mean	low	high	Mean	low	high	Mean	low	high	Mean	low	high	Mean	low	high
1	74	53	94	1	-1	4	10.0	8.7	11.4	1.2	0.7	1.6	1.2	0.6	1.9	17.6	16.7	18.4	47.5	45.1	49.8	82	16	147
2	72	51	91	1	-1	4	9.7	8.3	11.0	1.1	0.7	1.6	1.1	0.5	1.8	16.9	16.1	17.8	45.7	43.4	48.0	79	16	141
3	284	201	360	5	-5	14	38.3	33.1	43.6	4.4	2.7	6.2	4.4	2.1	7.2	67.0	63.7	70.4	181.2	172.1	190.3	311	62	560
4	2	1	3	0	0	0	0.3	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.5	0.5	1.3	1.2	1.4	2	0	4
5	54	38	69	1	-1	3	7.3	6.3	8.3	0.8	0.5	1.2	0.8	0.4	1.4	12.8	12.1	13.4	34.5	32.8	36.2	59	12	107
6	7	5	9	0	0	0	0.9	0.8	1.0	0.1	0.1	0.1	0.1	0.1	0.2	1.6	1.5	1.7	4.3	4.1	4.5	7	1	13
7	68	48	86	1	-1	3	9.1	7.9	10.4	1.0	0.6	1.5	1.0	0.5	1.7	16.0	15.2	16.8	43.1	41.0	45.3	74	15	133
8	19	13	24	0	0	1	2.6	2.2	2.9	0.3	0.2	0.4	0.3	0.1	0.5	4.5	4.2	4.7	12.1	11.5	12.7	21	4	37
9	32	23	41	1	-1	2	4.4	3.8	5.0	0.5	0.3	0.7	0.5	0.2	0.8	7.7	7.3	8.0	20.7	19.7	21.7	36	7	64
Total	**613**	434	776	**10**	-10	31	**83**	71	94	**10**	6	13	**10**	5	15	**144**	137	152	**390**	371	410	**671**	134	1208

[1] To tentatively estimate the effect on this end-point we have used a preliminary function from the interview study (Task 6-1).

Damage assessment for materials





(from NAPAP, 1991)

Dose-response functions from the international literature have been confirmed in Guangzhou for:

- **zink**
- **steel**

Field exposure test program:

- **1 year (Jan. 1997 – Jan. 1998)**
- **10 sites**
- **Weight loss vs. air pollution ⇒ dose-response (corrosion – mg/m^2)**
- **How much corrosion before repair is needed? ⇒ Lifetime equations**

Economic benefit for materials obtainable from implementation of nine control options in Action Plan 2001

Control option	Pollution reduction (%)	Estimated total benefit (mill. RMB)*
1	5.5	7.6
2	5.3	7.3
3	21	29.1
4	0.15	0.2
5	4	5.5
6	0.5	0.7
7	5	6.9
8	1.4	1.9
9	2.4	3.5
1-3	31.8	44.0
1-6	36.5	49.1
1-9	**45.3**	**62.3**

***Applies to about 65% of the materials. E.g. aluminium and glass excluded.**

Inventory of building materials:

The estimated total amount of materials in central Guangzhou (14 km x 10 km) is distributed into the AirQuis modelling gridsquares (250m x 250 m):

- **9 building types**
- **average material amount for each building type (based on field inspections and statistical data)**

Building repair and maintenance costs:

- **Data from Guangzhou Housing Administration Bureau and Guangzhou Construction Commission**

Damage assessment for vegetation

Some core elements:

- Forest damage on Baiyun Mountain
- Acid rain effects
- Agricultural crop loss
- Vegetation damage assessment in urban city
- Pollutant resistant plants in urban Guangzhou

The most important air pollutants regarding crop damage are:

- **O_3**
- **SO_2**
- **NO_x**
- **acid mist**
- **fluorine**

The SO_2 concentrations (particularly outside the central districts) are not very high, and the average value is well below what suggested as critical level for SO_2 in Europe:

- **No serious yield loss due to SO_2**

Estimated 7 hour day $^{-1}$ seasonal ozone levels (ppb) at the two monitoring stations in Guangzhou

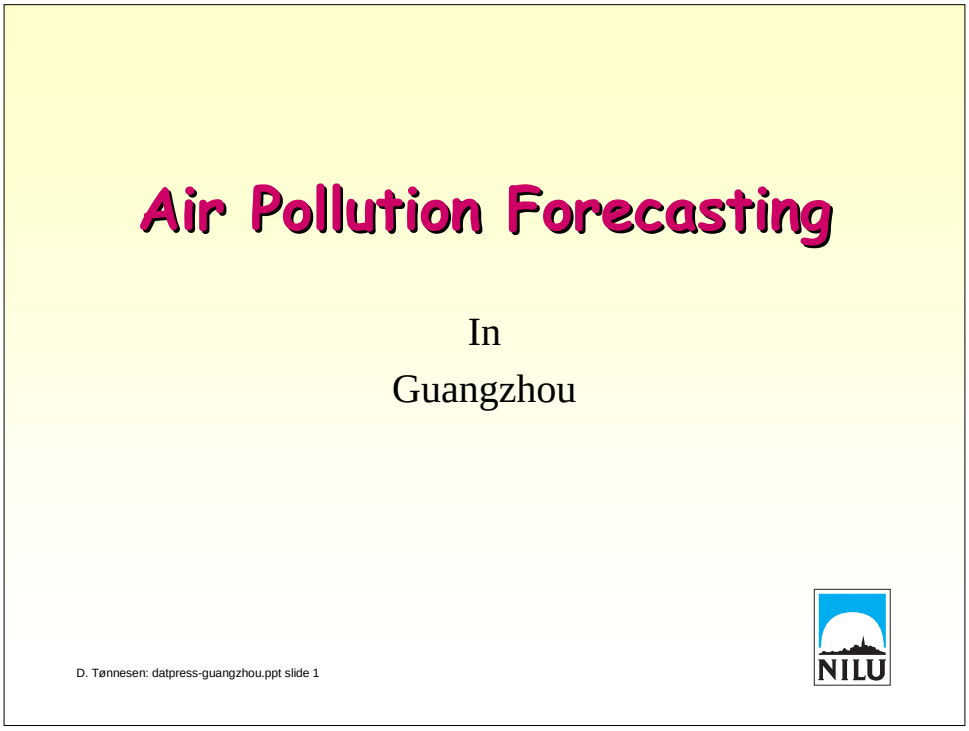
	Luhu	Longgui
1. quarter	23	29
2. quarter	28	25
3. quarter	31	29
4. quarter	33	36

Estimated yield-loss (in %) using dose-response functions.

	20 ppb	30 ppb	40 ppb	50 ppb
Turnip	1.1	3.6	8.0	14.8
Spinach	1.9	4.3	7.7	11.9
Lettuce	0	0	0.0	0.0
Tomato	1.0	2.5	4.9	8.1
Vegetables, average	*1.0*	*2.6*	*5.1*	*8.7*
Rice (?)	0.3	0.9	1.8	3.1

3.4 Air pollution forecasting system for Guangzhou Mr. Dag Tønnesen

A presentation was made of the forecasting system that had been provided for Guangzhou through the task work in Task 12. An executable version of the urban dispersion model EPISODE has been provided, and a system established for coupling meteorological forecasts and the dispersion model, to give 12-hour forecasts of the pollution situation, for primary pollutants. The potential for improvement of the forecasting system was also described.
Copies of the transparencies are shown below on the following pages.



- Report on conditions 12-12
- Forecast 12-12
- Indicators: nitrogen dioxide and particles
- Numerical prediction IN model area
- Low spatial correlation for measurements inside and outside model area
- No forecast for “upwind” area in the province

D. Tønnesen: datpress-guangzhou.ppt slide 2

Forecast elements

- General meteorological forecast
- Pre-processing dispersion data for the Episode model (measurement statistics)
- Pre-calculated emissions from the AirQuis model
- Results for NO_X and PM_{10}
- Statistical data for NO_2/NO_X

D. Tønnesen: datpress-guangzhou.ppt slide 3

Possible improvements

- More frequent meteorological forecasts to be used in the pre-processor (buying)
- Upwind background concentrations from “remote” measurement stations
- Improved description of spatial distribution of pollution sources
- Improved description of time variation of pollution sources

D. Tønnesen: datpress-guangzhou.ppt slide 4

3.5 Transfer of knowledge and tools. Summary of Project activities
Mr. Luo Jiahai, GRIEP.

The report prepared by the Guangzhou side on details re. the transfer of knowledge and tools was presented. This report relates to the fulfilment of one of the main objectives of the project, that of knowledge and tools transfer. This report is included in full in the Final Report of the project, where the fulfilment of the objective is also evaluated.

3.6 Improvement of Monitoring System in Guangzhou, as a result of the project
Mr. Sun Dayong, GEMC.

Here the report which had been prepared by the Guangzhou side was presented. This report also relates to the fulfilment of one of the main objectives of the project: the improvement of the monitoring system. This report is included in full in the Final report from the project, where the fulfilment of this objective is evaluated.

3.7 The establishment of an integrated Air Quality Management and Planning System in Guangzhou
Mr. Wu Zhengqi, Director,GRIEP

The most important main objective of the project relates to the integration of analytical, quantitative concept of Air Quality Management (AQM) that has been transferred to the Guangzhou during this project, how this concept is integrated into the air quality management work within the existing institutions in Guangzhou responsible for AQM work, and for improvement of the air pollution situation.

Mr. Wu presented the report which had been prepared on this issue. This report, as it has been modified since the workshop, is included in full in the Final Report from the project, and also here the fulfilment of this objective is evaluated.

4 Minutes from the Project Leading Group meeting

2 December 1999, 0900-1200.

4.1 Project finalisation: Clarification of the fulfilment of project objectives. Discussion.

The objectives of the project were as follows:

- Develop and establish an air quality management and planning system for GZ based on the URBAIR concept: Objective has been fulfilled.
  An outline of the system was presented by Mr. Wu on Tuesday.
- Development of an action plan, by the Chinese side. The Norwegian side will assist: Objective has been fulfilled.
  The 2001 plan is a finished example made primarily by the Norwegian side.

The 2010 plan is almost finished, primarily by the Chinese side
The Norwegian side will provide comments to the 2010 action plan after the final workshop.

- Update and improve the monitoring system: Objective has been fulfilled.
  An assessment was provided by Mr. Sun on Tuesday.
- Transfer of tools and knowledge: Objective has been fulfilled.
  An assessment was provided by Mr. Luo on Tuesday. To complete the capacity building process, GRIEP will encourage its scientists to write up and publish its research for review by experts, and later compete for research prizes.

4.2 Final reporting:

- List of Technical and other reports.
- List of publications.
- Workshop reports, 1999
- Final report: Contents and responsibilities.

A list of technical and other reports, to include all the reports made in the project, is being compiled by the Norwegian side. Will be sent to the Chinese side for completion. Each report in Chinese should have an English title page, summary and list of contents. All reports will be sent to NORAD. Each institution (GRIEP, NILU, ECON, CICERO, IFE) should have library of all reports.

The Chinese side has published research articles in Chinese journals related to the project. The Chinese side will compile a list of the articles, stating the names and journal and of publication, and the reference.

The workshop report from the first workshop of 1999 will soon be completed. The Chinese side will propose the contents of the final workshop report, from the present workshop. This proposal should be sent to NORCE side by 31.12.99.

The final report to NORAD should be made according to the specifications of the contract. The proposal for contents was accepted in general. The Chinese side will study the details of the proposal after the workshop. Proposals for changing the outline of the final report should be sent to NORCE side by 31.12.99. The Norwegian side will write the first draft of the final report to NORAD.

4.3 Project evaluation, by MOST and NORAD. Information.

A evaluation team selected by NORAD will probably visit GZ next year as part of an evaluation of the project.

MOST/SSTC will also evaluate the project. A mid-term evaluation in the spring of 1999 considered the project to be the most successful of the ongoing environmental projects.

4.4 Continuation projects. Discussion.

The following possibilities were considered:

- URBAIR project in Chengdu. GRIEP will check further with authorities in Chengdu/Sichuan. NORAD might fund a pre-feasibility study. Our goal should be to make a proposal to NORAD before the next annual meeting. The NORCE side is responsible for making the proposal, based on input from GRIEP and Chinese side.
- The annual meeting of UNICA next year, in Macau, will be informed of our projects. There is contact between GRIEP and UNDP. NORCE can prepare a PM/ozone/NOx proposal for GZ, but the decision lies with UNDP Beijing and the outcome of communication between GRIEP and UNDP. The first step is for GRIEP to find out from Beijing which plans they might have for continuing the the UNDP study.
- The health study has left valuable data. Both sides feel an obligation to process the data, on internal funds if necessary.
- GEF has funding for energy efficiency measures, in addition to renewable energy and low emission technologies. GEF will probably be interested to see how the 2001 and 2010 action plan fits with their ideas. GRIEP might also make contact with the Energy Conservation Information Dissemination Centre of SSTC and the Energy Research Institute. Both GEF and the EU could be interested in financing projects on renewable energy.

Appendix 3 gives some more details on possible continuation projects.

4.5 Agenda for the final Plenary, on Thursday Afternoon.

Proposal by Mr. Larssen accepted.

5 Final Task work reports

The Final Task Reports prepared by each task team are presented below.The reports were to be written according to the following set-up:

- main objectives
- activities and knowledge transfer, under the main objectives:
  - knowledge and tools transfer
  – data collection
  – development of AQMS system
  – development of action plans
- Main achievements of task and research work
- Problems encountered and solved
- References to reports and material produced.

The actual format of the reports from the various tasks differ rather significantly, and deviates sometimes from the given format. They are presented here as they were written by the task teams.

Task 1 Emission Inventory

- **Objectives**

Task 1 --Emission Inventory-- is the first task group of the Sino-Norwegian cooperating project, "Air Quality Management and Planning System for Guangzhou". According to the project proposal, the object of this Task is to study the air pollution sources in Guangzhou area, to establish a database of pollutant emissions, and finally, to deliver emission inventory to relating tasks.

Main jobs for Task 1 are the followings.

·To collect emission information from point sources, including production industries and third industry, and make out a basic database for point sources.

·To collect emission information from domestic sources, and make out a basic database for domestic sources.

·To collect emission information from traffic sources, including vehicles, planes and ships, and make out a basic database for traffic sources.

·To study and decide emission factors for fuel consumption and for traffic.

·Using Kilder model, AirQUIS system or others, to calculate pollutant emission amount from different sources.

·To study shares for emissions in different industries and areas.

·To supply data to other task groups.

- **Relations with Other Tasks**

Task 1 takes responsibilities to input the following data to relating tasks.

·Fuel consumption data to Task 2.

·Emission data from different sources to Task 3.

·Gridded population distribution to Task 5.

Other concerning tasks supply the following data to Task 1.

·Future development of fuel consumption, population and traffic volume in the year 2001 and 2010 from Task 8.

·Control measures or action plans of pollution abatement from Task 7 and Task 11.

·Concentration data from Task 3.

- **Tasks Performing**

1)Achieving schedule

1 Preparation: November 1996 ~ March 1997

In this stage, task members and task objects were decided. A draft researching proposal was also made.

2 Beginning: March ~ April, 1997

From 12 to 18 March 1997, task members from both sides made a discussion on data collection at GEMC. Details such as study area, coordinate system, data to be collected and ways to collect data, etc were discussed. The Norwegian side made introductions to the Kilder model. After the meeting, a draft work plan was completed, which later on (April 10) was modified according to the comments from Project Office.

(3) Investigation: May 1997 ~ December 1998

A. The definition of investigation questionnaire for point sources was finished by May 1997. Proved by Guangzhou Statistic Bureau and Guangzhou EPB, questionnaires were sent to part of fuel users in Guangzhou City in July and August. By the aid of EPB's of the 4 county-level cities and Baiyun district, investigation of the rest fuel users was made in October and November. As for data collection in Foshan, Nanhai and Shunde, task members finished the job in April 1998.

B. Data collection on domestic and traffic sources was finished by November 1997.

(4) Data processing and analyzing: January ~ November 1998

A Data examination and computerizing.

B Collecting data on cleaning efficiency and plane emission, ship emission.

C Calculation of data in basic year by Kilder model.

(5) Additional data collection: December 1998 ~ February 1999

A Collecting information on time variation for point sources.

B Making input files and data importing into AirQUIS system.

(6) Future emission inventorying: March ~ July 1999

According to the baseline scenarios from Task 8, deduced the fuel consumption data in the year 2001 and 2010. Imported the future emission data into AirQUIS system.

(7) Reports writing: May ~ November 1999

Studying report for work-by-now, May 1999.

Task report for emission inventory, September 1999.

Draft of technical report for emission inventory, October 1999.

Final technical report for emission inventory, December 1999.

2) Guarantee system

(1) Constitution assurance

Leaders Group, Advisors Group and Technical Group were set for the cooperating project. Still more, a full-time Project Office was organized for the responsibility for everyday events of management. Being a basic task group, Task 1 is under the supervision and management of Project Office.

(2) Technology assurance

According to Project Proposal, researching work must be adjusted to the advice from relative aspects.

A Studying area, ways to collect data and details of questionnaire be proved by Project Office and Technical Group.

B Researching work be guided by specialists and scholars of national level, if necessary.

C As a staged achievement, report on emission factor study be appraised by local learned.

D Feedback comments from other tasks be considered to modify emission inventory.

(3) Quality assurance

A To get the most feed-backs and keep high accuracy of them, investigation questionnaires were sent in the name of Guangzhou EPB and Guangzhou Statistic Bureau.

B Inquiry hot line was set to answer questions from fuel users being investigated.

C To entrust personnel from EPB's of the 4 county-level cities and Baiyun district with the investigation within areas under their administration, necessary training was given to them.

D Strict examinations were made to the recovered questionnaires. Obvious mistakes and any uncertainties were corrected or made sure.

E Focussing on important pollution sources, made sure that all the big fuel consumers had given their feed-backs and that they had delivered true information.

F Being checked independently, mutually and together, information from the feed-back questionnaires was input into computer to establish a mother-database.

G Most part of data on domestic sources was adopted from statistical department to keep its accuracy, usefulness and authoritativeness.

H Information from traffic department and environmental protection department were applied. Meanwhile, 24-hour measurement to the main crossings was made. This can keep data reliable.

I Training for task members on Kilder and AirQUIS at home or abroad was received. This led to unification for data processing and reliability of calculation result.

- **Data Processing**

1) Data processing for the basic year

(1) Industry sources

A. Deciding data collection area

B. Deciding foundation data and coding

C. Collecting Data

According to proposal from Norwegian partners and discussion between both sides, it was decided that data for 1995 would be obtained through investigation by questionnaires.

·With reference to the Norwegian sample, considering the project objects and local conditions, Task 1 made a draft of questionnaire for fuel user in Guangzhou. Through discussions among the other tasks, the modified version was delivered to Project Office and Technical Group for comments. The final style was approved by Guangzhou Statistic Bureau to get an official series number. At the end of this report is the sample.

·There were 3 ways to make investigations to fuel users in Guangzhou.

a. To those who were annually measured by GEMC, we sent questionnaires through local post-office. The feed-back time was limited to a specified date. Firstly the bigger, important users were considered, and then the rest. On the other hand, during the feeding-back we processed data already at hand in the same time.

b. To those who were under everyday management of the county-level cities, we sent questionnaires to the more important ones by the aid of local EPB's.

c. As for investigation in Foshan Area, with the help of Project Office, task members went personally to Shunde EPB and Nanhai EPB to collect data from important pollution sources located there.

Because of the irregularities of the feed-backs, task members made checking one by one, especially to the important sources. Finally put the data into computer to get a mother-database.

D. Deciding emission factors

To make emission calculations, emission factors were necessary. For details please see appendix 3.

E. Emission inventorying for year 1995.

Using the collected data and emission factors and cleaning efficiency for different cleaners, pollutant emission calculations for 1995 were made.

(2) Domestic sources

To put population data into the grids, we use data distribution in different streets from Statistic Bureau. Detailed operations include

A. Input data into computer to establish database.

B. According to the locations of grids and street boundaries, draw the maps of different districts and county-level cities containing their boundaries.

C. Rearrange population data in districts and cities to make input files.

D. Calculate the population percentage for different streets in relative districts and estimate the distribution for a district in one or more grids.

E. Make statistics on grids that a district covers and populations in the grids. Work out the input files for population distribution.

F. Use Kilder programs to calculate population distribution. Use relating emission factors and fuel consumption information to calculate fuel consumption and pollutant emission in grids from domestic sources.

(3) Traffic sources

Through discussion between both sides, it was decided that traffic sources should include vehicles, planes and ships, of which vehicles were the most important.

A. Collecting data concerning vehicles

Investigation on vehicle numbers, vehicle types, vehicle composition and oil types in 1995 was made.

B. Deciding driving conditions and emission factors

·Ways to get emission factors are: a. Practical measurement to running vehicles, b. Platform tests to some light cars, c. Using American model MVEI7gc to develop a local prediction model, d. Tunnel tests to make examination, e. Comparison with emission factors from abroad, f. Working out reasonable emission factors for Guangzhou.

·There are 3 cases for emission factors for MC: Less than 50CC, 50CC ~ 100CC and more than 150CC. Measurements to more than 50 MC's were made. Thank to the limitation of instruments, emission factors for only HC and CO were obtained. As for those for SO_2 and NO_X, we tried to consider the American ones.

C. Classification of vehicles

In this project we divided vehicles into 4 groups:

Heavy: trucks for GVW>3500kg, buses for more than 20 seats;

Medium: small trucks and mini buses;

Light: limousines, Taxi and mini cars;

MC: different types.

D. Traffic volume and Traffic work investigation

Investigation on traffic volume for 173 main roads was made. Hourly variation in typical crossings was measured. Traffic work was calculated from traffic volume.

E. Establishing emission database for vehicles

a. Details of the database include:

·Road type (5 classes);

·Coordinates of the road nodes;

·Traffic volume (daily average);

·Traffic volume and traffic work for 4 vehicle classes.

b. Vehicle emission calculation

·Input the coordinates of the road nodes or road crossing and traffic volume in road links for different vehicle types into the database.

·By means of Kilder model and AirQUIS system, calculate traffic volume in grids.

·Using emission factors for traffic, calculate the pollutant emissions in grids.

F. Other traffic sources

Planes: Plane types, number, daily average taking-off and landing were investigated. Adopt the emission factors for Boeing.

Ships: Ship types, number, hourly sailing on rivers in Guangzhou area were investigated. Use emission factors for national diesel engines.

G. Calculating emissions from all traffic sources to establish emission inventory for traffic.

- **Basic line emission inventory for future**

(1) Industry sources

A. How to predict the baseline fuel consumption for future?

a. Upon the basis of 1995 emission inventory, use a fuel consumption development factor to deduce the fuel consumption in 2001 for point sources already in use; add the new point sources to be in use in2001; make some modification to point sources to be expanded in 2001. Thus, we can tell the fuel consumption in 2001 for all point sources, old, new, or expanded.
b. Upon the basis of fuel consumption in 2001, we use the same method to deduce that in 2010.

The way to collect future data decided, it becomes important to get the so-called fuel consumption development factor. Task 8 had supplied the every-year change of industrial fuel consumption during 1994~1997. We take the average number as the yearly development factor for the period 1995 ~ 2001. Also, Task 8 had given an average increasing number for fuel consumption for the period of 2001 to 2010. Therefore, we can calculate 2 consumption amplifiers: one for year 2001 compared to 1995 and another for year 2010 to 2001.

B. How to make emission database for future?

Make a copy of the basic-year emission database, and sort on activity type and fuel type. The 2001 consumption is that of 1995 times the 2001 amplifier. Add new point sources and modify some sources to be expanded. Now we get the database for the year 2001. In the same way, make a copy of the 2001.database, and sort on activity type and fuel type again. The fuel consumption in 2010 would be that of 2001 times the 2010 amplifier. Appending new point sources to be in use in 2010 would result in database for year 2010.

Emission calculations for 2001 and 2010 would be done in the same ways. Data inputting in the AirQUIS system is a similar job, or we can do it manually.

C. Modification to emission inventory based on future scenarios

Control measures would be raised and assessed by relative task groups. Different control measures could make up different control options. Corresponding modification to concerning baseline inventory should be made according to some specified control option. This new inventory may be supplied to Task 3 to make concentration calculation. Thus, we could see the concentration abatement effect for that control option.

(2) Domestic sources

Based on the population increase and the trend of fuel consumption from Task 8, baseline emission inventory for domestic sources for future can be established in the similar way as that for basic year.

(3) Traffic sources

Using data on such as new road-net, increasing number of traffic volume and changes of emission factors for future from Task 11 and Task 8, we can calculate the traffic-works for the year

2001 and 2010. Traffic emissions for baseline alternative for future can be predicted.

- Main Achievements

Through studies on different sources, Task 1 have made achievements as the following:

1) Grasped the methodology to make investigation on air pollution sources. Learned to collect data and information. Finished the coding of different types of data. See appendix 1.

2)Made clear the characteristics and varying regulations of air pollution emission in Guangzhou. Analyzed the shares for fuel consumption and pollutant emission in different industries and different areas. Established the baseline emission inventories for year 1995, 2001 and 2010.

3)Mastered the Kilder calculation methods.

4)Learned the method to make import files for AirQUIS system and to import data. Finished the input of data for baseline alternatives.

5)Through studies on a variety of materials, obtained emission factors for fuel combustion appropriate to all burners in Guangzhou, which were applied in this project after appraisement from local learned specialists. See appendix 3.

6)Through training at NILU, one of the cooperating partners in Norway, learned the advantages of AirQUIS system and obtained some experiences to perform the approaching of our project. See appendix 2.

Task 2 Energy Consumption and Smoke Pollution

- **Main objectives**

According to the Project Proposal, the main objectives is:

-to investigate the present relation of energy composition, energy consumption and the coal smoke pollution in Guangzhou;

-to evaluate the best option of energy utilization and pollutant emission abatement according to the development of economy, and the planning of industrial development; and

-to predict the effect of economy development and energy consumption on ambient air quality.

- **Activities and knowledge transfer**

1) Knowledge transfer from NORCE to Guangzhou side

Norwegian experts, Fridtiof F.Unander and Andrew J. Yager (IFE) (CICERO) have provided Guangzhou group some international literatures and materials related to the study. And they have kept on discussing with Guangzhou group by the way of e-mails or workshops so that the project can be finished smoothly.

In the period of Nov. 28 to Dec. 2 in 1997, they held a short-term training cause in

GRIEP introducing the application in the world of MARKAK model in the field of energy planning. Under their guidance, the Guangzhou group has learned some knowledge such as the formula of data imported, model structure and its application. They also have discussed with Guangzhou side the methods and format of collecting data of energy consumption in 1995, which make a good base for disposal and import of data of different scenarios. Unfortunately, the model has not been applied in the project in Guangzhou.

2) Data collection

The needed data is collected from three paths.

(1)The Statistical Bureau of Guangzhou, the Communications & Energy Office of Planning Commission Guangzhou, and the Energy Office of CED Guangzhou offer:

-the information or data about the consumption of energy in 1995 and in histroy ;

-the 9th-five-year Plan of Energy and the Development plan of 2010.

(2) Guangzhou Environment Protection Bureau, the environment protection bureau of district in Guangzhou provide:

- the energy consumption from the main industries in Guangzhou (including 8 districts and 4 counties); and

- the emission amount of SO2 and smoke and dust in Guangzhou;

(3) The Task 1 pollutant emission inventory offers:

-the investigation data of energy consumption in Base Year 1995 in the studied region;

-the data of pollution sources in the Base Year (1995).

These data can help us to make clear the energy consumption and coal smoke pollution in Guangzhou, and provide the valuable information for developing the pollutant emission inventory.

3)Development of the AQMS transfer

The study of Task 2 on the alternative options of coal smoke pollution can give a basis of the different scenarios of industrial pollution control and emission abatement measures in the AQMS. It will provide a method for the similar research in future.

4)Development of the Action plans

Task 2 has analyzed SO2 pollution with energy demand increase in future, especially with the coal consumption growth for electricity generation. Task 2 also

has performed the feasibility assessment for optimizing of energy composition, increasing the energy utilization rate, phasing out the small power plant affiliated to the old enterprises and the boiler with low thermal efficient, and reducing the increasing rate of coal consumption. The assessment makes a basis of the pollution abatement measures for the Action Plan.

- **Achievement of Research and task work**

1) Research the relation of energy consumption and coal smoke pollution, and set up a database of energy consumption, pollutant emission sources and share rate for 1995.

2) Provide a set of alternative options for the prediction of energy demand for the development of scenario of energy utilization and energy demand in future Guangzhou.

3) Propose the alternative options of optimizing energy consumption and pollution control for coal smoke.

- **Technical report and work report**

1) Stage technical report ;

2) Stage work report I and II;

3) Work Report (draft);

4) Technical Report (draft).

- **Problem encountered and solution**

In the cause of data collection, especially for the information of energy demand in future, Task 2 has met a lot of problems. The leaders of the related departments and the Norwegian experts have provided a lot of help and guidance. But concerning the further study on energy planning and energy supply, we hope to get some help from Norwegian or other experts.

- **Reference list**

1)Strike Forward to the Modern City — The 9th-five-year-plan of Guangzhou and the long-term development target in 2010. 1996

2)Prospect Electric Power Market and Countermeasure Study Report, Guangzhou, 1998.

3)China Energy Annual Review, 1996.

4)China Energy Development Report, 1997.

Task 3 Dispersion Modeling

1 Main objectives

Dispersion modelling is one important part of AirQUIS. It provides tools necessary to calculate air pollution concentrations in the area as a function of time and location , which again is necessary to calculate the pollution exposure needed for the damage assessment.
Input to the dispersion models is the emission data from the emission inventory, dispersion data derived from meteorological measurements(wind, temperature, stability, precipitation), and topographical data.

2 Actives and knowledge transfer

2.1 Transfer of knowledge and tools from NORCE to Guangzhou side

- EPISODE Model and its User's guide, Import Excel Templates, ENSIS Import Templates. The model installed and running at the end of 1998 and updated to 2.02 version in Oct. 1999.
- EPISODE Model training: one person of Guangzhou side trained at NILU in September of 1997 and May-June of 1998. The experts from Norwegian side went to Guangzhou two weeks for installation, presentation and training in Oct. 1997, then used three weeks together to solve problems in imput, running and output, as well as short training.
- One HP NetSever LH and one HP Kayak Xu PC workstation were installed at Guangzhou in Oct. 1998, and used in EPISODE Model.
- KILDER model system and its User's guide. It was installed at Guangzhou in 1997.
- ROADAIR model and its User's guide. It was installed at Guangzhou in 1997.

2.2 Data collection

- Collection the meteorological information of 1995 according to EPISODE and KILDER.
- Collection and management some of the meteorological information of 1996 and 1997.
- Collection and management the electron map data
- Collection topographical data for EPISODE and KILDER.

2.3 Development of the AQMS

- Supply the simulation calculation of pollutant status and future concentration for each grid through dispersion simulation.
- Supply the simulation calculation data for damage assessment

2.4 Development of the Action Plan

- Supply the control objective and level for the Action Plan through the concentration contribution rate.
- Supply the basic for the Action Plan from the pollutant concentration and the simulation achievement of Action Plan

3 Main achievements of research and task work

- Simulated calculation of SO2, NOx, PM10 of 1995 in each grid
- Each pollutant of 1995 concentration contribution rate to SO2, NOx, PM10.
- Calculation and simulation of pollutant concentration level of 2001and 2010
- Calculation of pollutant concentration in 1996 and 4000 accept points for task 6-1
- Simulating concentration contribution for each option in the Action Plan
- Installing and running EPISODE and KILDER system, dealing with meteorological information, electron map, and topographical data.

4 Problems encountered and solved

- There are some problems in EPISODE model need to be solved and developed. Some problems have been solved, such as the speed of input and output, but there are other problems still need to be solved, such as slow speed of calculation and wrong concentration contribution rate of traffic source.
- The User's Guide of EPISODE lacks the structure of model and date, system running and management.

5 Reference list

- The first report of series reports of task 3: The report of topographical data management

- The second report of series reports of task 3: The report of meteorological data management
- The third report of series reports of task 3: The report of KILDER dispersion simulation calculation
- The forth report of series reports of task 3: The report of AirQUIS dispersion simulation calculation
- Ensis 2.0 Import Excel Templates April 1999.
- Ensis 2.0 User's Guide 1998.
- The EPISODE air pollution dispersion model, version 2.0 User's Guide 1997
- The "KILDER" air pollution modelling system, version 2.0 1996

Task 4 Monitoring

1 Preface

The Air Quality Monitoring is one of important sub-task of <<Guangzhou Air Quality Management and Planning System>>.

1.1 The Norway Develops Cooperative Office and China Nation Scientific & Technology Committee state that " Increasing the Air Quality Monitoring System (pollutant parameters and monitoring points) for Guangzhou " is one of cooperative aim about agreements to with the first of the books of Guangzhou Air Quality Management and Planning System.

1.2 Appendix 1 of project documents agreement book demands that renewing and improving Guangzhou Air Monitoring System as one of important achievements of project.

1.3 It's one of important content of the cooperative aim that the raise of the air quality monitoring ability is " the raise of ability in the environment field, particularly atmosphere quality aspect ".

1.4 It is clear and definite that the project action scheme is gone a step further:

1.4.1 Arrangement

1.4.1.1 the first stage (1 year)

--Participating and discussing at the started workshop;

--Making out the detailed work plan, and determining subject group member, director and the budget of subject;

--Collecting and analyzing related data;

--Improving air quality monitoring system, and appraising the air quality;

--Sending expert to be trained in NORCE;

--Participating twice special subject meetings.

1.4.1.2 the second stage (1 year)

--Finishing data collection and analysis;

--Finishing the evaluation of air quality;

--Participating twice special subject meetings.

1.4.1.3 the third stage (1 year)

--Improving air quality monitoring system, and making it achieving international standard and requires;

--Finishing the work report;

--Participating once special subject meeting and final work meeting.

1.4.2 contents

1.4.2.1 Appraise with the standard to the monitoring air pollution concentration data, and provides the foundation data for the auto-monitoring stations some place nearby area contact evaluation and diffusion model control scheme proved and lays down.

1.4.2.2 The existing monitoring stations location, method, equipment and data quality etc are described on the appraisal foundation, and making out the improvement monitoring plan.

1.4.2.3 It's necessary for replenishment monitoring equipment in Guangzhou, particularly O3 and PM10's monitoring instrument, and quality control and analysis equipment in laboratory (healthy demarcation gas and sensitivity microbalance etc).

1.4.3 training and scholar exchanges

Sending one expert to be trained in NILU and the other experts in Guangzhou about equipment use and laboratory analysis step and the quality control step, in order to raise Guangzhou subject component person's ability.

1.4.4 responsibility

1.4.4.1 Norway

--Appraisal Guangzhou monitoring system;

--If necessary, to put forward the improvement suggestion;

--Providing guidance and the help of quality control concerned the air quality data.

1.4.4.2 Guangzhou

--Monitoring air quality stations according to the project;

--Provides the air quality data of possessing the scope checked up enough and precision.

2 Major work

2.1 Starting Workshop

2.1.1 The starting workshop was convened on November 25, 1996 in Guangzhou. The leaders from both sides were attended opening speech, and the experts from both sides made the speech on special subject.

2.1.2 The first air quality monitoring special subject was held up on the morning of Nov. 27, 1996.

2.1.2.1 Steinar Larssen introduced general monitoring system.

Purposes

. To provide data to establish the state of the environment, for a continuous process of evacuating the need for improvement and the effects of pollution control efforts.

. To provide data for fast evaluation of the air quality, to be able to inform the public and set in corrective actions when the pollution level exceeds certain levels considered dangerous to health.

. To serve these purposes, automatic monitor and Geographical Information Systems (GIs) are important tools. They make environmental data more readily available to planners, authorities, and to the public.

In the process of raising the awareness of the seriousness of environmental pollution, and the need to develop a strategy and a continuous effort to control the problem, it's necessary that environmental information systems combine the latest sensor and monitor technologies with data transfer, data base developments, quality assurance, statistical and numerical models and advanced computer platforms for processing, distribution and presenting data and model results.

Topics

. Air Quality Guidelines
. Air Quality Indicators
. Monitoring network design
. Sitting (location of monitoring station)
. Selection of compounds
. Methods of measurement/monitoring/analysis
. Quality assurance/Quality control (QA/QC)
. Data retrieval/data base
. Data processing/presentations
. Reporting

2.1.2.2 Dong Tainting introduced "Plan for Air Quality Monitoring in Guangzhou"

Objective

. To enhance the ability in air quality monitoring and air quality evaluation.

. To provide planners, authorities and residents with air quality and its temporal developing trend.

. To improve and extend Guangzhou Air Quality Auto-monitoring System (GZAQAMS), and to carry out Guangzhou Air Quality Prediction.

Topics

. According to the sources of atmospheric pollution and natural conditions in Guangzhou, select of monitoring items.

. According to the plan for city development in Guangzhou, improve and extend GZAQAMS.

. With the optimum selection of sampling site locations (i.e., branch stations), the monitoring results obtained by GZAQAMS can effectively pattern upon the air quality on Guangzhou region, the contributions to the air pollution by various pollution sources can be estimated in the system.

. The system can be adjusted to follow the development in the city.

2.1.2.3 Song Weiping introduced Air Auto-monitoring Network in Guangzhou

. Monitoring tasks

. Monitoring items

. Performance of Monitoring Station

. Methods of measurement/monitoring/analysis

. Quality assurance/Quality control (QA/QC)

. Data transfer/data base

. Data processing/presentations

. Reporting procedures

2.1.2.4 NILU and GEMC discussed the defect of Air Auto-monitoring System in Guangzhou

. Inadequacy of monitoring area

. Lack of important monitoring items (e.g., O3, PM10)

. Necessity from a new-building meteorological station

2.1.2.5 NILU and GEMC discussed Work Plan

Because it was not enough of time and NILU were lack awareness of Air Auto-monitoring System in Guangzhou, discussing work plan was postponed next week, until Air Auto-monitoring System would have made an on-the-spot investigation.

2.1.3 Making an on-the-spot investigation of Air Auto-monitoring System in Guangzhou (02/12/1996)

. Introduction

. Observing Control Center of Air Auto-monitoring System

. Observing the laboratory of measurement/analysis atmospheric compounds

. Watching the demonstration of Geographical Information Systems (GIs)

. Viewing Data Base of Pollution Source in Guangzhou

. Surveying Air Auto-monitoring Stations (Guangzhou Environment Monitoring Center, Guangya Middle School, Xilaixi Primary School, Luhu Lake)

2.1.4 Second Seminar (05/12/1996)

2.1.4.1 Steinar Larssen introduced the Norwegian Institute for Air Research

. Norwegian area and population

. The scale of the Norwegian Institute for Air Research

. The organization of the Norwegian Institute for Air Research

. The scope of business of the Norwegian Institute for Air Research

. The achievement of research of the Norwegian Institute for Air Research

2.1.4.2 NILU and GEMC discussed the defect of Air Auto-monitoring System in Guangzhou

2.1.5 Third Seminar (06/12/1996)

Contents

. To discuss the objective, task, detailed work plan and arrangement completely and seriously.

Results

. To agree the three targets of Air Quality Monitoring defined by GEMC.

. To evaluate Air Auto-monitoring System (six existing sub-station network) firstly, select monitoring factors and decide to add some important monitoring items such as O3, PM10 and mete-factors preliminary according to air pollution condition and nature situation in Guangzhou, and optimize and improve Air Auto-monitoring Sub-station Network in Guangzhou depending on Guangzhou City Development Plan.

. To establish comparing point (Air Auto-monitoring Sub-station) in far suburb in order to define air nature background value, near-suburb background value and urban background value which means the need of comparing point in far-suburb, clean point in near-suburb and urburb points (including resident area, traffic area and industry area, etc.), so as to satisfy the need of the research (specially for testing the model and forecasting).

. To arrange monitoring points reasonably. For example, there is no monitoring station in a large area from Yuachun District to Huangpu District and Economic Technology Development District. It's necessary to establish Air Auto-monitoring Station in Huangpu District or (and) Economic Technology Development District in order to test air dispersion model by NILU and develop Air Quality Forecasting.

. To draft detailed work plan greed by NILU and GEMC, See appendix.

2.2 Work to on April 1997 (the 1st work meeting)

2.2.1 Network description

The station description tables had been filled out completely for all the 6 automatic stations. But tables had not been filled out for the many manual stations.

2.2.2 1995 air quality data

The statistics analysis of 1995's air quality data had been done under the guidance of NILU, and NILU requested that hourly data be presented for a full week around the chosen day (95/12/13).

2.2.3. Instrument purchase plan

After receiving offers from various companies, GEMC has decided for Thermo Electron, same as they have before.

2.2.4 Research background station for GZ

Installation background monitoring station (outside the city) was necessary in this study, because the possibilities for reducing the air pollution in GZ was very dependent upon how large was the background pollution contribution relative to the contribution from the local emissions. For most compounds it was clear that the local contribution was dominating, but for PM10 and O3 the regional background concentration was of importance.

The location of a background station would be selected during the coming visit of either Mr. Tannesen or Mr. Gram. PM10 and O3 measurements should start as soon as possible.

2.3 Work to on November 1997 (the 2nd work meeting)

2.3.1 Network description

The description of the other 37 manual stations was finished in September, and Song Weiping went to submit to NILU when he was trained Norway in August.

2.3.2 Network description Report

This topic was not discussed in the present meeting. The contents of such a report will be further discussed in the Detailed work Plan for 1998.

This topic, by both sides jointly to undertake, but could not complete according to the plan, Steinar Larssen thought to sum up not to provide one week hourly air quality monitoring data (including December 13, 1995) and 1995's air auto-monitoring statistics data in Guangzhou, and

Could not evaluate to the existing network, in 1998 work plan implementation can only be enlisted.

2.3.3 Improvement plan for the network.

2.3.3.1 Proposal from GZ team

The improvement plan to network should combine with Guangzhou Air Auto-monitoring System optimization some stations, and with the nation air quality

forecast was executed and the new environment air quality standard joined mutually, and would get the nation checks and approving.

The network improvement plan would be after stagnant, and adding up earlier the data with 1995 evaluated to the existing network, and evaluated to the network improvement plan after NEPA to approve to research again.

2.3.3.2 Network Improvement Step

. In order not to influence the whole project research course, branch two steps of network improvement were gone on: newly earlier increases the monitoring of project such as PM10 and O3s etc, and go on at the same time the network improvement design.

. Initial definite PM10 equipment to be put in the existing auto-monitoring stations, and the data were according to the transmissions of existing means, and recommended O3 equipment to be put the stations after evaluation by NILU.

. Drawing up initially two clean contrast stations, Modaoken Reservoir (northern the foot of Baiyunshan) and Longgui Ecology Center (2 kilometers western with Baiyunshan).

2.3.4 Purchase of equipment.

The models and number of monitors to be purchased had been proposed by GZ. NILU had agreed to the purchase plan.

2.3.5 Technique Training

. Guangzhou sent Song Weiping to go Norway to be trained the technique for a month at September, and harvesting sees the achievements part.

. Steinar Larssen putting forward NILU sent an expert to train the other the technique in

Guangzhou again, and discussed as a result of both sides, and determined mainly to maintain knowledge transfer and technical personnel's ability for QA/QC and the instrument equipment maintenance to train.

2.4 Work to on April, 1998 (the 3rd working conference)

2.4.1 Network description

2.4.1.1 Air Quality data to NILU

To be able to do a proper evaluation of the existing network, and propose modifications which would answer to the requirements to the monitoring network posed by the Guangzhou AQMS project, the GZ team picked out one week of hourly data from all automatic stations, for all compounds, and plotted hourly mean chart. The chosen week (13-19 Dec. 1995) was a fairly polluted week, and the same week for all stations.

Manual-monitoring Data, which came from Districts, was only average value for District. GEMC had not been obtained the data for any station. The form and figure of SO2, NOX, CO, TSP average value for Districts was given.

GZ Project Office put the material in NILU.

2.4.1.2 Report

Guangzhou and NILU respectively finished a report manuscript (including the mouth the data table collected, summary and monitoring network description table), but both sides still did not gather, and the report was not finally completed.

2.4.2 Improvement plan for the network.

2.4.2.1 Proposal from the GZ team.

GEMC had made a general technical proposal to NEPA on a new monitoring system for Guangzhou, and which was approved. GEMC was making a more detailed proposal of the new network, including station locations, compounds to be measured, QA/QC etc. When making this detailed proposal, GEMC waits for the proposals for system modification that NILU would give in sub-task 2.4.2.2 (see below).

2.4.2.2 Evaluation by NILU

NILU would make an evaluation of the existing monitoring program in GZ. This evaluation would be based upon the following:

…… The network description (finished in 1997).

…… The requested air quality data;

…… Maps over GZ, and data for population distribution.

The requested air quality data were necessary to do the network evaluation.

Based on this evaluation, NILU would give:

…… Requirements to the monitoring satisfy the needs of the GZ AQMS system;

…… Proposal on how to satisfy these requirements

2.4.3 Establish new monitors at stations

GEMC had purchased the new monitors. They are put into running in.

The first monitors were located the following place:

…… PM10: Background station (Location to be decided in 1997), GEMC, and GRIEP;

…… O3: As above. In addition: The Luhu station.

The monitors could be moved to other locations later, if the final network description requires that.

2.4.4 Provide data to other tasks

Task 3 team would use detailed air quality data for comparison/control of air pollution concentrations calculated with the dispersion models. The Monthly and

annual averages, SO2, NOX, CO, TSP, all stations with data, for 1995, hourly data for all available stations and compounds, for 12 months of 1995 were given.

As the need for Task 6.2(Material damage) and 6.3 (Vegetation damage) work, the monthly/ annual average data mentioned in the first point was given.

2.5 Work to on October 1998 (the 4th work meeting)

2.5.1 Network Description

According to the requirement of NILU, Guangzhou team had submitted to NILU the followed data in the form and the graph:

.1995 NO2 lunar average value of 6 auto-monitor stations;

.1991-1995 NO2 annual average value of 6 auto-monitor stations;

.13-19, 1995 Dec. NOX, CO, TSP hourly value of 6 auto-monitor stations.

2.5.2 Improvement plan for the network

After GEMC made a general technical proposal to NEPA on a new monitoring system for Guangzhou, GEMC was studying the improvement plan of the new monitoring system on the basis of NEPA opinion. It would be defined the number of stations, the position of station, and monitoring items, QA/QC etc. At the same time, GEMC was expecting that NILU made the evaluation and proposal of improvement plan of the network.

2.5.3 Install new equipment

PM10, O3 was installed at GEMC station, GRIEP station, Longgui station (background station), and O3 was installed at Luhu station. Now, all equipment is running in.

2.5.4 QA/QC training

According to '98 DWP and '98 the first workshop arrangement, Thor Christian Berg visited GZ/GEMC for 2 week in June. He discussed QA/QC (Data Quality Procedures) of GZ air auto-monitoring system with GZ team, and guidance and training GZ team QA/QC.

2.5.5 Data to other tasks

According to requests, data had been delivered to task 3, task 6.2, and task 6.3. And expecting specific requirement, data would be delivered to task 6.2.

2.6 Work to on June 1999 (the 5th work meeting)

2.6.1 Improvement plan for the network

2.6.1.1 The improvement plan of Guangzhou Air Quality Auto-monitoring Network improvement design was not still translated into English.

2.6.1.2 Mr.Larssen drawing up the evaluation report was basically completed, and went on the discussion with the GZ team on March, 1999, and desired the important part as the final plan of new network.

2.6.1.3 The new air auto-monitoring network design report was drawing up, and needed to translate into English to submit to NILU to evaluate.

2.6.2 Provide data to other tasks

According to requiring that provided the data needing to task 3 (diffusion model), task 6.1 (health), task 6.2 (material) and task 6.3 (vegetation).

Mr.Larssen put forward on March 1999 to use PM10 and O3's data, these data had been added up the analysis, and could provide after the project office did the examination.

2.6 Work to on December 1999 (the 6th work meeting)

The writing of below several reports is chiefly completed:

Guangzhou/NILU is cooperative, and finally finishes the Guangzhou Air Quality Report of 1990 - 1995 years by NILU;

The evaluation report of the air quality-monitoring network is finished by NILU;

Guangzhou finishes Guangzhou Air Quality Auto-monitor Network Improvement Report;

Guangzhou finishes the report of instrument normal operating maintaining.

3 Achievements

3.1 The knowledge and the technology

3.1.1 Network Description

Guangzhou Air Quality Auto-monitoring Stations and the Manual Monitoring Stations Description are finished to the guidance of NILU, and analyzing on the basis of the history monitoring data

Statistics, finishes the evaluation of Guangzhou Air Quality Auto-monitoring Stations and the Manual Monitoring Stations.

3.1.2 QA/QC

3.1.2.1 Song Weiping went Norway to be trained

The appendix one is seen.

3.1.2.2 Berg trained the other in Guangzhou

The appendix two is seen.

3.1.3 Network Improvement Suggestion

Based on the description and evaluation of Guangzhou Existing Air Quality Auto-monitor Stations and the Manual Monitoring Stations under the guidance of NILU, and the imitated result according to Airquis's air quality, and Guangzhou Function Area Layout and Industrial Structure Development Outline, and it's putting forward the improvement suggestion of Guangzhou Air Quality Auto-monitor Stations, and sees the appendix three.

3.2 Tools

Needing on the basis of project research, combining the instrument condition of Guangzhou Existing Air Quality Auto-monitor Stations, and presenting as a gift a batch of air quality auto-monitoring instrument, and sees the appendix four.

3.3 Achievements and Harvest

3.3.1 It is finished that the description and evaluation of Guangzhou Air Quality Auto-monitoring Stations and the Manual Monitoring Stations.

3.3.2 It is finished that Guangzhou Air Quality Report of 1990 - 1995 years.

2.3.3 It is finished that the improvement report of Guangzhou Air Quality Auto-monitoring Network.

2.3.4 It is finished that the report of the normal operating and maintaining of instrument.

3.3.5 Gaining the description and evaluation knowledge of Guangzhou Air Quality Auto-monitoring stations and the Manual Monitoring stations;

Receiving QA/QC knowledge;

Receiving the knowledge of Guangzhou Air Quality Auto-monitoring Stations Improvement.

3.3.6 GZ subject person's knowledge and ability gain the renewal and raise.

3.3.7 A batch of instrument presenting as a gift is gained, and it is corresponding to the thread monitoring data.

Task 5 Exposure calculations

1. Main objective

The objective of task 5 is to establish a methodology for estimating the population exposure in Guangzhou area. The aim is to calculate and assess the population exposure. Task 5 is the part of studying the pollution abatement strategy. It also supplies data to analyze the impact of air pollution on public health.

2. Activities and knowledge transfer

2.1 NORCE side

2.1.1 Suggested the concept of population exposure pollution.

2.1.2 Installed KILDER model at GRIEP. Trained Chinese personnel of Task 5 for two times on Nov. 1997 and Nov. 1998.

2.1.3 Made a primary calculation by use of KILDER model

2.1.4 Installed AIRQIUS model at GRIEP. Trained Chinese personnel of Task 5 for two times on Nov. 1998 and June 1999.

2.1.5 Found out a method to fix location in grids for the public health investigation along the roads.

2.2 Guangzhou side

2.2.1 Gathered the data of population distribution of Guangzhou in 1995

2.2.2 Finished the investigations of buildings and population along the two different typical road sections: Dongfeng Rd. M. (from Jixiang Junction to Dezheng Junction) and Beijing Rd. (from Zhongshan Junction to Wenxing Rd.). The content included the height and stories of buildings, the population distribution in buildings.

2.2.3 Calculated the population exposure in Guangzhou by use of KILDER model.

2.2.4 Submitted the interm report of population exposure (by use of KILDER model).

2.2.5 Calculated the population exposure in Guangzhou by use of AIRQUIS model. Up to now, finish part of calculation amount.

2.2.6 Edited the technical report of Task 5 “Guangzhou population exposure assessment”

2.2.7 According to the technical report, prepared a paper “study on population exposure level in Guangzhou ” for the Guangzhou UNDP workshop.

2.2.8 Fixed the coordinate of the distribution sites to the public health investigation in Task 6-1.

3. Main achievements

- The interm report “the primary assessment of population exposure in Guangzhou city”
- The technical report “Guangzhou population exposure assessment”
- The paper “study on population exposure level in Guangzhou”

4. Reference

- The detailed working plan of exposure pollution assessment in Task 5
- The minutes of the meeting on Nov. 1996 for Task 5.
- The working summary of 1997
- The working report from 1997 to Nov.1998
- The working plan for 1999/11/20
- “The primary assessment of population exposure in Guangzhou city”
- “Guangzhou population exposure assessment”
- “Study on population exposure level in Guangzhou”

Task 6-1 Health damage assessment

1. Main objectives

The objectives of Task 6-1 was to assess damage to human health due to air pollution by using dose-response functions for the relationship between air pollutants and health effects. This would form the basis for estimating the benefit of emission reductions. For some health end-points dose-response functions should be established from studies in Guangzhou, and for other end-points relevant epidemiological literature should be applied.

2. Activities and knowledge transfer

2.1 Transfer of knowledge and tools from NORCE to Guangzhou side

Norwegian experts, Dr. Jocelyne (NILU) and Kristin Aunan (CICERO) are the experts in the field of air pollution effect on human health and health damage assessment..They have provided Guangzhou group valuable guidance and suggestions with regard to the study methodology and the ways to handle with lots of detailed problems by e-mails, workshops or training program. The Guangzhou team was introduced to the research field in various ways:

- Generally about health effects of air pollution and dose-response relationships: Books, review articles and overheads.
- Concerning epidemiological research methods: Instructions and books on epidemiology and exposure estimation, book on logistic regression
- SPSS and detailed instruction on using the package. Detailed instruction on the necessary statistical procedures to be used in this study (written notes).
- Instruction on field practices including field manuals and questionnaires
- Application of dose-response functions in damage assessment: Exel spreadsheets for calculating effects of concentration reductions in Guangzhou.

2.2 Data collection

Data needed in the study is collected through two paths.

- A cross-sectional interview-study was performed during the period Feb.-Mar., 1998. The study included about 4000 adults and 2000 children in four areas (control area, traffic area, new industrial area and old industrial area). The study gives information *i.a.* on prevalence rates for several respiratory symptoms and other health conditions (e.g. eczema and allergy), medication, sources of indoor air pollution, pets, smoking habits, perceptions of the air pollution situation, and willingness-to-pay for reduced pollution.
- Data on the daily number of hospital admissions (specified by ICD9-code) to 4 hospitals in Guangzhou was collected for 1995 (partly), 1996 and 1997. The

study gives information i.a. on the length of hospital stay for various diseases, deaths due to various diseases at the hospitals, age and gender of the people being admitted, and status after treatment. Data includes total mortality or hospital admission (except accident and violence),Lung cancer cases,Respiratory diseases,Cardiovascular diseases.

- Both of the above mentioned studies give a basis for establishing dose-response functions. They also provide valuable information concerning the 'calibration' of dose-response functions reported from other areas.

2.3 Development of the AQMS

For the pollution scenarios the effects on health can be estimated by means of the dose-response functions that have been proposed.

Follow-up studies on respiratory health effects can be compared to the study done within the project. Thus, the study results provide a benchmark which may be useful in future for evaluations of air quality improvements in Guangzhou.

2.4 Development of the Action Plans

Exel spreadsheets for calculating effects of concentration reductions in Guangzhou have been used in 1st and 2nd sequence calculations.

3. Main achievements of research and task work

3.1 Main task work

- A cross-sectional epidemiological study on respiratory symptoms in children and adults versus air pollution has been performed.
- A time-series study on daily hospital admissions versus air pollution has been performed for four hospitals in Guangzhou.
- A methodology for estimating health effects of air pollution reductions in Guangzhou has been developed.
- Estimates of reduced health damage have been made for two abatement scenarios, in the 1st and 2nd sequence.

1.2 Data set

3.2.1 Interview study

1) data file for adult questionnaire;

2) data file for children questionnaire;

3.2.2 Health statistics

The daily death and hospital admission for 1995(partly),1996 and 1997 are collected from 4 large hospitals.

3.3 Work reports (including unfinished)

1) Health damage assessment – 1st sequence calculation. Technical report B6, Task 6-1 and Task 9. January 1999.

2)Reduced health effects from implementation of Action Plan 2001 – 2nd sequence calculation. It is included as a chapter in the Action Plan Report)

3)Health damage assessment for Guangzhou - using exposure-response functions. Task 6-1 Technical Report B7. November 1999.

4)Scientific training Report on health damage assessment. October 1999.

5)Health effects from air pollution in GZ - respiratory symptoms and diseases. Results from an interview study. *Not finalised*.

6)Health effects from air pollution in GZ - hospital admissions. Task 6-1 Technical Report . *Not finalised*.

4. Problems encountered and solved

1) Capacity

It is first time for Guangzhou to perform such a large scale of interview study with 4000 families. GZ team of cause has met many problems because of lack of work experience in the cause of data collection and data analysis. The project leader group in Guangzhou and NORCE experts have provided useful guidance so that the data is collected properly. But a part of data analysis still needs some help because the training is affected by the delay of calculation result.

2) Airquis model

The delay of the implementation of the AirQuis model caused serious delays in the task work that relied on output from the model. The aggregated concentration data of daily SO_2 and PM_{10} in 1996 and 1997 on the district basic needed by Task 6-1 has not been available yet. We only got the results for one component (SO_2) for one year (1996), which was not sufficient. It was not possible to do the time-series study on hospital admissions in a satisfying way within the time-frame of the project, due to lack of air quality data for requested components and time periods. However, it was agreed after discussion that the NORCE experts will continue providing the guide on the methodology and program especially for the delayed time-series study as soon as the results from Airquis model is available .

Reference list

1. *Health damage assessment – 1st sequence calculation*. Technical report B6, Task 6-1 and Task 9. January 1999.

2. (”*Reduced health effects from implementation of Action Plan 2001 – 2nd sequence calculation*” is included as a chapter in the Action Plan Report)

3. *Health damage assessment for Guangzhou - using exposure-response functions*. Task 6-1 Technical Report B7. November 1999.

4. *Scientific training Report on health damage assessment*. October 1999.

5. *Health effects from air pollution in GZ - respiratory symptoms and diseases*. Results from an interview study. *Not finalised*.

6 *Health effects from air pollution in GZ - hospital admissions.* Task 6-1 Technical Report . *Not finalised*.

Task 6-2 Damage assessment of building materials

1. Main objective

The goal of the task 6-2 has been to make an assessment of the damage to outdoor materials and the cost at the present level of pollution in Guangzhou. It is to provide the Chinese partner with sufficient tools, skill and knowledge to follow up this type of assessment later and to calculate the benefit to material costs based on different control options for reducing the air pollution levels.

2. Activities and knowledge transfer

2.1 Knowledge and Tools transfer from NORCE to Guangzhou side

Guangzhou and Norce team co-operation

- Dose-response equations and lifetime equations for material deterioration were presented. For testing the usefulness of these equations in the Guangzhou environment panels, of zinc and carbon steel were delivered to the Guangzhou group for a one-year exposure program.
- A method for obtaining the amount of material exposed in the Guangzhou area was introduced. Together with the Guangzhou team a project plan for how the team should obtain these data was made. Ref. the Kick-off seminar report.
- A model for calculation the cost of the material damage by air pollution was introduced. The model needs information on the air pollution concentrations of SO_2, NO_2, O_3, H+ in rain, time of wetness (TOW), amount of rain, temperature and relative humidity. The values should be able to be located in a GRID across the area. The material distribution inside each GRID is needed together with information about repair and maintenance cost for the work. The model has been delivered as an Excel module named CorrCost. Ref. CorrCost Excel V 1.0 report.

2.2 Data Collection

A study of the corrosion of carbon steel and zinc has been carried out and the results have been compared with the dose-response equations from the literature based on environmental measurements in the Guangzhou area. The best equations

for the Guangzhou area have been defined and the study has been reported as Technical Report 1 for Task 6-2.

A comprehensive field study dividing the Guangzhou area into small gridsquares and locating the type of buildings and materials inside each gridsquare has been carried out by the Guangzhou team. The results have been compared with the results from other studies around the world and the whole study has been reported as Technical Report 2 for Task 6-2.

The cost for repair and maintenance work has been performed by the Guangzhou team and the results from material distribution study, the prices and the first gridsquare concentrations of SO2 and NO2 for 1995 have been put into the CorrCost model. The results are reported as Technical Report 3 for Task 6-2.

2.3 Development of the AQMS System

The CorrCost model will be a part of the AQWS system for Guangzhou.

The Guangzhou team has tested the system and the results have been reported in Technical Report 3.

For each pollution scenario developed the effect on the lifetime of materials and its cost can be calculated.

2.4 Development of the Action Plans

Task 6-2 will contribute to action plans that will be derived from Task 7, 8 and 9 by calculating the cost and benefits for outdoor building materials for different action plans.

3. Main achievements of research and task work

- A one year field exposure program with exposing of zinc and carbon steel at ten test sites. Parallel measurements of environmental parameters have been performed. The results have been used to evaluate the best choice of dose-response equations for describing the corrosion behaviour for materials in the Guangzhou area.
- A field study to obtain a good database for materials exposed to the outdoor environment has been carried out. The material at risk has been distributed into a grid system for the Guangzhou area comparable to the air pollution grid systems for air pollution modelling. Repair and maintenance prices for different building materials have been collected.
- A calculation of the material costs in the Guangzhou area using the 1995 air pollution data has been carried. The calculation can be given as total cost or as cost which is related to the air pollution situation in Guangzhou by subtracting the effect from natural corrosion in the background area.

4. Problems encountered and solved

There have been only minor problems to be solved in the task. All problems have easily been solved in good co-operation between the partners.

5. Reference List

"Report Kick-off seminar and workshop". Guangzhou 23-29 November 1996.

"Material Field Test Report". Task 6-2 Material Damage Assessment Technical Report 1.

"Report of Construction Materials Calculation". Task 6-2 Material Damage Assessment Technical Report 2.

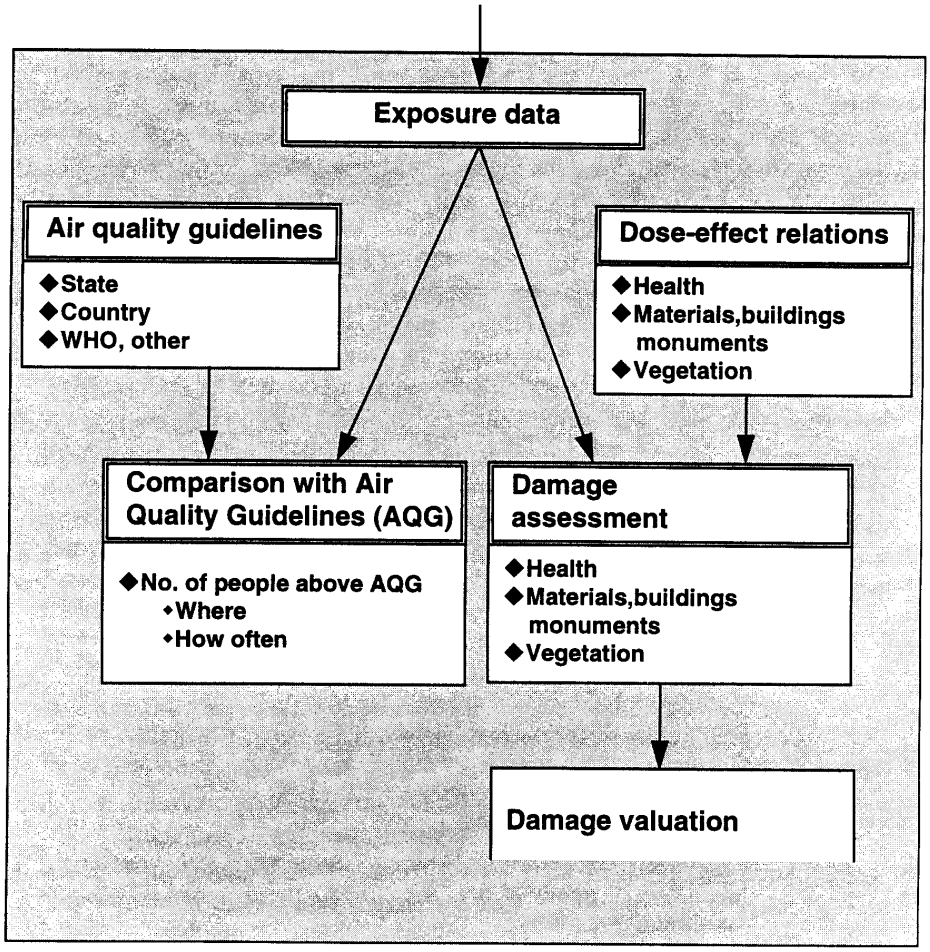
"Report of Material Pollution Cost Calculation". Task 6-2 Material Damage Assessment Technical Report 3.

"CorrCost Excel v 1.0. User Manual". NILU Report TR 2/99.

Task 6-3 Vegetation damage assessment

1. Main objectives

The objectives of Task 6-3 was to assess damage to both natural and agricultural vegetation due to air pollution. This figure shows the place of the damage assessment task within the Air Quality Management model.



2. Activities and knowledge transfer

2.1 Activities

2.1.1 Preparation and start-up of the task work (11/1996-03/1997)

- Preparation for the kick-off seminar in both Norwegian and Guangzhou sides
- Detailed work plan and time schedule during three years were made after discussing between both sides

2.1.2 Implementation of the task work (03/1997-11/1999)

Data collection

- Statistics of agricultural crop growth were selected for the period 1991-1995.
- Geographical environment information of Guangzhou was collected
- Vegetation response in various air pollutants was collected
- Species of vegetation with anti-air pollutants grown in Guangzhou were collected
- Vegetation survey in Guangzhou
- Baiyun mountain forest's type, character and growth situation were investigated
- Vegetation type, distribution character, forest area and volume quantity were collected
- Air quality situation of Guangzhou (1991-1998) was collected, but ozone data were briefly collected at the end of the project period.
- Critical levels of different kinds of vegetation (including crops), their sensitivities and dose-response functions with air pollutants were collected

2.2 Transfer of knowledge and tools from NORCE to Guangzhou side

The Guangzhou team was introduced to the research field in various ways:

- Generally about direct and indirect vegetation effects of air pollution.
- Introduction to status regarding dose-response function and their limitations.
- Application of dose-response functions in damage assessment and the importance of uncertainty discussions of the estimates.

2.3 Development of the AQMS

Information on crop production and the available dose response functions are prepared and made ready for estimates of yield loss when ozone air quality data are available.

2.4 Development of the Action Plans

The estimated losses of forest and crops due to SO_2 and acid rain can be used in Action Plans, but due to lack of ozone data, loss estimates have not been included as basis for the action plan.

3. Main achievements of research and task work

- Damage assessment of main type of forest grown in Guangzhou urban city due to SO_2 and acid rain
- Almost one hundred of species with anti-air pollutants in Guangzhou have been selected
- Discussion of the damage by air pollutants on Baiyun Mountain forest
- Preparation of crop statistics and review of the available dose response functions.
- Discussion of the possible impacts of air pollutants to agricultural crops in Guangzhou.

4. Problems encountered and solved

The delay of the implementation of AirQuis and the lack of ozone data from measurements caused serious delays in the work.

5. Reference list

Assessment of crop damage due to air pollution in Guangzhou (Task 6.3), 1999.
Assessment of Baiyun mountain forest damage due to air pollution in Guangzhou, 1999
Assessment of vegetation in Guangzhou urban city damage due to air pollution, 1999
The selection of plants species of air pollution resistant in Guangzhou Area, 1998
Effects and loss evaluation of acid rain on the plant in Guangzhou area, 1998
Effects and loss evaluation of acid rain on the plant in Guangzhou area (status report in Chinese version), 1997
Report for crop damage assessment. Crop statistics and Effects of pollutants on crop productions, 1997.
Vegetation Damage Assessment. Background information for “kick-off” seminar, 1996.

Task 7 Control Options

1 Main Objectives

The scope of this task is to identify control options in order to reduce the concentrations of SO_2, NO_X and particles in Guangzhou. Reducing the emissions from processes and energy conversion can lower the concentrations. This can either be done by removing the generated emissions or by treatment of the source of the emissions. The source of emissions is the fuel and can be reduced by energy efficiency and fuel switch.
Different measures can be carried out in order to reach the target. This task gives a technological description of the different measures and cost efficiency calculations for the energy efficiency control measures. In addition to this the availability of technology and equipment for China is described.

Task 7 completed two reports, one in Chinese and the other in English.

2 Activities and knowledge transfer

Two Guangzhou researchers attended formal training in Norway. This focused on energy system analysis. The principles of energy input/output were clearly presented by the NORCE side in a series of seminars. The Guangzhou counterparts learned the importance of the energy balance and became proficient in developing energy flow charts for several of the most polluting industrial sub-sectors.

The MARKAL energy analysis software was delivered to the Guangzhou side. This software is a valuable tool to assist policy analysts and decision makers to track the complex interactions and feedback systems in an energy economy, and to assist the quantification of policy impacts.

The objective of the exchange program was 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.

The results of the MARKAL model training at IFE included:

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

3 Main achievements of research and task work

The principle achievement of the Task 7 work was the identification of measures to reduce emissions causing air pollution in Guangzhou. These measures included energy conversion technolgies, improved energy efficiency, fuel switch, and end-of-pipe technologies.

The starting point for the task was to analyze the current and the historical emissions of different pollutants by sector/end-use, by geographic location, and by type of energy carrier. The details in the total energy balance were described by showing the energy balance in the different industrial sectors. Energy efficiency in these sectors influence the sectorial energy balances and hence also the total energy balances. In an excel sheet named Point.xls the emissions from the different sources are given. Data of existing technologies that are souces for current air pollution in Guangzhou were collected and analysed.

Task 7 performed energy analysis to determine the impact of the control measures and provided significant input the Guangzhou action plan. Particular achievements were:

a) The cost and abatement effect of *separate options*. This is calculated from the difference in emissions and costs for the entire system, including links to other options. The emission levels (abatement effect) are input to the loop; dispersion-exposure-damage assessment, and subsequently input to cost-benefit calculations.
b) Sets of control options to meet specified emission targets to a minimum cost, i.e. cost-effectiveness analysis. This analysis is only addressing cost-effective options for meeting emission reduction targets, and mot targets for reduced exposure, damage on buildings, etc. In order to address this iterations have to be made with the dispersion-exposure-damage assessments.
This task gives a technological description of the different measures, emission reduction potential by these measures and cost efficiency calculations for the energy efficiency control measures.

4 Problems encountered and solved

There were no particular problems encountered in this task.

Task 8 Baseline Secenario development

1. Main objective

The objective of the task has been to provide inputs to a baseline emission scenario and control emission scenarios for Guangzhou. The input mainly consists of disaggregate socio-economic indicators and growth in these indicators.

2. Activities and transfer of knowledge

2.1 Transfer of knowledge and tools from NORCE to Guangzhou side

- The principles of a constructing an emission scenario, including baseline scenarios (economic growth and static emission/output ratios), trend scenarios (economic growth and trend decrease in emission/output ratios), and target scenarios (economic growth and required (by target) decrease in emission/output ratios).
- Guidance on the choice of indicators for an emission scenario
- Guidance on designing a top-down emission scenario in a worksheet

2.2 Data collection

- Task 8 collected a substantial amount of socio-economic information for the benefit of the project. The information is available in Technical/Task report 6 (ECON Memorandum 29/99).

2.3 Development of the AQMS system

- The socio-economic information is needed to develop emission scenarios for future years, which is needed to assess the effects of control measures. In addition, the population data, in particular, improves exposure estimates.

2.4 Development of the action plans

Task 8 will contribute to the action plan by helping to develop emission scenarios for the future, on which basis the assessment of future control measures will be made.

3. Main achievements of research and task work

- The main achievement of the task is to direct attention in the project to solving the pollution problems of the future. The problems of the future are sometimes different from the problems of today or yesterday. For instance, emissions from transport are expected to grow considerably in the baseline scenario, despite improved emission/kilometre ratios in vehicles.
- Another important achievement is to direct attention to the link between economic development targets and environmental development targets.
- A third important achievement is to demonstrate the feasibility of an emission scenario on a worksheet made on a minimum of time and money.

4. Problems encountered and solved

The objective of the task changed during the course of the project – from designing an emission scenario to providing input to an emission scenario and other scenarios, as well as socio-economic input to the project as a whole. The change in objective was made for the benefit of the project, and was not due to any lack of commitment from the task. The change was easily accommodated. The Chinese and Norwegian sides have co-operated well in the task.

5. Reference list

Fan Changzhong, Maj Dang Trong and Haakon Vennemo (1999): *The general development scenarios during 1995–2000–2010 in Guangzhou (GZ)*, Technical/task report 6, Guangzhou AQMS Project, also available as memorandum 29/99, ECON Centre for Economic Analysis, Norway.

Task 9 Cost-benefit analysis

1 Main objective

The objective of the task has been to provide support to the AQMS in the form of cost-effectiveness and cost-benefit analyses. The cost-effectiveness analysis is useful to determine the least costly way of meeting a specified environmental target. The cost-benefit analysis is useful to determine the right environmental target as well as the least costly way of meeting that target.

2 Activities and transfer of knowledge

2.1 Transfer of knowledge and tools from NORCE to Guangzhou side

- The principles of constructing a cost-effectiveness and cost-benefit analysis
- Guidance and suggestions on how to value damage to health, damage to crops, damage to recreational services etc.
- A Master Thesis applying the cost-benefit method to environmental problems in Guangzhou.
- A worksheet for cost-benefit evaluation and guidance on how to use it.

2.2 Data collection

- Task 9 has collected data on costs related to health damage, including data on costs of hospital admissions.
- Task 9 has collected data on costs related to vegetation damage, including data on price of vegetables,timb and so on.
- Task 9 has collected data on costs of measures related to SO2 reduction.
- Task 9 has collected data on costs related to comfortibility in the way of questionnair.

2.3 Development of the AQMS system

- The cost-benefit analysis is important for the AQMS, especially in the long run when targets have not yet been set.

2.4 Development of the action plans

The cost-effectiveness method has proved crucial in the development of the action plan 2001. Since Guangzhou has explicit environmental targets, cost-benefit calculations have come somewhat in the background.

3 Main achievements of research and task work

- The action plan 2001 is based on the cost-effectiveness method. Using this method we analyse the least costly way to reach targets for SO_2 and NO_x emissions.
- The cost-effectiveness calculations are supported by a partial cost-benefit analysis of measures related to SO_2.

4 Problems encountered and solved

It has proved more fruitful to concentrate on cost-effectiveness than cost-benefit.

5 Reference list

Li Zhiqin, Yu Jican, Kristin Aunan, May Dang Trong, Haakon Vennemo and Xu Zhao (1998): *Health damage assessment for Guangzhou – 1st sequence calculations,* Technical report B6.

Task 10 policy options

1 Main objective:

The main objective of task 10 has been to review, identify and propose appropriate policy measures for an effective and cost-efficient approach to abatement of air pollution. The task should cover both administrative and legal aspects as well as specific policy instruments.

2 Activities and knowledge transfer

There were two different approaches to realize the main objective of task 10: One alternative was to apply a top-down approach in which the present policies, regulations and administrative as well as legal aspects were identified, described and evaluated. Then, on the basis of such an evaluation of strengths and weaknesses of the existing systems, reforms and changes could be proposed, changes that could be expected to produce less polluting behavior. The second alternative approach was a bottom-up approach: to start out with from a set of concrete technical control options applied on a set of identified sources and then consider what kind of policies and policy instruments that were required in order to facilitate or ensure the actual carrying out of the technical control options.

Task 10 has applied both approaches above in its work. It has tried to undertake evaluations of the existing system, identifying strengths and weaknesses of this system and proposing changes on this basis. But as the work with the action plans have had an inherent bottom-up character, it has also tried to anticipate the most attractive technical control options and carry the analysis further from analyzing

the cost effectiveness of concrete control options to an analysis of what kind of policy instruments that might stimulate or ensure the implementation of the control options.

The main bulk of the activities of task 10 have been related to:

- mapping existing policies, regulations and management structures
- reviewing of implementation, enforcement and effectiveness of policies and management measures
- identification of strengths and weaknesses of present system
- Proposing changes and reforms of policies, regulations and organizational structures of environmental authorities

This have been carried out through:

- Visits and interviews with representatives of NEPA, Guangdong EPB, Guangzhou EPB, Guangzhou Planning Committee, Guangdong Energy Research Center, Guangzhou Science and Technology Commission, district EPBs and county EPBs.
- Visits to other cities in China in order to study their policies, regulations and experiences in air pollution control: Beijing, Shanghai, Shenzhen, Zhuhai, Dalian, Nanjing, Xiamen, Zhungshen, Shenyang, and Hongkong.
- Literature surveys of regulations and experiences in other countries.
- Consulting and presenting inquiries to experts on air pollution control and policies.

Apart from the above mentioned activities, task 10 has – in cooperation with task 8-compiled and presented information on environmental and economic development targets for Guangzhou.

Task 10 has also devoted considerable time and resources to the provision of input date on costs, effects and technical aspects of control options considered in the action plans apart from policy considerations and recommendations. It has also taken and active role in the elaboration of the action plan documents.

The knowledge transfer has centered on the following points:

- Presenting and understanding of typologies of environmental policy instruments
- Awareness and understanding of general advantages/disadvantages of different policy instruments.
- Awareness and understanding of the main criteria for selecting specific policy instruments for different environmental targets.
- Different policy and regulatory approaches to air pollution control,particularly integrated approaches.

Task 10 participated in training in Norway in 1997. GRIEP staff on task 10 also participated in training in environmental economics provided by the ODA.

3 Main achievements of research and task work

- A detailed inventory of present air pollution control regulations and policies for main sectors have been elaborated: industry, power and traffic. As a result, an in-depth knowledge of existing political and legal system for air pollution control and management has been acquired.
- Recommendations on general environmental policy reforms such as integration and harmonization of the main systems of air pollution control as well as reforms of the organizational and management structure have been made.
- Capacity in principles and methodology for policy analysis of air pollution control has been developed and established.
- Insight and knowledge of other contries' successful experiences in air pollution control has been gained and will provide basis for developing new policies and systems for air pollution control in Guangzhou.
- Task 10 has provided policy suggestions and recommendations for organizational changes both to local environmental authorities as well as central authorities such as the Environment and Natural Resources Committee of the National People's Congress in connection with the recent revision of Air Pollution Prevention and Control Act(APPCA). These proposals relate to the need for increased emphasis on implementation and stronger enforcement of the provisions of APPCA, integration of different regulatory systems and a stronger regional approach to SO2 control.
- articles have been published in external journals such as Guangzhou Environmental Science, China Environmental Protection Industry, Urban Science and Technological Management, Guangzhou Investigation.

4 List of reports

Report	Authors	Report type			Status
		TR	SR	MR	
Air Pollution Control in China	Knut Aarhus Liang Yujie Ge Yi	E			F
Legal and Administrative Framework for Pollution Control in Guangzhou.		E			F
Forecast of Social & Economic Development in Guangzhou		E			F
Air pollution regulations: Emissions from Transport, industry and Power Plants.		E			F
Policy instruments: Some successful international experiences	Knut Aarhus	E			F
Relevant Policies status and Trend	Ge Yi and Liao Yundong	E/C			F
Technological and Economical Policy Proposal Report about SO2 Pollution Control in Guangzhou		E/C			F
Policy evaluation of stationary sources air pollution control		C			F
Policy evaluation of transport air pollution control		C			F
Air pollution prevention and control in Hongkong		C			F
Air pollution control techniques		C			F
Integrated evaluation of coal-burning SO2 pollution control technique status		C			F
Policy evaluation of motorcycles air pollution control		C			F
Emission Standard Development of motor vehicles in China		E/C			F
Policy evaluation of energy environmental protection in Guangzhou		C			F
Policy evaluation of industry environmental protection in Guangzhou		C			F
Adjustment of the power structure in Guangzhou using big generators instead of small ones		C			F
Policy analysis and proposal of traffic air pollution control		C			D
Overview of ambient air protection policy in China		C			F
Policy trend of reforming pollution charge system		C			D
Status of power energy development in China		C			F
General report outline of task 10		C			D
Indexes rationality analysis of the NOx limit in “Ambient air quality standard” (GB3095-1996)		C			D
Distances analysis between environmental status and target in year 2000 and 2001 of Guangzhou		C			D
Cost-effectiveness analysis of fuel switch to LPG about public vehicles		E/C			F
Proposal to the environmental management system reforming		C			F
Trend about standard of emission control for cooking fume		C			F
Inquiry essentials of air pollution control policy and management methods in Guangzhou		C			F
Technique development of industrial NOx control		C			F
Pollution prevention and control countermeasures of vehicle emission		C			D
Update emission standard of pollutants control from light-duty vehicles		C			D
Policy and management method essentials about air pollution control		E/C			F
Resolution Proposal Outline in Guangzhou		E/C			F

Task 11 Motor vehicles pollution

1.Objectives

- Investigate vehicle population over years in GZ and grasp the status of vehicle annual inspection, road spot check and driving condition
- Forecast vehicle amount in the future based on economic development and vehicle status in history
- Analyze environmental air quality status in GZ, especially the contribution to air quality by vehicle emission
- Provide vehicle emission factors
- Establish comprehensive control plan on vehicle emission,

2.Research activities, data collection and knowledgetransfer

The research working have almost been done by Chinese side. Except the discussion during the working shop, Norce side almost gave no knowledge transfer. But Norce side gave good comment for every planning or phase result.

3.Contribution to the action plan

- Provide vehicle basic data in GZ
- Provide basic parameters on LPG reconstructed
- Provide emission factors which are suit for GZ
- The step of local vehicle emission standard establishment must be quickened
- Suggestion on in –use vehicle control, including I/M, vehicle reconstructed, fuel improvement, washing out vehicle quickerlyt, spreading double fuel vehicle
- Others such as encouragement of vehicle updated, buses first and improvement of traffic pattern and so on

4. Results

- Provide emission factors for different kinds of vehicle
- Provide vehicle population in the future
- Provide basic data to action plan, especially for parameters of LPG reconstructed
- Assess contribution to air quality by vehicle emission ,especially for effect on NOx VOC
- Calculated vehicle emission factors by EMVI
- Do tunnel test to validate the factors calculated by model

5.Research report and work plan

- Complete work report
- Complete research report (first draft)

6.Problem and solving method

It was Guangzhou side to surggest setting up Task 11.So the work has almost been done by Guangzhou. It was difficult for us to complete the work. Fortunately we can obtain some technological support from UNDP.

7.References

(1) Environmental quality report in GZ from 1994 to 1997, GZ EPB

(2) The plan of the ninth—five years and perspective objectives in 2010

(3) Air environmental protection research in GZ Chinese Academe of Environmental Science, Guangzhou Research Institute of Environmental Protection, Peking University

(4) Statistic yearbook of Guangzhou from 1994 to 1998, GZ statistic Bureau

(5) Effect on photochemical smog pollution caused by traffic development and countermeasure research Peking University, Guangzhou Research Institute of Environmental Protection,October 1996

(6) City Traffic report of Guangzhou 1995

Task 12 Air pollution Forecasting

1 Main objective

The goal of the task 12 has been to establish a system for short range forecasting of air pollution in Guangzhou. It is to provide the Chinese partner with sufficient tools, skill and knowledge to carry out continous forecasting for 24 hours timespans of the air pollution levels in Guangzhou City and in the Guangdong province. The pollutants chosen to be forecasted are nitrogen doixide (NO_2) and suspended dust (PM_{10}).

2 Activities and knowledge transfer

2.1 Knowledge and Tools transfer from NORCE to Guangzhou side

- Training in the use of the AirQuis system and the Episode dispersion model have been given. Ref. Description of Episode by Liu Li (Chinese version only)

- The Episode dispersion model have been installed at the GEMC, along with supporting software including a preprosessor using a general meteorological forecast to calculate the neccesary input data for the dispersion model. A system description will be given in Technical report 3.

2.2 Data Collection

For the purposes of evaluating model prediction results, a study of the spatial correlations of measured concentrations in the Guangzhou air quality monitoring network has been carried out. In addition , a study of the variations in time and space of the relation between NO_2 and NO_X have been carried out to make possible a calculation of NO_2 concentrations based upon the models predicted NO_X concentrations. These results have been reported in Technical report 1.

For the purpose of examining possibilities of using prediction results within the model area to determinate pollution levels outside the model area, spatial correlations between the central monitoring network and the rural monitoring network have been carried out. These results have been reported in Technical report 1.

To make possible improvements of the simple meteorological preprosessor and to create a helptool for interpretation of the predicted air polluition levels, an analysis of wind statistics for periodes with high pollution have been undertaken. This Technical report (nr 2) is not yet completed.

2.3 Development of the AQMS System

Forecasting is not directly linked into the AQMS system, but it will provide a possibility for the authorities to decide measures on days of forecasted high pollution, such as imposed restrictions on traffic. Forecasting will also provide additional benefits of the AQMS as a daily service to the public.

2.4 Development of the Action Plans

Task 12 does not contribute to the action plans .

3 Main achievements of research and task work

- The study of spatial correlations of measured concentrations in the Guangzhou air quality monitoring network have provided information for analysing the nature of pollution episodes and to evaluate the models behaviour in these episodes.
- The analysis of variations in time and space of the relation between NO_2 and NO_X have been made it possible to predict NO_2 concentrations based upon the models predicted NO_X concentrations, thereby avoiding the need to run a photochemical model.
- The examining of possibilities of using prediction results within the model area to determinate pollution levels outside the model area, have shown that the spatial correlations between the central monitoring network and the rural monitoring network is too low for this approach.

- The analysis of wind statistics for periodes with high pollution provides help to identify meteorological situations in which the forecasters should pay close attention to the development of air pollution levels.

4 Problems encountered and solved

A major problem in developing the forecasting system was that it was not possible to link the air pollution forecast directly to prognostic meteorlogical model results. This problem was solved through the meteorlogical preprosessor, but the preprosessor would function better by having more prognostic data, covering at least 24 hours of future meteorlogical development.
The delay in getting the AirQuis system operational caused delays in creating an emission inventory for the forecast application. The transfer of the Episode model to Guangzhou was also delayed.
A secondary problem was encountered when software compiled at computers in Guangzhou behaved slightly different than that compiled on a corresponding computer in Oslo. The problem was solved by recomputing all neccesary parts at the computer in Oslo.

5 Reference List

“Description of Episode model” by Liu Li (Draft, Chinese version only)

"Statistical relationsfrom the monitoring network 1991-1995” Task 12 Forecasting Technical Report 1.

"Analysis of statistical relations between measured wind conditions and peak concentrations in 1994-95". Task 12 Forecasting Technical Report 2.

"Establishing Air Quality forecasting in Guangzhou with the Episode dispersion model". Task 12 Forecasting Technical Report 3.

Appendix A

Workshop Programme Proposal

Guangzhou AQMS Project (NORAD project CHN 013)
STL/28.11.99

Guangzhou Air Quality Planning and Management Project
1996 - 1999

Cooperation project between institutes in Guangzhou and Norway

FINAL SEMINAR AND WORKSHOP

PROGRAM

LongGui – Guangzhou, 28 November – 3 December 1999

Sunday 28.11	Arrival at LongGui
Monday 29.11	Task work **Preparation for the Seminar**
Tuesday 30.11 *0900 – 1800*	**Final Project Seminar**

Participants:

Invited guests from Guangzhou and Guangdong:

Mrs. Cheng Ming	Dty. Director, Guangdong EPB
Mr. Li Zhisheng	Chief Engineer, Guangdong EPB
Mr. Liu Zhigang	Div. Director, Guangdong EPB
Mr. Ling Yuanhe	Vice Mayor of Guangzhou city
Mr. Li Xing hua	Dty. Director, GSTC
Mr. Liu Zheng yong	Div. Director, GSTC
Mr. Gan Hai zhang	Director, Guangzhou EPB
Mr. Hao Enhe	Div. Director, GZ Planning Comm.

Media:
Guangzhou Environmental Education Centre
Guangzhou newspapers (4)
1-2 TV stations

Project participants:
Guangzhou side: Project leader Mr. Wu Zhengqi
Project team

NORCE side:	Project leader Mr. Steinar Larssen Mr. Haakon Vennemo (Deputy PL) Mrs. Kristin Aunan Mr. Dag Tonnesen Mr. Andrew Yager Mr. Knut Aarhus.

Program:

0900	Opening Seremony. Chairs:	Mr. Wu Zhengqi Mr. Steinar Larssen
0915	Opening Addresses	
0930	Presentations:	
	Summary of Main Results, and fulfilment of objectives of the Guangzhou AQMS Project.	
0930-1020	*Action Plan 2001*	Mr. Knut Aarhus, NORCE/ECON
1020-1040	Tea break	
1040-1130	*Action Plan 2010*	Mr. Luo Jiahai, GRIEP
1130-1200	Discussion on the Action Plans	
1200-1400	Lunch and rest	
1400-1440	*Air Pollution Effects Studies in Guangzhou*	Mrs. Kristin Aunan, NORCE/CICERO
1440-1500	*Air pollution forecasting system for Guangzhou*	Mr. Dag Tonnesen, NORCE/NILU
1500-1540	*Transfer of knowledge and tools. Summary of Project activities*	Mr. Luo Jiahai, GRIEP
1540-1600	Tea break	
1600-1630	*Improvement of Monitoring System in Guangzhou, as a result of the project.*	Mr. Sun Dayong, GEMC
1630-1700.1	*The establishment of an integrated Air Quality Mangement and Planning System in Guangzhou.*	Mr. Wu Zhengqi, Director,GRIEP
1700	Closing seremony	

Evening: Banquet

Wednesday 1.12

Mini-workshop on Control on Mobile Sources
Topics: - cost-effectiveness calculations
- regulatory issues.

These topics have been studied in both the NORAD GZ AQMS project and in the UNDP project on NOx control of mobile sources.
The final workshop of the UNDP project was carried out at LongGui last week, and Mr. Charles Freed, former Director of EPA Mobile source control office in Wash. DC, participant in the NOx workshop is still in Guangzhou, to continue to work on these issues with GRIEP.
We will use this opportunity to get the groups working on these issues in the two projects, together, to discuss and exchange experiences.

Participants:
Mr. Charles Reed, US EPA
Mr. Knut Aarhus and others from NORCE side
Mr. Tian Kai, Mrs. Ge Yi and others from GRIEP/GZ side.

Task work
to prepare for the final workshop on Friday, and to complete task work and reporting
(Final Task Reports, and Technical Reports).

Thursday 2.12

Morning: Project Leading Group Meeting

Main topics:
- Project finalisation: Fulfilment of objectives and requirements
- Final reporting
- Project evaluation
- Continuation projects
- Etc.

More detailed agenda to be made.

Afternoon: Final Project Plenary Meeting

Participants: *All project members*
Will representatives from GSTC, GEPB, etc.

Program
1. Final reporting from the project

- List of Technical and other reports and publications

- Final report : Contents and responsibilities.

2. *Possible continuation projects*.

- Presentation of proposed plans.
- Suggestions from the Task teams (Guangzhou side) on needs for further work.
- Discussion

3. *Any other topics or business*

4. *Closing of the Final plenary meeting*.

Appendix B

Presentations at the workshop 2/99

Guangzhou AQMS system (NORAD project CHN 013)
STL/14.11.99

PRESENTATIONS AT THE WORKSHOP 2/99

THE FIRST PLENARY DAY, ON WEDNESDAY 1 DECEMBER (PROPOSED)

The objective of the first plenary day is to present to the representatives for authorities, media etc. the main results of the project. We propose that the presentations are planned on the basis of the 4 main objectives of the project. In addition, we should high-light some of the more important studies that have been carried out as part of the project.

We propose the following presentations, with an overview of main contents. Also, we indicate which side , and sometimes who should make the presentations.

A. Action Plan development and results

To be presented by Mr. Knut Aarhus (or by Mr. Steinar Larssen).
About 45-60 minutes (incl. translation).
The results of the Action Plan development is probably what the representatives from the authorities, and of the media, are most interested in. It deals with the possibility of meeting the air quality targets in Guangzhou, the costs involved, and also the value of the benefits related to reduced damage.

This presentation should include e.g. the following topics:

- About cost-effectiveness (C-E) / cost-benefit (C-B) analysis
- List of the measures that have been analysed
- Actual methodology of the analysis
  - complete
  - simplified
- Results
  - cost – effectiveness / potential
  - priorities / strategy
- Feasibility, for each selected measure (technical, financial, etc.)
- Policy instruments, for each selected measure
- Conclusions

B. Air Pollution Effects studies in Guangzhou

To be presented by Mrs. Kristin Aunan.
About 30-45 minutes (incl. transl.)
As part of the project, special studies have been carried out in Guangzhou on the effects of air pollution on the health of the population, on damage of materials, and on damage on vegetation and crops. The objectives included to study and develop dose-response relationships that are based upon Guangzhou data.

A presentation will be given on the results from these studies. We propose that Mrs. Kristin Aunan, the NORCE task leader for Task 6, gives this presentation.

C. Transfer of knowledge and tools

This presentation should be prepared and given by the Guangzhou side. If necessary, the NORCE side can provide assistance.

About 30 minutes total.

- This presentation should list and describe briefly the transferred methodologies and tools, for each of the 12 tasks. The NORCE side will assist in making this list.

- Also the exchange program shall be presented: Persons, training stay, main topics of the training and acquired knowledge.

D. Monitoring system improvement

This presentation must be prepared and made by the Guangzhou side (Mr. Sun?).
About 30-45 minutes total.
The contents must include:

- list of instruments and other equipment that has been acquired and put into operation during the time of the project period (1997-99), incl. which has been:
- transferred through the GZ AQMS project;
- - acquired through Chinese and other funds.
- Overview of the improved air quality monitoring system in GZ
- – the new system as compared to the old system.
- Improvements in the QA/QC procedures, as a result of our project, and other QA/QC improvements.

- Improvements in the systems for:
- data transfer from stations to the central data base
- data reporting, that is, the time schedule of reporting of data to: the national and
- municipal authorities, and to the public.
- Further potential and plans for improvement of the monitoring system.
- Description of the long term maintenance procedures of the equipment from the NORAD project.

E. Establishment of system and procedures for continued AQMS work in Guangzhou

This presentation shall be prepared and made by the Guangzhou side, with assistance from the NORCE side.
About 30 minutes.

The presentation should take as a starting point the URBAIR AQMS system, to show the various tasks (e.g. emission inventorying, dispersion modeling, control options, cost calculations, etc.) and the relationships between them, that need to be handled in a functioning integrated system for Air Quality Management in Guangzhou, and the institutions it must include, to take care of these tasks.

The presentation must show:

- the composition of the central, coordinating group of institutions and persons,
- a list of the tasks, and the institutions and groups that are responsible,
- the "lines of command" from the municipal authorities, to the coordinating group, to the implementing institutions, and the lines of cooperation between the task groups.

Appendix C

Continuation Project Topics

Guangzhou AQMS Project (NORAD Project CHN 013)
CONTINUATION PROJECT TOPICS

- *Urban Air Quality Management project in Chengdu.*

Cooperation between NORCE and Guangzhou side to carry out an AQMS project in Chengdu city. Such a project would utilise the experience built up in Guangzhou on the methodologies of air quality management through the Guangzhou project. GRIEP will check further with authorities in Chengdu/Sichuan. A proposal of a prefeasibility study will be sent to NORAD before the next annual meeting.

- *Continuation of GZ project: Follow-up on control of photochemical pollution in Guangzhou, including ozone and fine particles.*

In parallel with the NORAD project in Guangzhou, there was a UNDP project concentrating on pollution by motor vehicles, also a knowledge transfer/ training project. Based upon the combined results of the two projects, there is a need for follow-up, towards the development and implementation of effective control strategies. For such a project, combined funding from NORAD and UNDP should be attempted. UNDP Beijing should be approached.

- *Continuation of the study of health effects of air pollution in Guangzhou:*

The health study has left valuable data, and it was not possible to complete the study by the end of 1999. Both sides feel an obligation to process the data and complete the study. A proposal has been sent to MOST/NORAD.

- *Combined cost-effectiveness analysis of local and global effects of air emissions*

The action plans, and the cost-benefit analysis has so far been based only upon the local effects of the air pollution. It would be of large interest to include the global effects (i.e. mainly the effects of CO2 emissions) into the analysis.
GEF has funding for energy efficiency measures, in addition to renewable energy and low emission technologies. GEF will probably be interested to see how the 2001 and 2010 action plan fits with their ideas. Contact could aslso be made hwith the Energy Conservation Information Dissemination Centre of SSTC and the Energy Research Institute. Both GEF and the EU could be interested in financing projects on renewable energy.

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ABSTRACT

The Sino-Norwegian cooperation project "Guangzhou Air Quality Management and Planning System" holds two workshop per year. The 2nd workshop in 1999 was held in Guangzhou during Nov. 28~Dec.3, 1999. It was arranged according to the agreement about this made between the partners, at the 1st workshop in 1999 in Guangzhou.

The workshop was attended by the full Guangzhou team, and from NORCE by 5 NORCE Task Leaders and by the project leader Mr. Steinar Larssen.

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ABSTRACT (in Norwegian)

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