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Norsk institutt for luftforskning
Norwegian Institute for Air Research

Selected NILU projects

Prepared for a Chinese delegation to visit NILU
16 October 2013

Bjarne Sivertsen

Contents

Selected NILU projects

Prepared for a Chinese delegation to visit NILU 16 October 2013

1 Introduction

This presentation was prepared for a Chinese delegation to visit NILU on 16 October 2013. The visit was postponed.

NILU, Norwegian Institute for Air Research, is an independent, non profit institution established in 1969. The institute holds a strong position both on the national and international level within its core fields. NILU's 200 researchers, technicians and other experts are primarily commissioned by the Norwegian research council, by industry in Norway and offshore, and by governmental institutions on local, national and international level. About 30% of the institute's activities come from international operations.

NILU holds air pollution expertise on all scales and is based on the scientific tools and results established through the research undertaken by the institute.

We are covering issues outdoor, in traffic and industrial areas, generally on the urban scale, on the regional scale and based on global problems. Our projects include all the elements of an integrated air quality assessment:

- Emissions
- Monitoring
- Modelling
- Assessment
- Planning

NILU can perform a number of different studies on the urban scale such as:

- Design monitoring programmes
- Undertake measurements
- Siting studies
- Background studies
- Modelling for estimates of consequences
- Develop optimal mitigation plans
- Undertake urban AQ assessments
- Air Quality forecasts
- Dissemination of information

2 Air Quality management planning (AQMP)

The main purpose of the AQMP development process is to establish an effective and sound basis for planning and management of air quality in the selected area. This type of planning will ensure that significant sources of impacts are identified and controlled in a most cost-effective manner. The best air quality management tools and practices may be used in order to assure the most adequate solutions.

The ultimate goal will thus be to assure that health effects and impact on building materials and the environment will be avoided in the future.

The NILU approach is based on an Integrated AQM approach. The AQMP is considered a dynamic process consisting of 6 parts:

1. Goal setting and legislation
2. Baseline studies
3. The AQ management System (based on AirQUIS)
4. Intervention strategies
5. Action plan development and implementation
6. Evaluation

The main objective is to identify actions needed to improve the air quality.
A major tasks in this work is to collect the necessary input data. The programme starts with preliminary assessments based on available data and the identification of zones. We assume that the setting of standards and regulations is already available.

3 AirQUIS, an integrated monitoring and management system

The AirQUIS system was developed by institutions dealing with air pollution, information technology and geographical information systems (GIS). The combination of on-line data collection, statistical evaluations and numerical modelling enable the user to obtain information, carry out forecasting and future planning of air quality.

The system can be used for monitoring and to estimate environmental impacts from planned measures to reduce air pollution.

The AirQUIS system contains the following modules:

• Geographical Information System (GIS)
• Automatic Data Acquisition System (ADACS)
• A measurement module
• Statistical and Graphical Presentation Tools
• Emission Inventory
• Emission Model
• Wind Model
• Dispersion Model
• Exposure Model

On-line measurement system
A measurement system of modern on line sensors for selected air pollution indicators can be designed specific for the area concerned.

The emission inventory database
A modern database for the air pollution emission inventory represents a flexible system containing a user friendly map oriented inter phase to treat the main sources for emission to air such as industry, traffic, energy (consumption of fossil

fuels) and emissions related to other mobile sources such as airport and harbour activities.

Atmospheric dispersion models
The models included in the AirQUIS system covers air pollution on all scales; along streets and roads, industrial emissions, gridded pollution from household etc. within the urban areas and on a regional scale. The models may be used as integrated into the AirQUIS system, or as stand alone models if needed.

Exposure
Based on concentration calculations and population distribution, exposure estimates for human health can be performed. The exposure estimates can be related to air quality guidelines or other air quality indicators used for the component considered.

Air Quality Planning
The AirQUIS system is an effective tool for air quality abatement strategy. The contribution of air pollution from different source categories such as traffic, household and industry to the population exposure in an urban area can be calculated based upon data on emissions, dispersion and population distribution. The system has also been used in cost-benefit or cost-efficiency analyses, and has represented the basis for Action planning.

4 Some NILU projects

4.1 URBAIR

The first large international project where NILU demonstrated the integrated air quality management concept was undertaken on behalf of the World Bank in 1992-1996. Demonstration projects were reported from Manila, Katmandu. Mumbay and Djakarta. The project ended in an Urban Air Quality Management strategy Guideline, issues by the World Bank in October 1996.

4.2 Projects in China

The first two project that NILU started in urban areas in China was located in Yantai and in Guangzhou.

The goals and objectives here were:

- Evaluate and update air quality monitoring system
- Establish database and AQM system
- Transfer tools and knowledge
- QA/QC system and training
- Demonstrate action plan

In Guangzhou NILU developed a priority list of the most cost effective actions in order to reduce the SO2 exposure to the population.

A later project and analyses in three major cities in the Shanxi province ended in an advanced cost benefit analyses. A cost benefit ratio was developed based on the ratio between the cost of action and the value of improved health to the population.

A number of mitigation actions were balanced against some selected health end points. The study proved that in one of the cities, Taiyuan, the introduction of centralized heating and the use of natural gas gave significant payback in the sense of improved health in the population.

4.3 Projects in Vietnam

To identify and assess the air pollution situation in Ho Chi Minh City (HCMC) and automatic air pollution monitoring and assessment system was installed by NILU funded by NORAD. Training and institutional building supported local experts to operate the whole system. The key features of the system was the integrated approach that enables the user in a user friendly way to not only access measured data quickly, but also use the data directly in the assessment and in the planning of actions. The demand of the integrated system to enable monitoring, assessment, planning and forecasting has been and will be increasing in the future.

The basic GIS based database and planning tool used in HCMC was based on the NILU developed AirQUIS system. This system has been installed and is being applied in several large urban areas worldwide.

The data collected through the automatic monitoring and telemetric network is being quality controlled and transferred for storage in the AirQUIS database. Statistical programmes for quality control and data representativeness are being used and an automatic air quality index (AQI) generator provides AQI values for traffic and for urban background microenvironments to be displayed on the information web site.

Air pollution dispersion models have also been installed as part of AirQUIS for HCMC. Templates and routines for emission inventories are presently being applied to collect emission data and model estimated have been presented. Concentration estimates were used to evaluate different source's relative importance to the total exposure, impact assessment and to perform optimal abatement planning.

In Hanoi NILU was requested by the World Bank to evaluate the existing air quality monitoring system.
Nine actions were identified:

1. Improve the air quality monitoring programme
2. Support siting of new stations
3. Evaluate the QA/QC programme, and give advice
4. Specify instruments for (new) monitoring stations
5. Improve emission inventory capability
6. Collect input data for modelling; future WB project
7. Introduction to modelling, the needs and use of models

8. Estimate importance of sources
9. Institutional framework and organization

In addition to the monitoring programme models were established in order to estimate the relative importance of different sources based on air pollution population exposure estimates.

4.4 Bangladesh

NILU is working with the Clean Air and Sustainable Environment Project, Department of Environment (CASE/DOE) on an institutional building project financed by NORAD. As part of this project NILU performed two screening studies aimed at identifying the air pollution problem.
The NORAD project includes 4 main tasks:
Task1: Emission inventorying (top-down & bottom-up!)
Task2: Monitoring and laboratory procedures,
and data acquisition capability
Task3: Air quality management capability,
including modelling of air pollutant dispersion and population exposure
Task4: Health impact and scenario research,
and strengthening capacity

As part of the NORAD project as well as the World Bank project NILU has performed three field experiments (screening studies). We have identified very high PM concentrations in Dhaka during the dry winter season. The PM10/PM2.5 ratio was higher than found in other cities around the world. One main reason for this was probably that a major part of the suspended particles during high PM episodes were originating from regional and long range transported aerosols.

The AQ results presented can only confirm claims that Dhaka can certainly be considered to be one of the world's top polluted mega-cities (or potentially the worst during winter months). All components measured far exceed the AQG's set by WHO, which puts the health of the cities approximate 12+ million residents in certain harm.

NILU has also been funded by the World Bank to perform studies in Bangladesh on emission inventories and receptor modelling in order to identify sources of air pollution.

4.5 Mongolia, Ulaanbaatar

Ulaanbaatar is affected by serious air pollution caused by coal and wood burning stoves used for heating and cooking. The new market economy of the country and its very cold winter seasons has led to the formation of Ger districts, where 60% of the coldest capital city in the world's population resides. The resulting air pollution problem is characterized by very high concentrations of airborne particles.

Daily concentrations in Ulaanbaatar are much higher than Mongolian or international standards. The extremely episodic nature of the PM pollution, which

is caused by the combination of Ger heating practices and the meteorological situation, causes extremely high short-term PM concentrations

5 International co-ordination

NILU has a long experience in co-ordinating international research projects. NILU has had projects on all continents, NILU has undertaken a number of EU financed projects and is also coordinating several international projects

5.1 NILU in Kuwait 1991

NILU was asked by the World Health Organization (WHO)/United Nations Environment Programme (UNEP) to provide and install monitoring stations for air quality studies in Kuwait. The NILU tasks were part of the UN Inter-Agency Action Plan for the Gulf Region. The Norwegian objective through a financial support was to combat the destruction of the environment by supporting necessary air quality equipment to monitor and inform agencies and the public about the status of air quality.

A first visit to Kuwait in June 1991 defined the needs for sampling stations, sampling location and data acquisition systems to be used. The equipment included two new monitoring stations, and data transfer systems from four complete air quality stations were installed in September-October 1991.

5.2 The EMEP programme

An example of international co-ordination is the Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP), where NILU is responsible for recommending measurement methods and for assembling and evaluating data.

NILU also has a leading international role in collecting and storing measurement data from other atmospheric research and monitoring programmes, and is responsible for a series of international databases.

5.3 Long range transport and acid rain

As part of the studies of impact of long range transport NILU has been studied the acid rain problems since the early 1970s.

Acidifying emissions have declined substantially in Europe, although less so in transport and agriculture which now represent 50 % of total acidifying emissions. Sulphur emissions have declined to the extent that nitrogen is now the principal acidifying component.
There has been a clear decline in deposition of acidifying substances in northeast and southeast regions. Western Europe, however, has witnessed much smaller declines. Whereas the deposition of acidifying substances is greatest in central and southern areas of Europe, the greatest ecosystem impact caused by deposition continues to be felt in the north-west and central regions.

6 Pole to Pole observatories

NILU monitors climate change, global air quality and air pollution transport pathways through observatories in Norway (Birkenes and ALOMAR – Andøya), in the Arctic (Svalbard, Zeppelin) and in Antarctica (Troll). NILU's observatories supply researchers all over the world with important data on a wide spectre of pollutants, green house gasses and climate forcing agents.

7 Training programmes

NILU has developed and been performing a number of training programmes in Africa, Middle East and Asia.

The main objectives of the training has been to build capacity and institutional strengthening related to air quality management planning (AQMP). The selected local staff is trained to be specialists in selected fields related to their educational background. An important part of this training is to "understand air pollution". Examples were given based on actual data collected locally concerning assessment of sources as well as understanding the physical and chemical processes in the atmosphere.

The training covers all thematic areas within Air Quality Management. In addition to training in specific fields, NILU was also offering on-the-job training in operation of the different parts of the day-to-day work, such as the use and interpretation of data presented in the web portal, including the national database and the data transfer interface. Selected engineers were also trained in operation of the standardization unit, covering aspects like quality manuals for network operation and preparation and daily work with calibration gases.

The atmospheric dispersion models included in the AQMS system cover air pollution on all scales; along streets and roads, industrial emissions, gridded pollution from household etc. within the urban areas. Introduction to the use of different air pollution dispersion models is given including theoretical and practical training in air quality modelling.

Most of these training programmes developed as part of the institutional building and air pollution problems in urban areas has been based on the integrated air quality management concept, air quality planning and abatement strategy planning.

Appendix A

Handouts of the presented power point slides.

NILU projects

Presented at NILU
October 2013
Bjarne Sivertsen

NILU

1

NILU

Air Pollution Expertise on all Scales
Scientific tools and equipment

- ✓Outdoor/Indoor
- ✓Traffic/Industrial
- ✓Urban
- ✓Regional
- ✓Global

- ✓Emissions
- ✓Monitoring
- ✓Modelling
- ✓Assessment
- ✓Planning

NILU international data providers

NILU

NILU projects on the

Urban scale

- Air quality monitoring
- Air quality assessment
- Air quality planning

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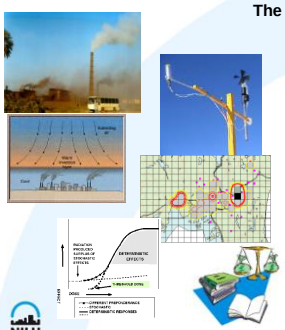
Urban local scale

AQ Monitoring and EIA

- ✓Design monitoring programmes
- ✓Undertake measurements
- ✓Siting studies
- ✓Background studies
- ✓Model estimate consequences
- ✓Optimise mitigation plans
- ✓Urban AQ assessments
- ✓Air Quality forecasts
- ✓Dissemination of information

NILU

Integrated Air Quality Management



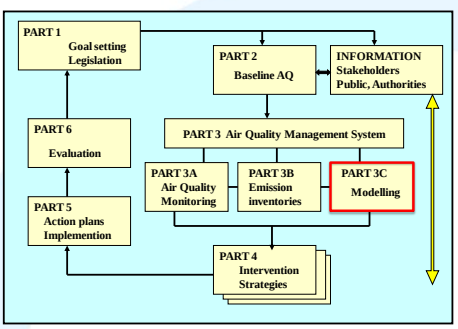
The complete integrated analyses

Emission inventory
⇩
Meteorology
⇩
Modelling
⇩
Concentrations
⇩
Exposure
⇩
Impact/ costs

Planning

NILU

AQMP A dynamic process

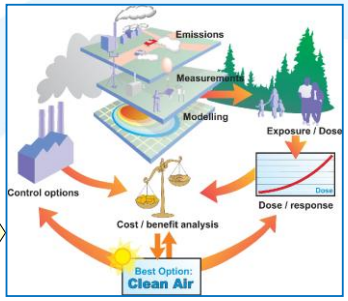


NILU

AQMS – main objective:

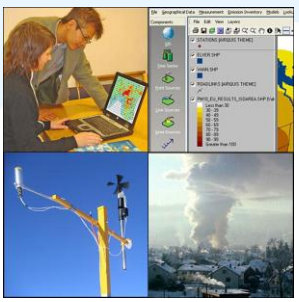
Identify actions to improve air quality

Identify most cost-effective options

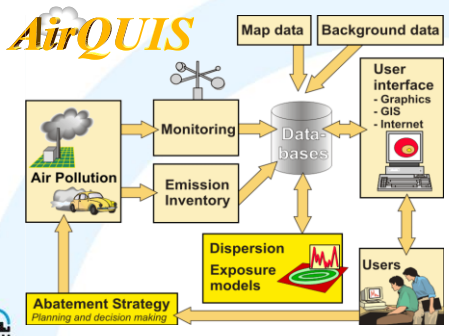


A complete AQMS

- Monitoring
- Data retrieval
- QA/QC
- The GIS database
- Models
- Input data
- EIA
- Forecasts



The elements of an AQMS

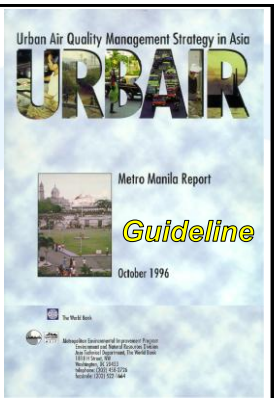


World Bank 1994

AQM strategy plans

developed for:

- **Manila**
- **Katmandu**
- **Mumbay**
- **Djakarta**



Yantai, China

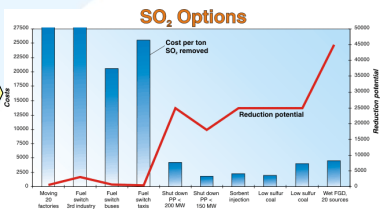
Goal and objectives

- ✓ Evaluate and update air quality monitoring system
- ✓ Establish database and AQM system
- ✓ Transfer tools and knowledge
- ✓ QA/QC system and training
- ✓ Demontrate action plan

Guangzhou

- A.Q. Assessment
- Health impacts
- Abatement options
- Cost/benefit analyses
- Optimal abatement strategy

Cost effective SO_2 options



Shanxi 费用效益分析

Cost benefit analysis

针对SO_2和TSP的不同控制方案的费用效益分析列表比较（太原）

A comparison of cost-benefit of various control options for SO_2 in Taiyuan

Control option	Conc red. µg/m3	Cost benefit ratio: negative payback	positive payback
Centralized heating	52,0		
Natural gas utilization	20,0		
Clean coal technology	6,2		
Desulphurization in pow	6,5		
Productivity policies	5,8		

-300 -200 -100 0 100 200 300 400

Similar analyses for TSP indicate same top two control options

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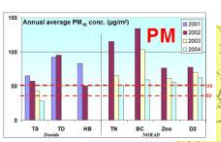
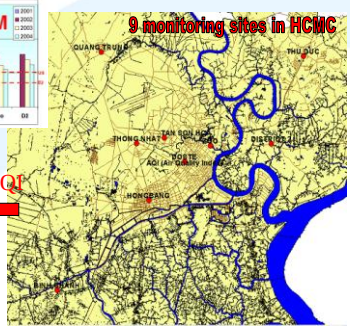
AQM in Ho Chi Minh City

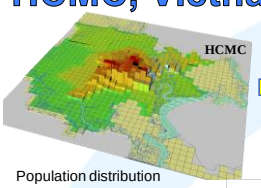


AQI

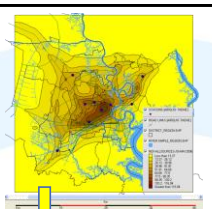


NILU

HCMC, Vietnam

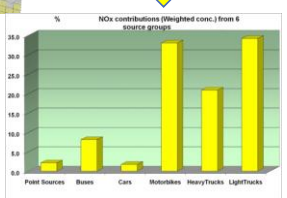


Population distribution



Estimated concentrations

Relative contributions of sources to the exposure in HCMC



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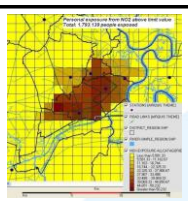
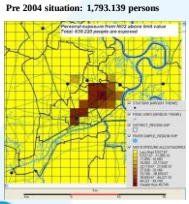


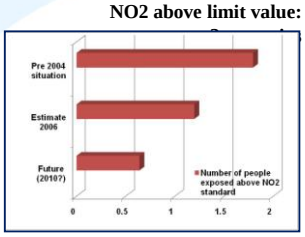
Pre 2004 situation: 1,793.139 persons



Future scenario: 639,220 persons

Total NO_2 exposure estimates

People living in areas with NO2 above limit value:



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WB project 2006

Hanoi AQM programme

Nine actions identified:

1. Improve the air quality monitoring programme (Appendix D)
2. Support siting of new stations (Appendix E)
3. Evaluate the QA/QC programme, and give advice (Appendix F)
4. Specify instruments for (new) monitoring stations (Appendix G)
5. Improve emission inventory capability (Appendix H)
6. Collect input data for modelling; future WB project (Appendix I)
7. Introduction to modelling, the needs and use of models (Appendix J)
8. Estimate importance of sources (Appendix K)
9. Institutional framework and organisation (Appendix L)

Need for organisation and co-ordination !

Roadmap available

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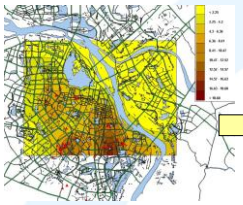
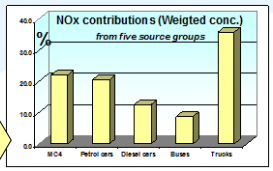
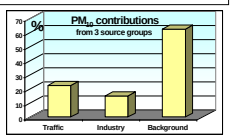
Relative importance of sources

Population exposure NOx







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Dhaka, Bangladesh AQM planning and GHG

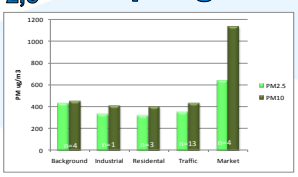
BAPMAN

Task1: Emission inventorying (top-down & bottom-up!)
Task2: Monitoring and laboratory procedures, and data acquisition capability
Task3: Air quality management capability, including modelling of air pollutant dispersion and population exposure
Task4: Health impact and scenario research, and strengthening capacity

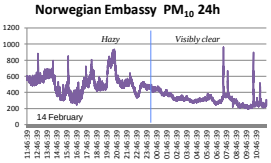
Technical training
On the job experience
Workshops and seminars

NILU

PM_{10} and $PM_{2,5}$ sampling

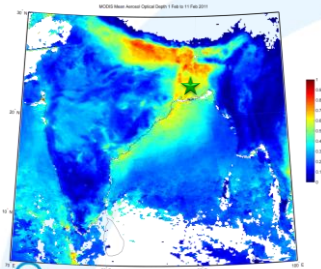


Norwegian Embassy PM_{10} 24h

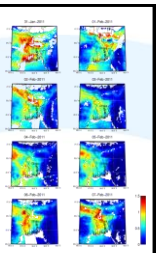


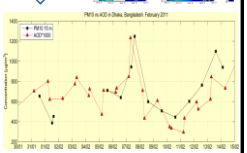
Satellite data; AOD/PM

MODIS-derived Aerosol Optical Depth (AOD) over Bangladesh



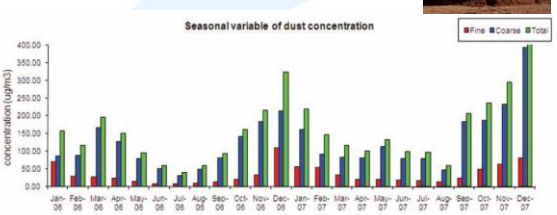
Daily AOD vs. PM10





Ulaanbataar, Mongolia Monthly average PM concentrations

Seasonal variable of dust concentration

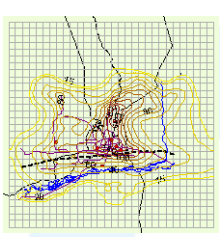


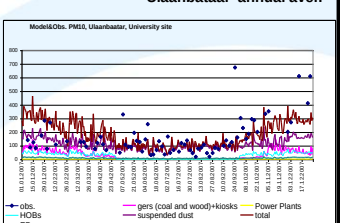
NUM station, 2006-2007 (Lodoysamba et.al., 2008)

NILU

Model estimated PM_{10}

Concentration distributions of PM_{10}, Ulaanbataar annual aver.

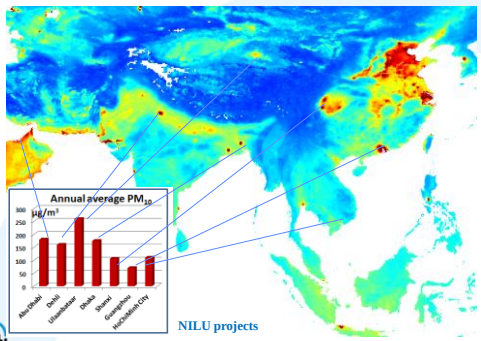




Source	Max. conc.	Area of influence (see Figure .. below)
All sources	190	
Ger households	120	Extended area from east to west in ger areas north
Paved roads	70	UB centre area, smaller in the ger areas
Unpaved roads	30	Across the ger areas
HOBs	30	West and north of city centre
Vehicle exhaust	10	UB centre area, smaller in the ger areas
CHPs	8	Areas south of city centre

NILU

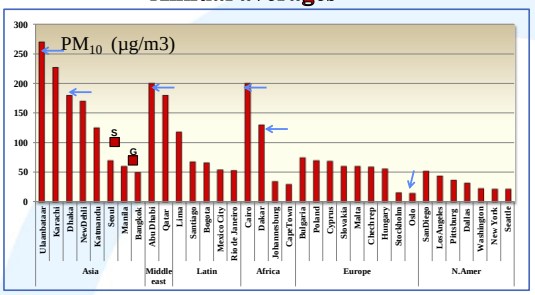
Average PM_{10} concentrations in Asia



NILU projects

PM_{10} concentrations around the world

Annual averages

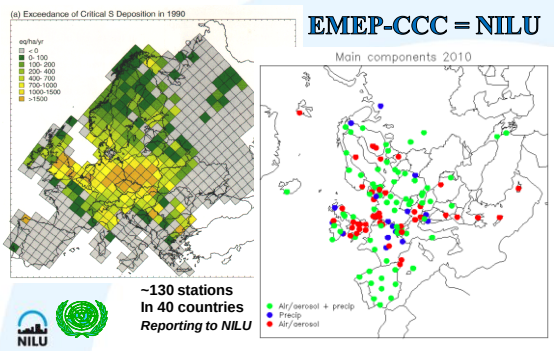


NILU in Kuwait, 1991

On-line monitoring and alarm

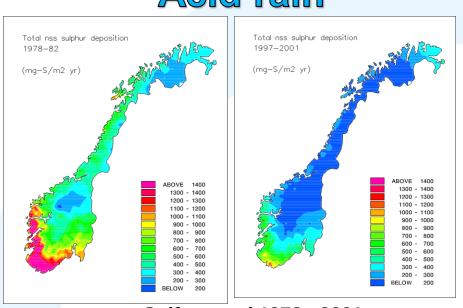
UN-ECE Convention on Long-Range Transboundary Air Pollution

EMEP-CCC = NILU



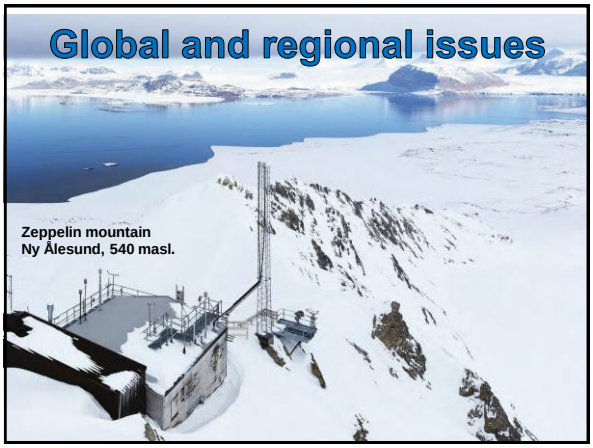
~130 stations
In 40 countries
Reporting to NILU

Long range transport Acid rain



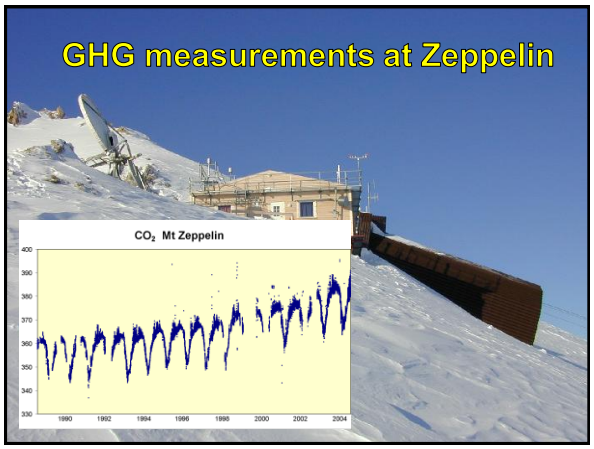
Sulfur trend 1978 - 2001

Global and regional issues

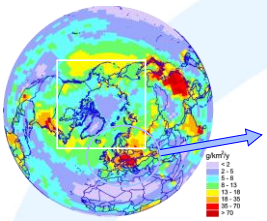


Zeppelin mountain
Ny Ålesund, 540 masl.

GHG measurements at Zeppelin

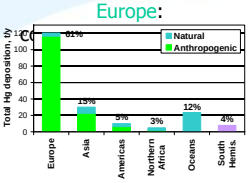


Interkontinental transport av Hg



Total annual Hg deposition in the Northern Hemisphere

Mercury deposition to Europe:



TFMM 5th Meeting, Prague 2004

Training programmes:

Clean Air for Asia training programme

Held in 2006 in Bangkok and in Hochiminh City

Invited countries with limited developed AQMS

NILU:
Monitoring design
Models
Reporting Air Q.
AQ assessment

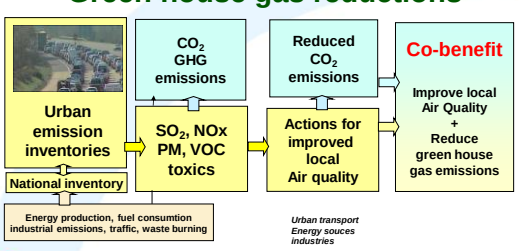
Integrated energy and air quality management

- The world is faced both with climate change and air pollution challenges,
- We must identify and implement policies and technologies that act on both problem areas
- And develop integrated cost-effective strategies

Co-benefit/co-control

Integrated assessment

Urban Air Quality Planning + Green house gas reductions



Co-control actions and requirements in Asia

Possible actions

Structural changes better than end-of-pipe

- From fossil fuels to renewable
- Energy efficiency improvements
- Energy savings
- Improvement of housing: construction and heating/cooling
- From individual to public transport
- From road (and air) to rail

Impacts and costs

Integrated approaches

Requirements

Needs for detailed data, on:
- Emissions
- Control options and their costs
- AP source-receptor and exposure-effects relationships

Costly and time consuming tasks
Requires skilled expertise


Integrated Assessments and Co-controls are needed to support Sustainable Urban Developments.
Thank you !
Questions ???