Department of Natural Resources and Environment (DONRE)
Ho Chi Minh City

NORAD
DIREKTORAT FOR UTVIKLINGSSAMARBEID
NORWEGIAN AGENCY FOR DEVELOPMENT COOPERATION

Ho Chi Minh City Environmental Improvement Project
Air Quality Monitoring and Reference Laboratory

Presentations from the seminars at NILU
During the visit 24 - 29 April 2006

Norwegian Institute for Air Research

Ho Chi Minh City
Environmental Improvement Project
Air Quality Monitoring Component

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Presentations from the seminars at NILU during the visit 24-29 April 2006

Edited by Bjarne Sivertsen

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During the visit 24 - 29 April 2006

1 Introduction

Regarding the remaining fund from the HEIA project supported by NORAD it was suggested that the money would be used for organizing one study tour for 3 Vietnamese persons to Norway. The programme should include Air quality monitoring and management. The participants of this study tour will include leaders from DONRE, Mr. Chien, Mr. Hien and Dr. Tuan. NILU organized the tour and prepared the programme

In addition NILU suggested that HEPA need to improve the application of the air quality data collected for modelling purposes. This is necessary in air quality planning, impact assessment and support to the ADB "Air Pollution, Poverty and Health (APPH)" project. We have suggested that the modelling expert at HEPA, MR Dam, spend two weeks with a group of NILU experts at NILU in June 2006.

The programme for the three Directors from DONRA was developed as presented at the next two pages. The schedule included seminars at NILU and visit to the Norwegian Pollution Control Authorities. The visit was organized as lectures and presentations, demonstrations, visits to laboratories; field visits and visits to national authorities. The content of the lectures was be related to the daily activities and tasks undertaken by NILU and related to the air quality management programme undertaken by the authorities in Ho Chi Minh City.

2 Participants

The following persons from DONRE participated in the seminars and visits during their stay in Norway:

- Mr. Nguyen Van Chien - Vice Director of DONRE HCMC
- Mr. Tran Nguyen Hien - Director of PIU of VIE1702 Project (Component: Air Quality)
- Dr. Nguyen Dinh Tuan - Director of HEPA

3 Air quality understanding and future applications

An important part of the training at HEPA/DONRE has been the understanding of air pollution. In the presentations at NILU we also included elements important for the follow-up and sustainability of the programme developed by the NORAD funds. Several presentations included air quality assessment, understanding of atmospheric processes and dissemination of data end information.

In the continued use of the data it will be possible to evaluate the relative importance of the impact from selected sources or categories of sources. Also the comparisons between measured air pollution levels and the air quality limit values as presented by the Vietnamese authorities have been important. Finally we hope that HEPA will be able to perform abatement planning and action plans to reduce the air pollution load in HCMC.

Three Directors of DONRE/HEPA, HCMC Vietnam
24 – 28 April 2006

4 Draft Programme

Monday 24 April	Arrival Lillestrøm at 11.00	

Monday 24 April		Trainer
13.00-13.15	Welcome address at NILU, Kjeller	
13.15-13.45	Presentation of NILU	Gunnar Jordfald (Director)
Topic 1-2	**Introduction to AQM, AirQUIS**	
13.45-14:30	The air Quality Management system	Bjarne Sivertsen
14.30-14.40	Tea/Coffee break	
14.40-15.10	AirQUIS a modern GIS based planning tool	The Nguyen Thanh
15.10-15.45	Technical tools for AQM: emission inventories and modelling	Herdis Laupsa
15.45-16.00	Questions, summary and discussions	

Tuesday 25 April		
Topic 3	**Air Quality Monitoring**	
9.00-9.45	Presentation of Air Quality Monitoring in Norway	Britt Ann Høiskar
9.45-10.45	AQM in Asia, with examples from China	Steinar Larssen
10.45-11.15	Tea/Coffee Break	
11.15-12.00	Quality Assurance and quality control	Kjersti Karlsen Tørnkvist
12.00	Visit Reference laboratory, Questions and discussions	KjK, Rolf Dreiem
12.30-13.30	LUNCH	
Topic 4	**Air quality monitoring and management in HCMC**	
13.30-14.30	Air Quality monitoring system design Content and status of AQM in HCMC	Bjarne Sivertsen and The Nguyen Thanh
14.30-14.45	Tea/Coffee Break	
14.45-15.30	AQI, reporting and future work at HEPA	DONRE team and NILU team
15.30-16.00	Any other business	
19.00	Dinner in Oslo	

Draft Programme (cont.)

Wednesday 26 April		
Topic 5	**Visit to SFT and station**	
9.15-10.15	Introduction to the work undertaken at the Norwegian Pollution Control Authority (SFT)	SFT representative
10.15-10.45	Coffee Break	
10.45-12.30	Presentation of work at SFT	Maren Wikheim
11.30-12.15	SFT as technical advisor to NORAD	Maren Wikheim
12.30-13.30	LUNCH at SFT	
13.30-14.30	Visit to air quality monitoring station in Oslos	Rolf Dreiem
14.30-15.00	Transport to Oslo – Coffee Break	
15.15-16.00	Visit to NILU laboratories	Ole-Andres Braathen Leif Marsteen/BAK

Thursday 27 April		
Topic 6	**Data dissemination and information systems**	
9.15-10.15	Air Online presentations and demonstrations	Britt Ann Høiskar
10.15-10.45	Coffee Break	
10.45-11.45	Data dissemination systems and applications	Geir Endregaard
11.45-12.30	NILU in media, information and public awareness	Stig Martin Solberg
12.30-13.30	LUNCH	
13.30-15.30	Administrative issues, Final discussions	
15.30	Closing the programme	Gunnar Jordfald

Friday 28 April		
	Leaving Norway	

The participants from Vietnam are:

Mr. Nguyen Van Chien - Vice Director of DONRE HCMC
Mr. Tran Nguyen Hien - Director of PIU of VIE1702 Project (Component: Air Quality)
Dr. Nguyen Dinh Tuan - Director of HEPA

Appendix A

Presentations from the seminars at NILU

Welcome to NILU

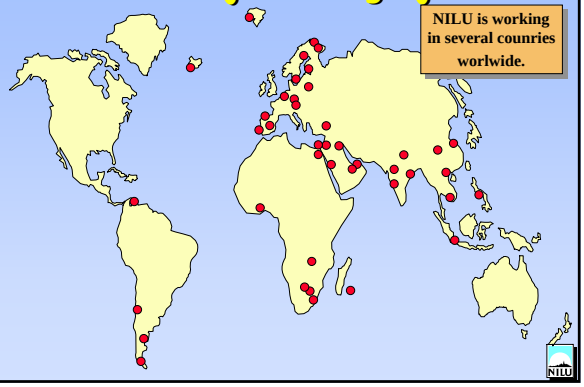
Welcomes three Directors from HEPA/DONRE Vietnam

Mr. Nguyen Van Chien - Vice Director of DONRE HCMC

Mr. Tran Nguyen Hien - Director of PIU of VIE1702 Project (Component: Air Quality)

Dr. Nguyen Dinh Tuan - Director of HEPA

NILUs internasjonale engasjement



NILU is working in several counries worlwide.

NILU internasjonalt

- India (NewDelhi, Bombay)
- SørAfrika (SADC)
- Botswana
- Zambia
- Kathmandu (WB)
- Manila (WB)
- Djakarta (WB)
- Mauritius (NIB)
- Egypt (Danida)
- China Yantai
  Sangzhou
  Harbin
  Acid Rain
- Venezuela
- Chile
- Saudi Arabia
- UAR - Quatar
- Damaskus
- Haifa

Europa
- Norden
- Polen
- Belgia
- Spania
- Portugal
- Ungarn (Pecs)

- **Shanxi, China**
- **Manila**
- **HoChiMin City**
- **Sudan**
- **Mozambikk**
- **SørAfrika**

Introduction to NILU

Gunnar Jordfald
Director

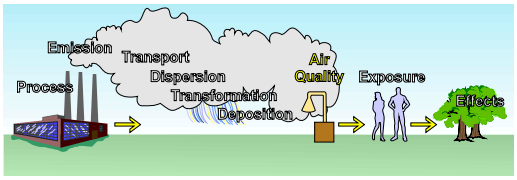
www.nilu.no

NILU's mission statement

Norwegian Institute for Air Research www.nilu.no

NILU's task is to establish quantitative relationships between:

Emissions • Dispersion • Deposition • Air Quality • Exposure • Effects



Work areas

Norwegian Institute for Air Research www.nilu.no

1. Industrial pollution
2. Urban air pollution
3. Acid rain and Surface Ozone
4. Toxic compounds
5. Climate change, Ozone layer and UV radiation
6. Coastal Zone Management

NILU's organisation

Norwegian Institute for Air Research www.nilu.no


Kjeller

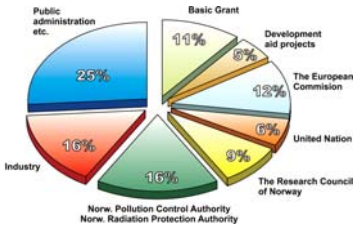

Tromsø

NILU's key numbers

Norwegian Institute for Air Research www.nilu.no

- Founded in 1969
- Independent foundation from 1986
- Annual turnover 16 mill US$

145 employees
- 70 scientists
- 42 scientists with a doctoral degree



NILU's business philosophy

Norwegian Institute for Air Research www.nilu.no

International knowledge company


Publication


Competence

Products

Science based services


The research

Money
Competence
Research needs

Research goal

Norwegian Institute for Air Research www.nilu.no

NILU shall be an international recognised research and development institute within atmospheric issues, air quality and toxic/hazardous compounds. On selected areas we shall be the best in Europe.

EU-research 2004:

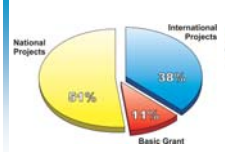
Member of 41 projects

Coordination of 10

Services and products goal

Norwegian Institute for Air Research www.nilu.no

NILU shall be an international oriented and competitive supplier of services, systems and products of high quality towards authorities and industries.



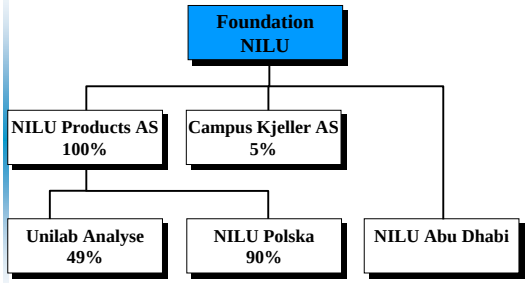
Knowledge dissemination goal

Norwegian Institute for Air Research www.nilu.no

NILU shall have an active dissemination of scientific knowledge by high number of publications and be in the fore front of utilising new information technology.

International and innovative concern

Norwegian Institute for Air Research www.nilu.no



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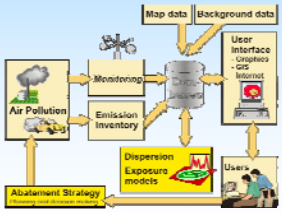
The end

The Air Quality Managment System

Bjarne Sivertsen, NILU

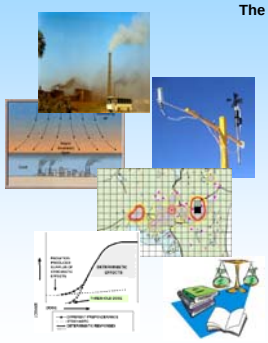


A complete Air Quality Management System

- Monitoring (AQ+met)
- Data retrieval
- QA/QC
- A database (GIS base)
- Models
- Asessment tools
- Planning tools
- Forecasts

Impact Pathway Approach

The complete integrated analyses



Identify sources
Emission inventory

Meteorological data
Dispersion and turbulence

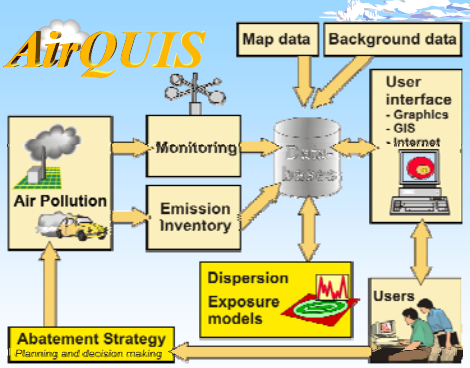
Dispersion modelling
SO2, NOx, PM +

Concentrations, Exposure

Exposure/response functions

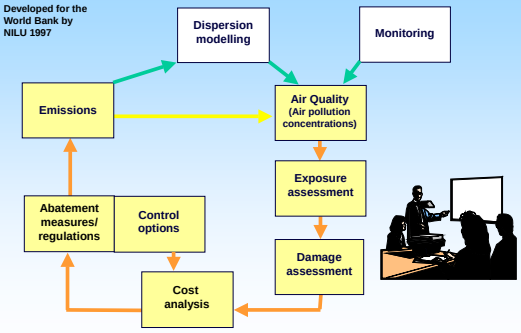
Effect / cost data

AirQUIS



AQ Management Model Concept

Developed for the World Bank by NILU 1997



Elements of the AQMS

- ❑ Sources – Emission inventory
- ❑ Measurements – AQ + Meteorology
- ❑ Models
- ❑ Impact assessment
- ❑ Applications

Typical classes of sources

- Traffic
  - local problems
  - hot spots
- Domestic sources / energy
  - regional
- Industrial sources
  - local, hot spots
  - toxic
  - specific impact
- Regional and large scale
  - "background"

Typical sources are:

Traffic, small industries, open air burning and "natural" emissions

Emission Data Base

Geographical Information System (GIS)

Calculation of Emission Fields → Modelling

Industry	Traffic	Population	Consumption
• stacks • process • consumption • component • time variation	•road information •road type/class •vehicle class •emission factors •time variation	• distribution in sub areas • area use	• fuel type • emisson factors • temp. variation • time variation

Air Quality Monitoring

- ✓ Objectives
- ✓ Site selection
- ✓ Select indicators
- ✓ Limit values
- ✓ Frequency and period
- ✓ Instruments
- ✓ Statistics
- ✓ Compare to meteorology
- ✓ From which sources?
- ✓ Impacts?

Indicators

Identified to:

- Provide a general picture
- Be easy to interpret
- Respond to changes
- Provide international comparisons
- Be able to show trends over time
- Identify Needs for and Support the Design of Control Strategies
- Support Input to Management and Policy Changes

Air Pollution Indicators

First priority pollutants

- SO_2 (Sulphur dioxide)
- NO_2 (Nitrogen dioxide)
- PM_{10} (Particles with aerodynamic diameter < 10 micrometer)
- Pb (lead)

Not all compound in the atmosphere can be measured !

Limit values developed for other indicators:

- Ozone
- Benzene (BTX)
- CO
- $PM_{2,5}$

Indicators for HCMC air quality monitoring

- Sulphur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Particulate Matter (PM_{10})
- Ground-level Ozone (O_3)
- Carbon Monoxide (CO)

AQ Guidelines and standards

Pollutant	Averaging Time	WHO (µg/m^3)	TCVN-2005 (µg/m^3)
SO_2	Annual Avg.	50	50
	24 Hours	125	125
	1 Hour	500 (10min)	-
CO	8 Hours	10 000	10 000
	1 Hour	30 000	30 000
NO_2	Annual Avg.	40	40
	24 Hours	-	-
	1 Hour	200	200
O_3	8 Hours	120	80 *(24 h)*
	1 Hour	-	120
PM10	Annual Avg.	20	50
	24 Hours	50	150
Pb	Annual	0.5	

Instruments

Many kinds:

- Simple passive samplers
- High volume samplers
- Sequential samplers
- Automatic Monitors (in situ)
- Monitors for remote measurements
- Mobile stations
- Automatic weather stations

Air quality Monitors

SO_2	➡	fluorescent signal exiting SO_2 with UV
NO, NO_2	➡	chemiluminiscent reaction NO/O_3
O_3	➡	UV absorption analyser
CO	➡	non-dispersive infrared photometer

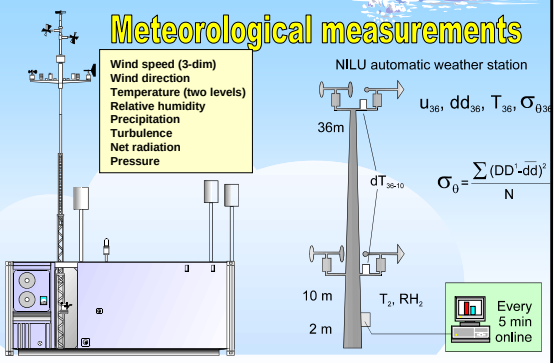
Reference instruments !

PM_{10} : ➡ Measurement on filter tape using the principles of beta attenuation

All air quality monitoring programmes include

Meteorological measurements

- Wind speed (3-dim)
- Wind direction
- Temperature (two levels)
- Relative humidity
- Precipitation
- Turbulence
- Net radiation
- Pressure



A typical monitoring station

Urban background site in HCMC

Quality Assurance

All planned and systematic activities which are needed to assure and demonstrate the predefined quality of data

1) Monitoring Objectives
Determine use of data, e.g. monitoring of trends

2) Data Quality Objectives
Determine necessary data quality to fulfil the Monitoring Objectives

3) Equipment selection
Results must fulfil the DQO. Select best measuring practice

4) Site selection
Must be representative for the Monitoring Objectives

Quality Control

Operational techniques and activities that are undertaken to fulfil the quality requirements

- **Calibration and maintenance plan**
- **Standard Operations Procedures (SOPs)**
  - **Describe how to perform and document all operations**
  - **Maintenance, calibration, repairs, data validation, e.t.c.**
- **All operations are documented in forms**
- **All forms are stored in files for later reference**

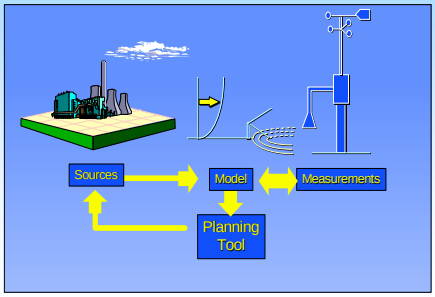
Quality Assessment

Determining the actual quality of the data and if the data fulfils the Data Quality Objectives

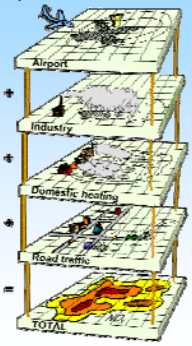
- **Audits**
  - **System Audit: Inspection of QA/QC plan and documents**
  - **Performance Audit: Instrument response is checked at the station using a test standard**
- **International intercomparisons**
  - **Instruments measure a test standard in parallel**
- **Round robin tests**
  - **A test standard is measured at each laboratory**

Air pollution Dispersion Models

A planning tool

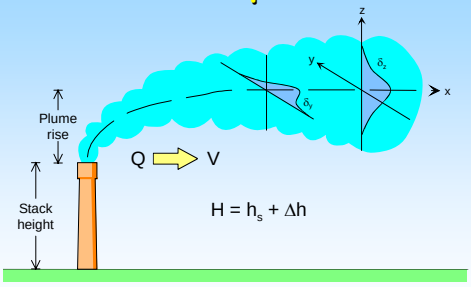


Dispersion modelling



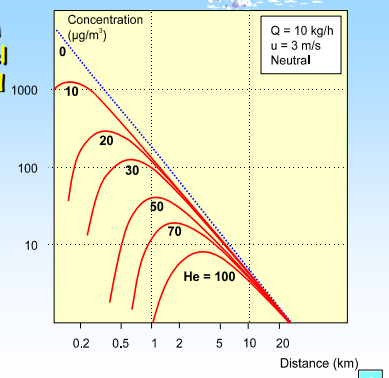
- **Spatial distribution of pollutant concentrations**
- **Source contribution quantification**
- **Effects of suggested measures**
- **Exposure Estimates**
- **Forecasting**

The Gaussian plume model



$$\text{Concentration} = \frac{\text{Release rate}}{\text{Wind speed} \bullet \text{dispersion}}$$

Concentration at ground level along the wind direction



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Road network models

- **Line source (HIWAY) and Eulerian models used to calculate concentrations at building sites.**

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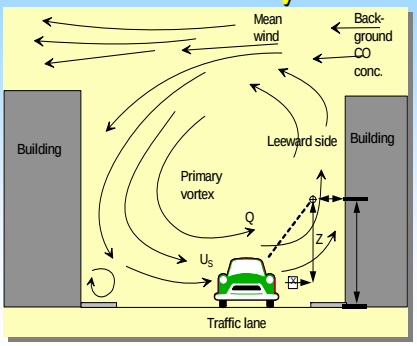
Street canyon



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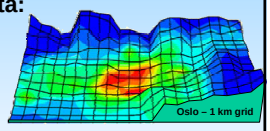
Numerical models

- **Hourly gridded input data:**
- **Emissions**
- **Meteorology**:
  - Wind field (u, v, w)
  - Temperature at ground level
  - Vertical temperature gradient (stability)
  - Mixing height
  - Turbulence (σ_v and σ_w)



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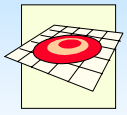
Models in AirQUIS

Wind
- Meteorological pre-processor
- Wind field models

Emission Model
- Traffic and stationary sources

Dispersion Models
- Urban scale grid model
- sub-grid point source model
- street and road models

Effect Models
- Population exposure
- Impact on materials and buildings



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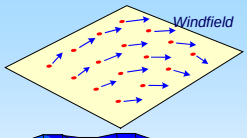
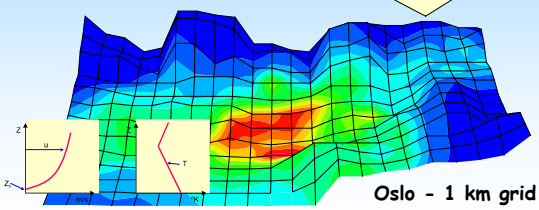
"EPISODE"

The Numerical Dispersion Model in AirQUIS

Meteorological hourly gridded input data:
- **Windfield (u, v, w)**
- **Temperature at ground level**
- **Vertical temperature gradient (stability)**
- **Mixing height**
- **Turbulence (σ_v and σ_w)**





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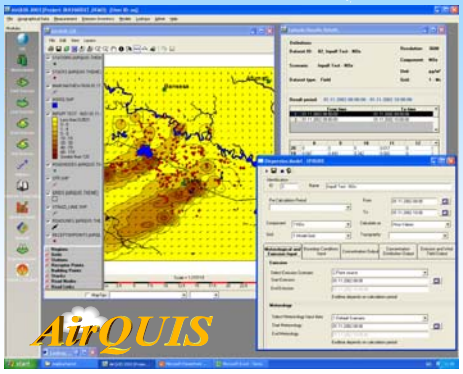
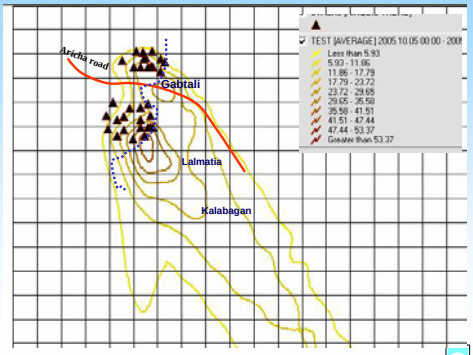
Modelling with AirQUIS



Estimated 24-h concentration

SO_2

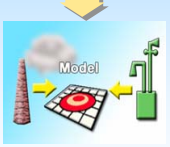
33 stacks random positioned



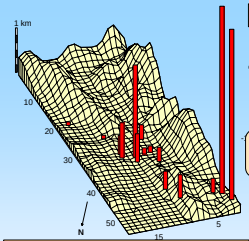
Model Application

1 Existing and future single source impact
2 Siting of large single source impact
3 Stack height evaluation
4 Estimate of effect of cleaning device
5 Accident releases
6 Deposition problems
7 Odour problems
8 Photochemical oxidants
9 Estimate of impact from remote sources
10 Area planning
11 Traffic planning
12 Planning of measurement programs
13 Analysis of measurement data
14 Trend analysis
15 Forecast of episodes

Siting, Planning, Environmental Impact Statement



Impact assess-ment



Emission inventory

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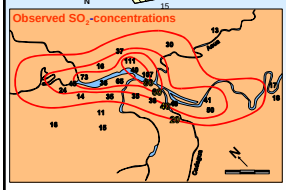

observed concentrations

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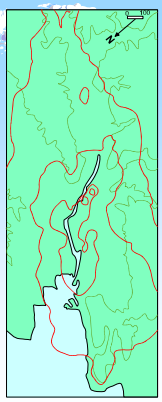
Model estimated concentrations



Development of Air Quality Management Strategy Plan

Assessment
- Sources
- Monitor
- Exposure
- Source - exposure
- Contributions to exposure
- Damage

AQMS

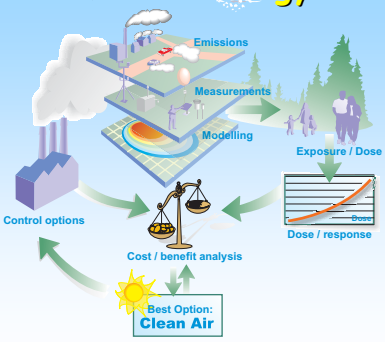
Control
- Control options
- Cost – efficiency/benefit
- Control strategy
- Investment plan

Masterplan

Surveillance
- Develop institutions
- AQ Information System

Optimal Abatement Strategy plan

Identify actions to improve air quality

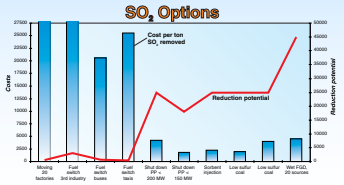


most cost-effective options

Guangzhou

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

Cost effective SO_2 options

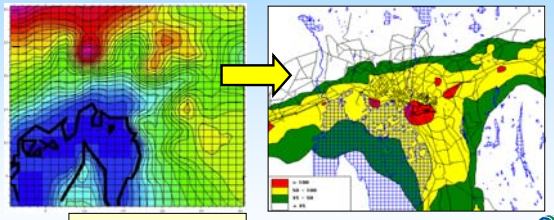


Air quality forecast

1. HIRLAM 50 (Atlantic ocean north of 20 deg)
2. HIRLAM 10 (North Western Europe)
3. MM5 (regional scale 3 km res.)
   (inner city, local 1 km res.)

24 h prognoses - 1,25 hours at CRAY T3E

"Better city air" -



Important parameters:
- Topographical and surface features
- net radiation - surface temperatures
- clouds and snow cover
  Uses NOAA Satellite data

NO_2 (µg/m³) 24h forward

DNMI

Air Quality Management Training needs

- ✓ Air Quality Assessment
- ✓ Environmental Damage Assessment
- ✓ Abatement Options Assessment
- ✓ Cost Benefit Analysis or Cost Effectiveness Analysis
- ✓ Abatement Measures
- ✓ Optimum Control Strategy

→ **Training**

Norwegian Institute for Air Research

www.nilu.no

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No-2027 Kjeller
Norway
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E-mail: nilu@nilu.no

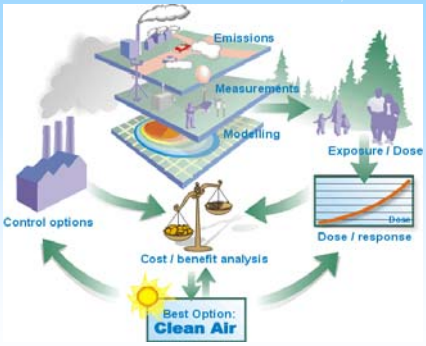
The Air Quality Management System

AirQUIS

Presented by: Herdis Laupsa

www.NILU.no

Air Quality Management



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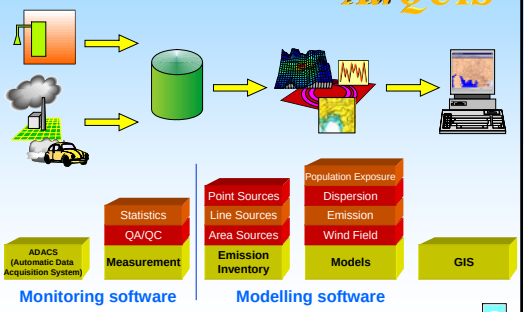
AirQUIS software

AirQUIS



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Applications

- **Measurement module**
  - **acquisition, validation and presentation**
- **Assessment**
  - **Source contribution**
  - **Source exposure**
- **Trend analysis**
- **Abatement**
  - **Exposure**
  - **Cost benefit and cost efficiency of control options**
- **Industry accidents**
- **Forecasting/now-casting (Norway, Haifa)**
- **Scientific research (e.g. EU/NILU)**

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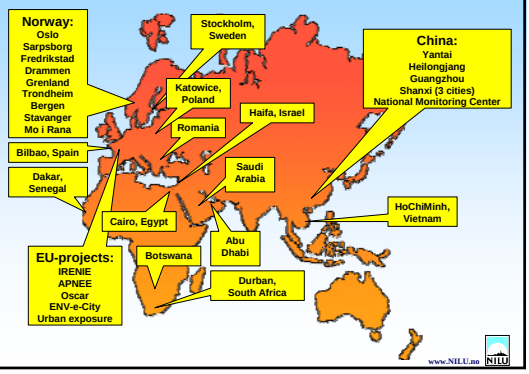
AirQUIS Installations



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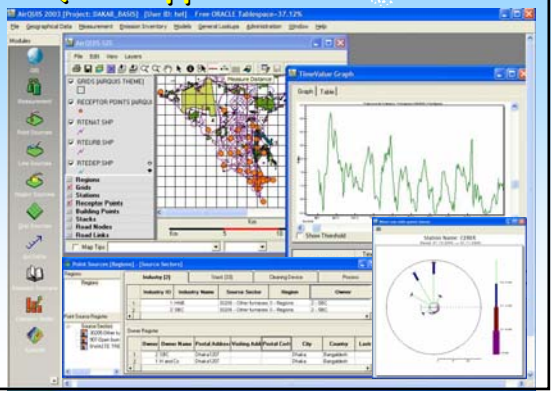
AirQUIS applications



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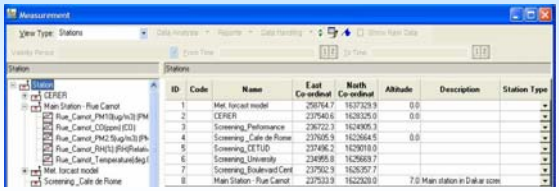
Measurement database

- Database: Retrieve, organise and store data
- Quality control
- Data presentation
- Graphics and statistics
- Data as input for model calculations

Measurement database – User interface

- Stations
- Components
- Time series

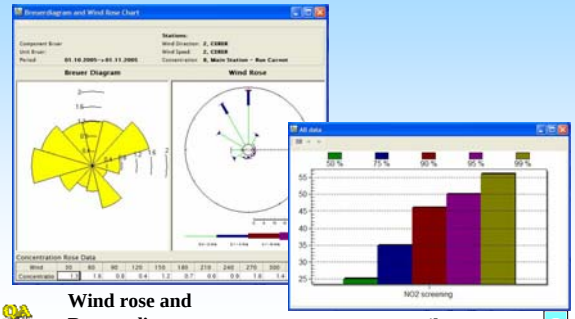


Measurement - Time series

$PM_{2.5}$ and wind speed

Daily values of PM_{10}

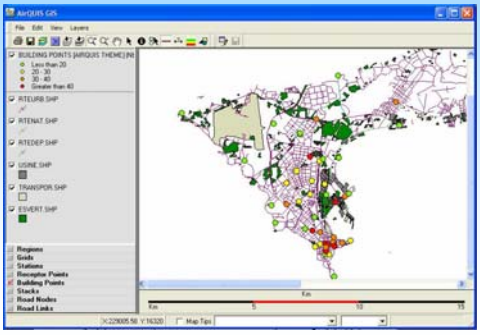
Measurement-air quality assessment



Wind rose and Breuer diagram

Percentiles

Measurement data – presentation



The Emission Inventory

The atmospheric emissions inventory is a compilation of all sources of air pollution within an area

Emission Inventory Features

Point source emission - single activities like industries, energy production linked to single stacks

- **Line emission** - road traffic, ships

•**Area sources** - open air burning, public and private services, agricultural activities etc.

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Emission inventory database

Geographical Information System (GIS)

Calculation of Emission → Modeling

Point Sources	Line Sources	Area sources
• Industry • Stacks • Consumption • Emission • Production • Emission factors • Time variation	• Static road data (Geography, road classification) • Dynamic traffic data • Emission factors • Time variation	• Consumption • Emission • Production • Source sector • Fuel /Raw material • Emission factors • Time variation

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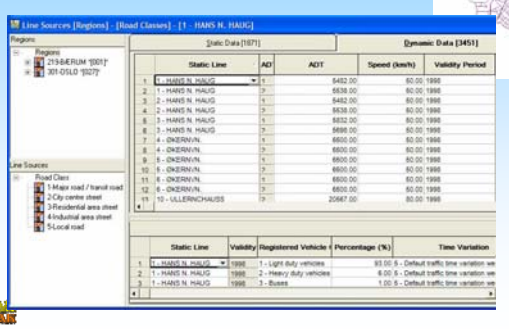
Traffic data



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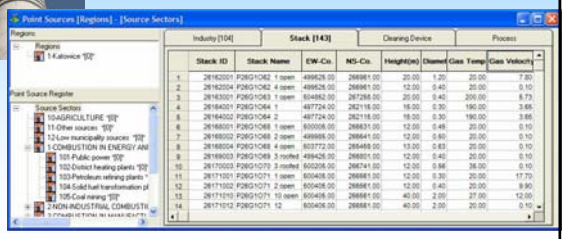
Industrial data



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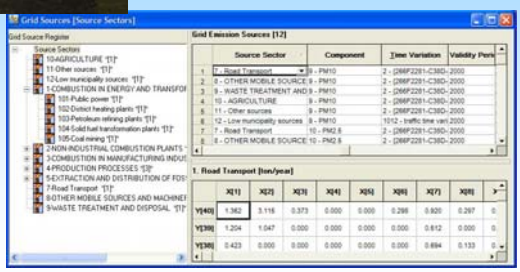
Area source data



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AirQUIS Models

- **Emission model**
  - Calculates hourly emissions from area, line and point sources. Stores results as field, line or point data set
- **Wind field model (MATHEW)**
  - Calculates 3-dimensional hourly wind fields from measurements of wind speed and direction, temperature, gradient and topography
- **Dispersion model (EPISODE)**
  - Calculates hourly concentrations of pollutants in grids and individual receptor points
- **Exposure model**
  - Combines pollution concentrations with population distribution

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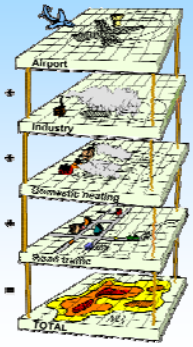
Dispersion modelling

AirQUIS



- Spatial distribution of pollutant concentrations
- Source contribution quantification
- Effects of suggested measures
- Exposure Estimates
- Forecasting

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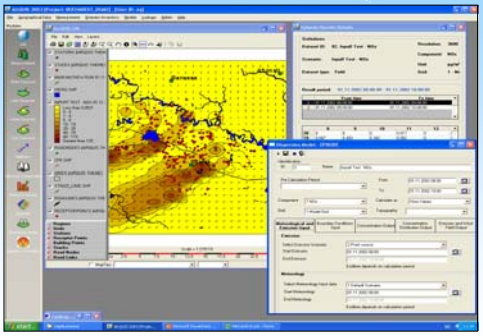
Dispersion Models



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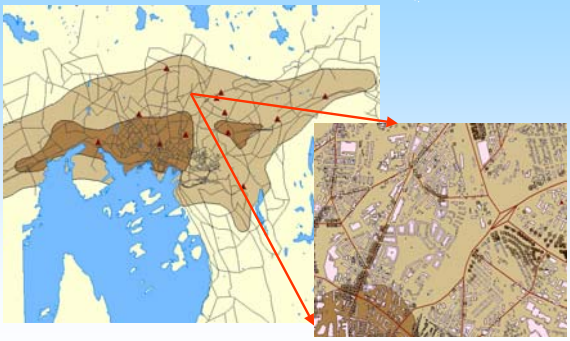
Calculated concentrations



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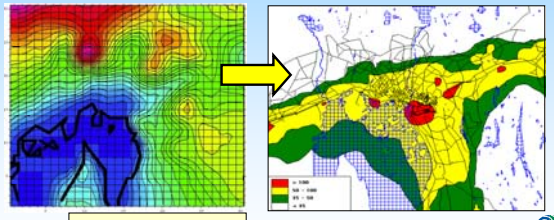

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  Uses NOAA Satellite data

NO_2 (µg/m3) 24h forward

DNMI

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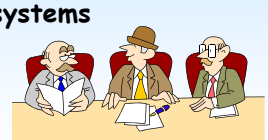
Model applications

- Environment impact assessment
- Surveillance and management
- A.Q. forecasting and early warning
- Optimal abatement strategies
- A.Q. information systems



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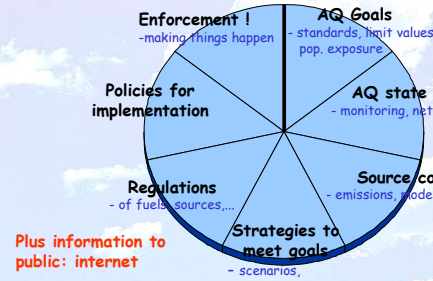
Air Quality Management in Asia

Methods and examples

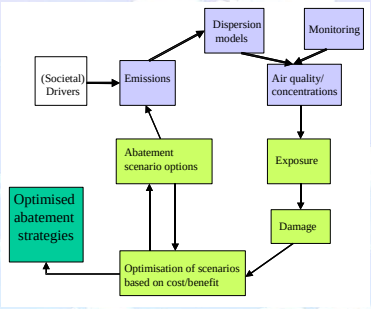
Steinar Larssen
Norwegian Institute for Air Research (NILU)

The basic items of AQ Management



Plus information to public: internet

The AQM loop:from Drivers to cost-effective urban abatement - control at what cost ?



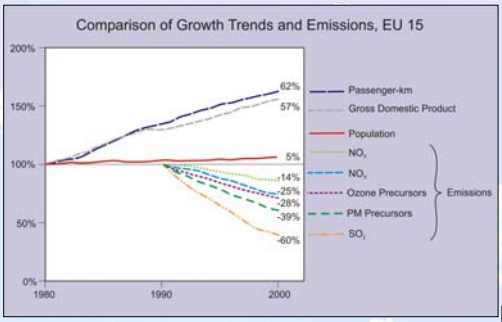
Do we all have the same Air Quality goals ?

Present Air Quality Standards/Limit Values (µg/m³)

	SO2		NO2			PM10		Ozone
	Year	Day	Year	Day	Hour	Year	Day	1-8 hours
Europe		125 (3)	40		200 (18)	40	50 (35)	120 (26) 8h
USA	80	365 (1)	100			50	150 (1)	157 (4) 8 h
Australia	50	200 (1)	57		225 (1)		50 (5)	160 (1) 4h
Japan		105 (0)		75-115			100 (0) SPM	160 (0) 1h
China, cl.2	60	150	80	120	240	100	150	160 1h
India, res.	60	80	60	80		60	100	
Ratio µg/m³ ppb	~ 2.65		~ 1.9					~ 2.0
Vietnam	50	125	40			50	150	120 1h

(#) **Number of allowed exceedances per year**

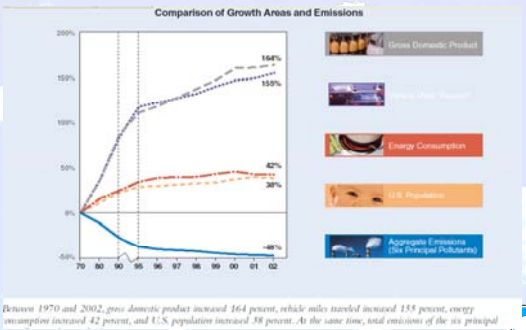
Example: Air Pollution development in Europe



www.eea.eu.int / click on /air or /traffic, etc

Example: Air Pollution development in USA

Similar in the other regions



Between 1970 and 2002, gross domestic product increased 164 percent, vehicle miles traveled increased 155 percent, energy consumption increased 42 percent, and U.S. population increased 38 percent. At the same time, total emissions of the six principal

All success ?? Not quite

- Despite significant reductions in ozone precursor emissions (NO_x, VOC):
  - Health relevant Ozone concentration indicators have been almost stable the last decade
- PM10 and PM2.5 are hard to tackle:
  - AQ standards are made stricter
  - Secondary particles (organic and inorganic) on the regional scale are difficult to reduce enough
  - Road traffic is steadily increasing
  - Particle resuspension from roads as well as natural PM sources cannot easily be reduced

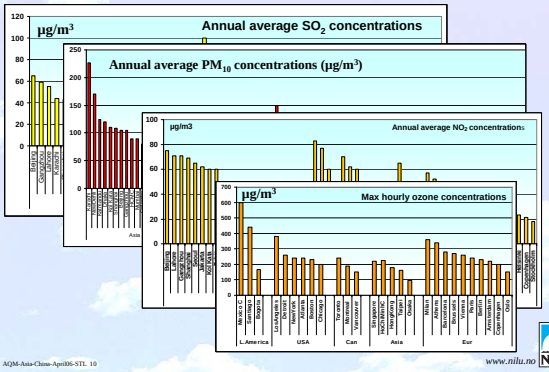
What about Air Pollution in Asian cities ?

- **$PM_{2.5}$ is the most significant pollutant**
- **Other pollutants are Pb, VOC, CO, NOx, SOx**
- **Impact on human health is serious**
- **Major sources:**
  - *transport, power plants, industries,*
  - *bio-mass and refuse burning,*
  - *domestic and commercial fuel burning,*
  - *resuspension of road dust ...*

Achievements to-date

- **Ambient, Emissions and Fuel standards**
- **Unleaded petrol has reduced lead dramatically**
- **Control of Industrial sources is progressing**
- **Air quality monitoring is coming along**
- **Reduction in road and construction dust has been achieved in some countries**
- **I/M Initiated in some countries but implementation is <u>not</u> successful**
- **TSP, SOx, and CO levels are going down in many cities <u>but</u> $PM_{2.5}$ levels are above standards**

Asian urban Air Quality compared to rest of the world



Key topics for improvement of AQM in Asia

- **Invigorate areas and lines of responsibility:**
  - *national to province/state **to local !***
- **Continue to strengthen institutions:**
  - *increase capacity, knowledge, experience*
- **Accumulate high quality data !**
- **Continue to raise awareness of health risks:**
  - *key info to policy makers, get support from the public*

Key topics for improvement of AQM in Asia

- **Use integrated assessment methods and tools to develop urban AQ strategies**
- **Use cost-effectiveness as the primary criterion for selection of abatement measures**
- **Strengthen compliance:**
  - *build awareness, businesses and consumers*
  - *strengthen enforcement provisions*
- **Speed up process to improve fuel quality !**
- **Work towards "state-of-the-art" vehicle emissions regulations**

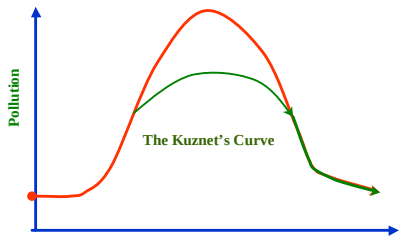
Use Integrated assessment tools to develop urban AQ strategies

- PC-based software tools have been developed for urban AQM
- They have gone through several levels of sophistication
- They exist on the market
- Overview of European tools: look at:

  http://aix.meng.auth.gr/saturn/finalreport/n-ch9.pdf
- A special example: look at www.airquis.no

This conceptual, theoretical curve indicates that by innovation, cost-effectiveness and utilising others' experiences, it should be possible to take the top off the pollution curve on the way to prosperity. But it still does have a cost.

~ Kuznet's Curve, opportunities for cities to bypass a BAU future for environmental and other benefits...
...by developing cost-effective analytical frameworks, exploring innovative opportunities and learning from other city experiences...



URBAIR

Air Quality Management Strategy for:

- Bombay
- Jakarta
- Kathmandu
- Manila

for the World Bank

Urbair project

Categories of abatement measures

1. Improved fuel quality
2. Technology improvement
3. Fuel switching
4. Traffic management
5. Transport demand management

Urbair cities: Costs of health impacts

	Mumbai 1991	Metro Manila 1992	Jakarta 1990	Kathmandu Valley 1993
Exposure (% of pop.)[1)]				
TSP>90 µg/m³	97%	67%	>99%	50%
TSP>180 µg/m³	5%	15%	~50%	3-4%
Health impact from PM_{10} (cases/10^6 inhabitants)				
Mortality	279	155	459	79
Morbidity				
Chronic Bronchitis	2 000	1 430	n.c.	477
Restricted Activity Days (10^3)	1 870	1 310	3 265	448
Emergency Room Visits	7 600	5 360	13 370	1 835
Bronchitis in Children	19 000	13 330	33, 00	4 575
Asthma attacks	74 100	51 900	130 000	17 800
Respiratory Symptom Days (10^3)	6 000	4 170	10 410	1 430
Respiratory Hospital Admissions	400	238	714	93
Monetary value of health impact, Total city	Mill. US $	Mill. US $	Mill. US $	Mill. US $
Mortality 2)	22.7	18.8	49.7	0.57
Morbidity 3)				
Restricted Activity Days	17.2	67.7	69.4	0.53
Asthma attacks	24.3	19.8	6.9	0.23
Respiratory Symptom Days	39.0	59.1	1.6	1.51

Urbair cities: Costs and benefits of abatement

Abatement measure	Mumbai (1991) Benefits	Mumbai (1991) Costs	Manila (1992) Benefits	Manila (1992) Costs	Jakarta (1990) Benefits	Jakarta (1990) Costs
	Mill. US $.		Mill. US $		Mill. US $.	
Unleaded gasoline	NQ	NQ	NQ	NQ	146	24
Low-smoke lubrication oil for 2-stroke MCs	4.9	1.0	n.a.		16	1-5
Inspection/ maintenance, vehicles	8.2	4.9-9.8	30-40	5.5	15	33
Control gross polluters	4.1	NQ (small)	16-20	0.01	12	Low
Clean vehicle standards:						
- Cars/vans	4.1	24.6	94-116	5-20	33	41
- MC/TC	7.8	19.7	n.a.		NQ	NQ
Improved diesel quality	2.6	9.8	10-12	10	2.9	Low
Cleaner fuel oil	1.6	14.8	10-20	10-20	NQ	NQ

NQ: Not quantified.

New AQM instruments bear promise ?

- **Cost-effective** pollution abatement for urban areas in Europe (responsibility of municipalities) and Japan (and USA?)
- **Emissions trading** "cap and trade" in USA
  - Success of market forces?
  - Will drive technology development?
- **Multi-pollutant, multi-scale integrated assessment**
  - as basis for cost-effective abatement
  - in Europe, and also in USA (?)
  - e.g. resulting in cost-effective region-specific *emission ceilings* (Europe and Japan)

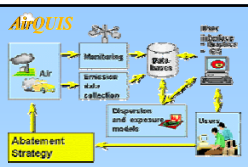
Sharing experiences with the regions which are further along

How to continue in Asia ?

Effective sharing of responsibilities:

Federal or national:	laws, standards, taxes and prices
States or provinces:	environmental plans and control
Municipalities:	action plans, investments and control
NGOs:	awareness raising, public participation process

Thank you for your attention !

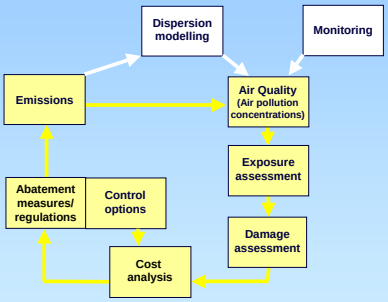


NILU and Air Quality management in China

Steinar Larssen

steinar.larssen@nilu.no

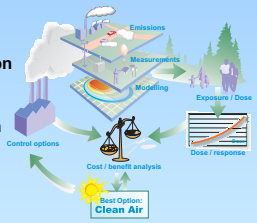
Air Quality Management Model



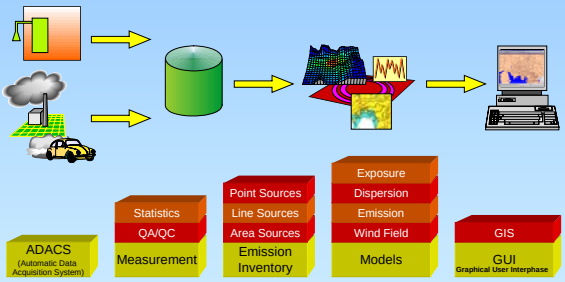
AirQUIS - GIS-based Air Quality Management System

Main objectives of the system

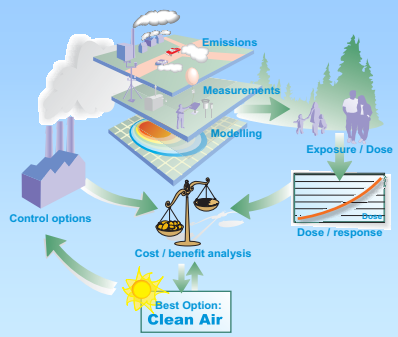
- To enable **on-line air quality data presentation** Internet
- To provide complete **air pollution exposure information**
- To enable development of **cost-effective air pollution abatement strategies**



AirQUIS Modules



Optimal abatement – Action plan



AQMS / AirQUIS in China

- Guangzhou: Development of Air Pollution Action Plans 1996-2000
- Yantai: Establishment of AP monitoring and modelling system 1996-2000
- Yantai Consolidation 2003-2005
- Shanxi: Development of Provincial AP Master Plan. AirQUIS in Taiyuan, Datong, Yangquan 2001-2005
- China National Env. Monitoring Station (CNEMC): ENSIS as national environmental data base 2002-2005

NILU Air Quality Management work in P.R. China

Urban Air Quality Management:

- Guangzhou
  - AirQUIS
  - 2010 Scenario development
  - Action Plans for SO2 and NOx
  - Urban concentration/population exposure reduction
- Yantai
  - AirQUIS
  - Monitoring network - on-line
  - Analysis of effects of control options on urban concentrations

NILU Air Quality Management work in P.R. China

Province AQM: Shanxi Province

- Province-wide emissions inventory
  - sector-specific
  - partition into administrative districts
- Air pollution modelling in 3 selected cities
- Distribution of "total allowable emissions" between districts
- Generalising city-specific action plans

Categories of Air Pollution control options in P.R. China

- **Economic structure adjustment**
- **Energy structure adjustment**
- **Cleaner production**
- **Process techn. improvement**
- **Industrial location adjustment**
- **Co-generation and district heating**
- **Ecological improvement**
- **End-of-pipe technologies (emission cleaning)**
- **Improving and implementation of environmental laws and regulations**

Most of these classes of control options can be analysed in terms of cost-effectiveness using AQM tools such as AirQUIS

Analysis of Actions / Measures

What	**Description**
Effects	**Reduced emission / exposure / damage costs**
Cost	**Cost of measure**
Feasibility	**Technical feasibility / economic / political**
How	**Policy instrument to start and carry out measure**
When	**When should actions be started When can results be expected**
Who	**Institutions / organizations responsible or affected**

Action Plan development for Guangzhou, P.R.China

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

Guangzhou – Control options considered

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)

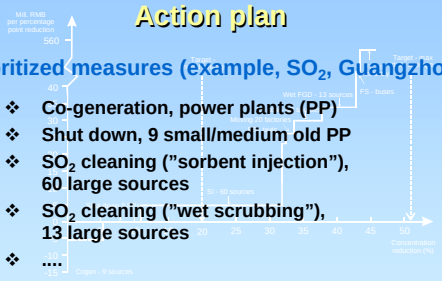
Guangzhou Air Quality Action Plan 2001 KAA-6

Main result of development of air quality management strategy

Action plan

Prioritized measures (example, SO_2, Guangzhou)

- Co-generation, power plants (PP)
- Shut down, 9 small/medium old PP
- SO_2 cleaning (”sorbent injection”), 60 large sources
- SO_2 cleaning (”wet scrubbing”), 13 large sources
- ....



S. Larssen: Beijing 20 Jan-02: AQ China 8

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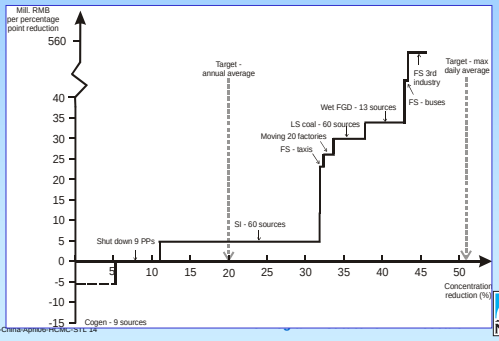
ACTION PLAN 2001, GUANGZHOU
CONTROL OPTIONS FOR SO2
Prioritized according to Cost Effectiveness



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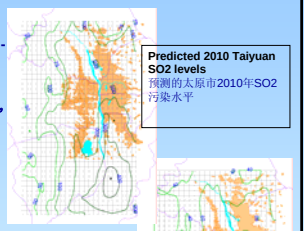
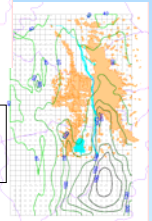
中挪合作“山西省大气污染防治总体规划”
Master Plan Against Air Pollution in Shanxi Province

- Cost-benefit analysis
  对所有污染控制方案进行费用-效益分析
- Using AIRQUIS in 3 cities
  应用于山西省的三个城市 太原，大同，阳泉
- Best cost-benefit control options: **优选的污染治理措施**
  - District heating 集中供热
  - Cleaning coal 清洁煤
  - Natural gas 天然气的利用
  - Desulfuration 脱硫
  - Shutdown and eliminate out-of-date processing technologies
    关停以及淘汰陈旧技术



Predicted 2010 Taiyuan SO2 levels
预测的太原市2010年SO2污染水平



Taiyuan SO2 levels in 2010 (district heating applied)
采用集中供热措施后的太原2010年SO2污染水平

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Master Plan against Air Pollution in Shanxi

Steinar Larssen
Norwegian Institute for Air Research

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Master Plan against Air Pollution in Shanxi

- A Sino-Norwegian cooperation project
- implemented during 2001-2005 by the Shanxi Environment Information Centre (SEIC) and the Norwegian Institute for Air Research (NILU)
- funded by Shanxi Provincial Government and NORAD.

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Project objectives:

- The air quality of the urban areas should conform to the standard of 2nd grade in 2015
- To build up the modern air quality management system which is applicable for Shanxi Province in Taiyuan, Datong and Yangquan, using the platform of AirQUIS management model.

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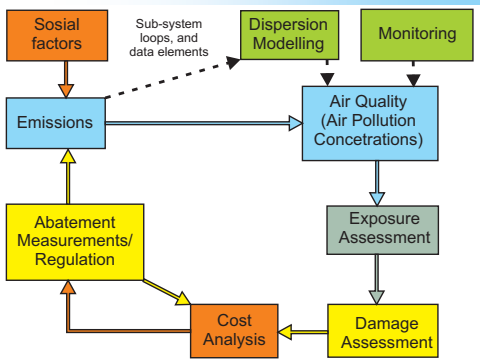
The basic planning tool:



The concept concerning the Air Quality Management System (AQMS)

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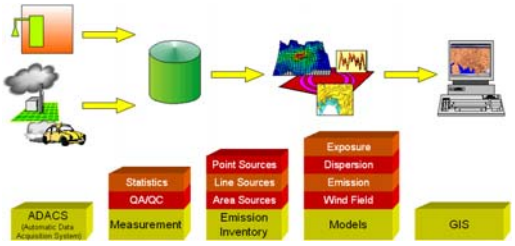
Concept drawing of the contents of modules in the AirQUIS system:



AirQUIS - Air Quality Management and Information System developed by NILU - is a software system with multiple functions to be used in the air pollution management. The system has modules allowing for on-line transmission and collection of data from air quality monitoring for disseminating this information to users via web applications, and for using this information together with data on emissions and dispersion (meteorology) for the effective quantitative analysis of the air pollution situation, contribution from various sources, and of the implementation of pollution control strategies.

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3 cities in Shanxi Province

- The project mainly focus on 3 pilot cities: **Taiyuan, Datong** and **Yangquan**.
- The map shows the Shanxi province and the three selected city administrative areas.

AirQuis Modeling Area in Taiyuan

The AirQuis Modeling Area in Taiyuan, with the model grid system, and location of main point emission sources.

Emission data

- This project investigated 2350 polluting sources (including industrial plants and companies).
- Data were made available for 2775 SO_2-emitting and 3173 TSP-emitting smoke stacks.
- 43% of SO_2-emitting smoke stacks and 75% of the TSP-emitting smoke stacks have cleaning devices.
- The emission inventory shows that in 2000 the total SO_2 emissions from the key industries (polluting sources with stack at or above 30 meters) were 660,694 tons, and TSP emissions were 957,407 tons.

Summary of SO_2 and TSP Emissions in all 11 Cities and Prefectures in Shanxi in 2000

City	SO_2				TSP			
	Emissions (Ton/year)	Number of Polluting Sources in Emission Inventory	Sources with Cleaning Devices	Average Cleaning Efficiency	Emissions (Ton/year)	Number of Polluting Sources in Emission Inventory	Sources with Cleaning Devices	Average Cleaning Efficiency
Taiyuan	144423	247	103	20	103868	221	203	98
Datong	67245	212	33	16	72738	88	73	97
Yangquan	70983	143	53	13	141163	157	130	91
Changzhi	44117	243	116	13	71819	381	196	89
Jincheng	7933	164	143	15	14599	224	200	93
Shouzhou	80703	92	82	15	57753	93	83	91
Xinzhou	23284	103	21	11	35268	85	70	84
Luliang	24728	343	51	10	85715	334	259	90
Jinzhong	40766	435	126	12	44767	367	124	85
Linfeng	75029	407	168	13	197870	639	579	72
Yuncheng	81483	386	308	14	131847	587	476	87
Total	660694	2775	1204	14	957407	3176	2393	89

A strategy for air pollution control

A strategy for air pollution control was developed, based upon costs of control options, and analysis of costs of health effects

Air pollution modelling and projections

A full sequence of calculation of

- air pollution concentrations in km^2 grids based upon the complete emission inventories and collected meteorological data,
- population exposure and evaluation of health effects
- estimation of costs of the control options used in the various scenarios.

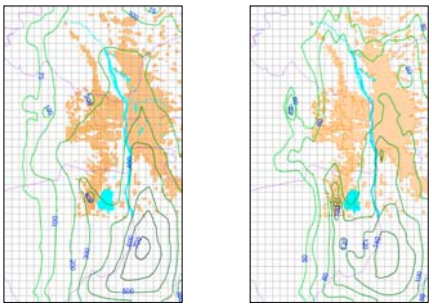
Control scenarios

- Implementation of the state industrial policies, (estimate threshold and plans) production processes.
- Speed up utilization for natural gas.
- Enlarge the area of district heating system with special attention on “villages in the city”.
- Further develop the clean coal technology and increase utilisation.
- Control of dust pollution.
- To improve the efficiency of de-sulphurization and particle control for the boilers within the city area, and enhance the SO_2 emission trading, especially for power plants.

Principal features of AirQUIS

- **Urban Eulerian model (~1 km grid resolution) with embedded subgrid line- and point- source models for near source description**
- **Includes O_3, NO_2, NO_x, PM_{10}, $PM_{2,5}$, wet and dry deposition**
- **MM5 meteorology, 1 km resolution.**
- **Extensively used for urban AQ and policy purposes**
- **More details: http://www.airquis.com**

SO_2 modelling example in Taiyuan:



- The results of modelling of SO_2 for Taiyuan are shown below, for the basecase (2000 situation, *left*) and for the 2015 scenario (*right*), where a full set of control scenarios was implemented.

Cost benefit analysis

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

SO_2

A comparison of cost-benefits of various control options for SO2 in Taiyuan

	Emission Reduction (t)	Concentration reduction (μg/m³)	Cost-benefit ratio	Rank
Natural gas utilization	20400	19.79	-52	2
Desulfuration in power plants	18460	6.47	115	4
Centralized heating	30000	51.89	-424	1
Implementation of productivity policies	9280	5.75	2000	5
Clean coal technology	36600	6.24	-23	3

TSP

A comparison of cost-benefits of various control options for TSP in Taiyuan

	Emission Reduction (t)	Concentration reduction (μg/m³)	Cost-benefit ratio	Rank
Natural gas utilization	31900	16.7	-0.489	2
Centralized heating	69400	90.29	-1.601	1
Implementation of productivity policies	17000	18.57	3.711	5
Clean coal technology	47100	93.13	-0.008	3
Dust control		50	1.813	4

Prioritized control scenarios

According to the cost-benefit analysis, the resulting ranking of the emission control scenarios is

1. centralized heating,
2. natural gas utilization,
3. clean coal technologies,
4. implementation of productivity policies,
5. dust control,
6. improved desulfurization in power plants.

However, the implementation of the state productivity policies is mandatory without preconditions, therefore with the priority over others.

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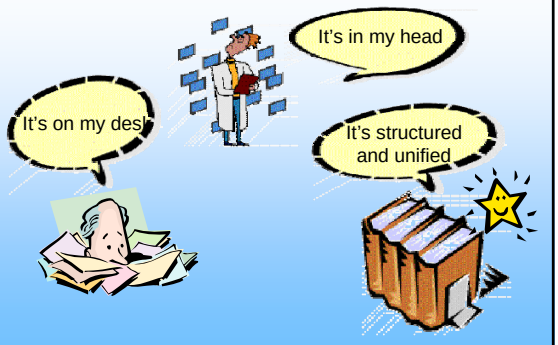
Introduction to Quality Assurance and Quality Control for Air Quality Monitoring

Presentation at seminar at NILU for DONRE/HEPA (HCMC Vietnam)
25 April 2006
Kjersti K. Tørnkvist

Norwegian Institute for Air Research www.nilu.no

The 3 levels of QA/QC



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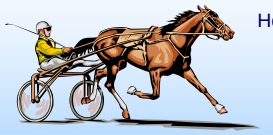
What is quality?

It depends on your needs



Horse racing - Speed

Farming
- Strength

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Fundamental aims of a quality control system for ambient air (1)

A QA/QC system will ensure

- Reliable data for intended use
- Known measurements uncertainty and precision
- Reproducible data
- High data capture
  - To get meaningful seasonally or annually averaged measurements
- Comparable data from different sites and networks
  - Traceable calibrations through an unbroken chain to international standards
- Increased confidence by the public

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Fundamental aims of a quality control system for ambient air (2)

- Have documentation that explains in detail how to perform and document all operations necessary to run, maintain and calibrate the instrumentation both in the laboratory and in the field
- Have a system to ensure traceability

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Why QA/QC systems?

We want information not only numbers

- Operations documented
- Results documented
- Easy training
  - Documentation exists
- Competitive edge

Reliable results with known quality

Elements of the quality system


Quality Organisation


Quality Assurance


Quality Control

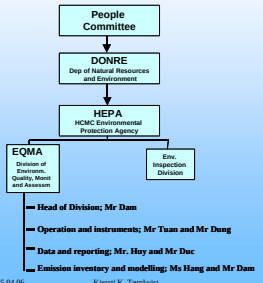

Quality Assessment

Quality Organisation

- Specify a quality organisation
- Specify tasks and responsibilities of the participants in the quality organisation
  - It is essential that the role of the individual participants is well defined AND accepted by all involved

Quality organisation of the DONRE/HEPA Air Quality Monitoring and Management System

Organisation of the DONRE/HEPA Air Quality Monitoring and Management System



Example of different roles and responsibilities (1)

SFT, Department of environment

National reference laboratorium

Other laboratories

Many participants

Network owner
Local authorities,Road administaion

Network operator

Example of different roles and responsibilities (2)

Task	NRL	NO	CAL
Maintaining the quality system	X		
Measurment network design	X		
Selecting instruments		X	
Instrument approval	X		
Selecting monitoring sites		X	
Maintaining monitoring sites		X	
Data validation	X	X	
Calibrating instruments,working gass standards		X	X
Maintaining national reference std.	X		
Providing traceability	X		
Maintaining the central data base	X		
Audits, once a year	X		

NRL: National Reference Laboratory, NO: Network Operator, CAL: Calibration Laboratory

Quality Assurance

All planned and systematic activities which are needed to assure and demonstrate the predefined quality of data

1) Monitoring Objectives
   Determine use of data, e.g. monitoring of trends
2) Data Quality Objectives
   Determine necessary data quality to fulfil the Monitoring Objectives
3) Equipment selection
   Results must fulfil the DQO. Select best measuring practice
4) Site selection
   Must be representative for the Monitoring Objectives

Quality Control

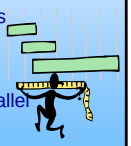
Operational techniques and activities that are undertaken to fulfil the quality requirements

- Calibration and maintenance plan
- Standard Operations Procedures (SOPs)
  - Describe how to perform and document all operations
  - Maintenance, calibration, repairs, data validation, e.t.c.
- All operations are documented in forms
- All forms are stored in files for later reference

Quality Assessment

Determining the actual quality of the data and if the data fulfils the Data Quality Objectives

- Audits
  - **System Audit**: Inspection of QA/QC plan and documents
  - **Performance Audit**: Instrument response is checked at the station using a test standard
- International intercomparisons
  - Instruments measure a test standard in parallel
- Round robin tests
  - A test standard is measured at each laboratory



System audit

- Inspection of QA/QC plan and documents
- Check to see if
  - The quality system is used as supposed
  - Procedures are followed
  - Results are documented and stored
  - Station and instruments are in working order

The Quality Manual

Part 1: Description of the Quality System
- The quality organisation
- Criteria for the individual participants in the quality organisation

Part 2: The Quality Control Manual (Operational level)
- Site specific documentation
- Standard Operations Procedures (SOPs) including schemes to document what is done and observed
- Instrument performance acceptance criteria
- Description of traceability and calibration standards

⇒ Ensure that all operators perform the different tasks in the same manner and that this will be documented

Standard Operations Procedures

SOPs on:
- Quality control at station (weekly)
- Operating instruments
- Data transmition and data validation
- Reporting
- Calibration of gas cylinders and analyzers
- Quality Assessment

Traceability and referances for calibration (1)

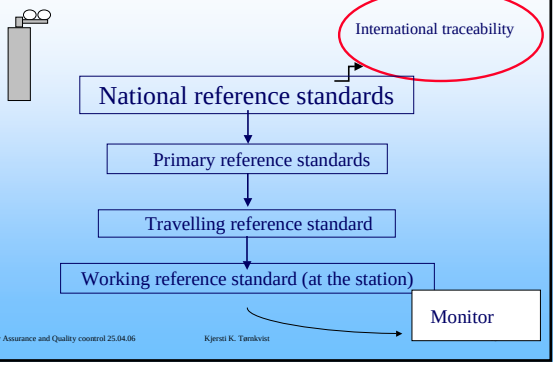
To assure reliable and comparable data ⇒ periodically calibration of the instruments

Not convenient to bring advanced calibration equipment in the field

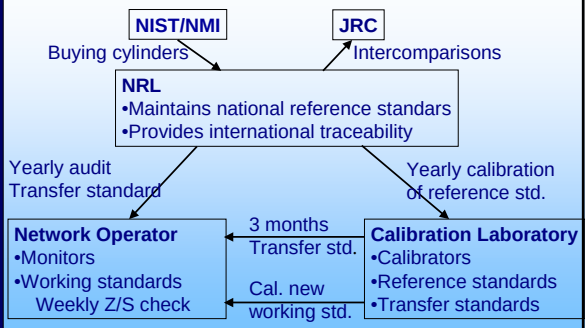
Solution!

Have a system for the calibration and documentation that make it possible to have reference to a calibration standard of high quality without being in direct contact with it.

Chain of traceability



Chain of traceability – Gas monitors

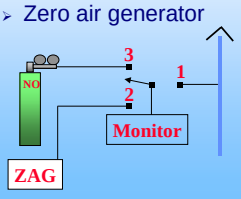


Basic checks and maintenance

- Gas monitors:
  - Weekly zero/span checks
  - Change inlet filters as necessary
- PM monitors:
  - Change filter tape approx. 1 per year
- All:
  - Check status parameters, warnings, alarms
  - Compare parameters with previous checks
  - Look for trends

Zero/span check equipment

- Zero/span checks are performed to:
  - Verify instrument response
  - Calculate scale factors for adjustment of measurement data
- "Normal" concentration gas cylinders
- Zero air generator

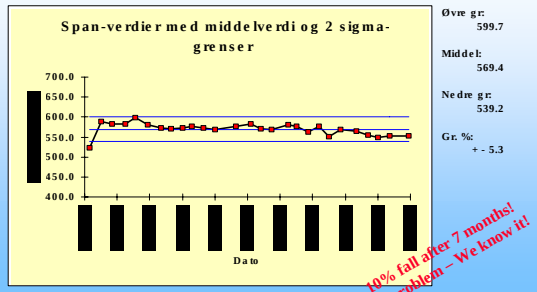


Monitor connected to:
1. Inlet – normal operation
2. ZAG – Check zero level
3. Gas – Check span level

The Necessity for Quality Control

Comparing weekly span checks

Site: 1099 Kirkeveien Comp: NO



10% fall after 7 months!
No problem – We know it!

Maintenance

Valid data requires maintained instruments

- Change consumables regularly
- Clean air inlets and manifolds
- Clean outdoor sensors and inlets
- Check instrument status
- Maintain air condition
- Keep station tidy
- Look at data every day

No instruments will run without problems but periodic maintenance will prevent some of them

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The Reference laboratory
Tasks and Responsibilities

- Develop and maintain a complete quality system for ambient air measurements
- Develop and maintain a system to ensure traceability
- Guide the operators in use of the quality system, where to put the station, what instruments to choose etc.
- Measurement network design
- Perform audits in the monitoring networks
- Maintaining the central data base
- Store and maintain the national gas standards

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Yearly service and calibration at Reflab
Tasks

1. Perform linearity test to document instrument status after measurement period
2. Clean tubes, junctions, reaction cell, e.t.c.
3. Change spare parts
4. Perform two point calibration, adjust zero and span, perform linearity test
5. Calibrate working standard gas cylinder

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Thank you for your attention!

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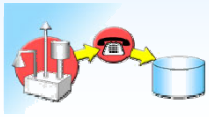
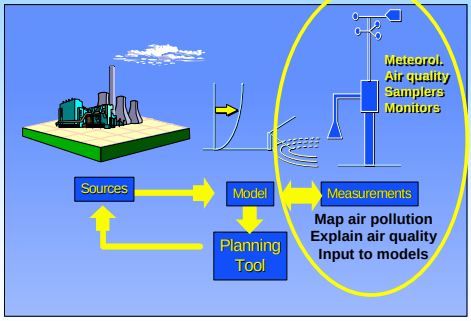
Air Quality Monitoring System Design

Bjarne Sivertsen
Norwegian Institute For Air Research



Air pollution Measurements



The Monitoring Programme Design

- Why do we measure?
- Where should we measure?
- What should we measure?
- How shall we measure?
- How do we store data?
- How do we want to present the results?

Monitoring programme design

Characteristics of ambient air pollution :

- ✓ source mixture (local, area or regional sources)
- ✓ air pollution vary spatially on different scales.
- ✓ annual and diurnal variations
- ✓ depend upon winds
- ✓ avoid random local impacts

Air Quality Monitoring

- ✓ Objectives
- ✓ Site selection
- ✓ Select indicators
- ✓ Limit values and standards
- ✓ Frequency and period
- ✓ Instruments
- ✓ Statistics
- ✓ Compare to meteorology
- ✓ From which sources?
- ✓ Impacts?

Air Pollution Indicators

Not all compound in the atmosphere can be measured !

First priority pollutants

- SO_2 (Sulphur dioxide)
- NO_2 (Nitrogen dioxide)
- PM_{10} (Particles with aerodynamic diameter < 10 micrometer)
- Pb (lead)

HCMC:
PM_{10}, SO_2, NO_2, CO, O_3,

Limit values developed for other indicators:

- Ozone
- Benzene
- CO
- PM $_{2,5}$

AQ Guidelines and standards

Pollutant	Averaging Time	WHO (µg/m^3)	TCVN-2005 (µg/m^3)
SO_2	Annual Avg.	50	50
	24 Hours	125	125
	1 Hour	500 (10min)	-
CO	8 Hours	10 000	10 000
	1 Hour	30 000	30 000
NO_2	Annual Avg.	40	40
	24 Hours	-	-
	1 Hour	200	200
O_3	8 Hours	120	80 *(24 h)*
	1 Hour	-	120
PM10	Annual Avg.	20	50
	24 Hours	50	150
Pb	Annual	0.5	

Monitoring Programme Sequence

1A: Siting, planning and design of the surveillance programmes

1B: Procurement; select, purchase, evaluate and install

1C: Start Monitoring and sampling

1D: Data retrieval, database and presentation

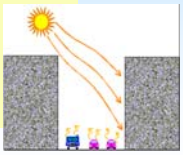
1E: Establish quality (QA/QC) and maintenance procedures

1F: Training in data analyses and data presentation

1G: Internett based on-line presentations to media and public

Where do we locate sites?

- Regional background
  - *3 km < x < 50 km from build up areas*
- City background
  - *in cities*
  - *away from local sources (streets, industries etc.)*
- Traffic impacts
  - *curbside, along streets*
- Industrial pollution
  - *downwind from industries*



Types of Monitoring Stations

Classification system:

Type of area	Description	Type of station
Urban	Continuously built-up area	Traffic Industrial Background : - Near city - Regional - Remote
Suburban	Largely built-up area: continuous settlement of detached buildings mixed with non-urbanized areas	
Rural	Areas that not fulfil the criteria for urban/suburban areas	

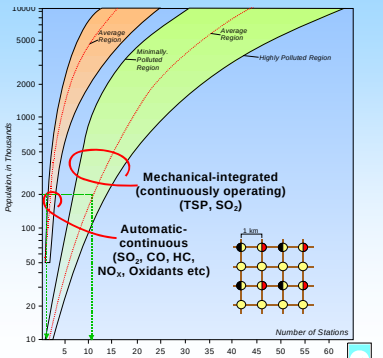
Area of representativity of station classes (typical values)

Station class	Radius of area
Traffic stations	<10-15 m
Industrial stations	10-1000 m
Background stations:	
- Urban background	0,1-1 km
- Near-city backgr.	1 - 10 km
- Regional stations	25-150 km
- Remote stations	200-500 km

Sampling Station Density depends upon several factors:

- types of data needed,
- mean values and averaging times,
- frequency distributions,
- geographical distributions,
- population density and distribution,
- meteorology and climatology of the area,
- topography and size of area,
- location and distribution of industrial areas.

Number of monitoring sites needed in an urban area



Minimum numbers of sampling points for fixed measurement of concentrations of SO_2, NO_2 ,particulate matter and lead in

AMBIENT AIR

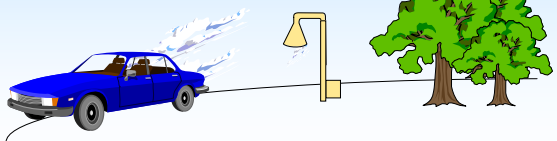
fixed measurement to assess compliance with limit values for the protection of human health and alert thresholds (EU Directives)

urban areas

Population of agglomeration or zone (thousands)	If concentrations exceed the upper assessment threshold	If maximum concentrations are between the upper and lower assessment threshold	For SO_2 and NO_2, in agglomerations where maximum concentrations are below the lower assessment threshold
1000 – 1499	4	2	1
2000 - 2749	6	3	2

Sampler Location

- Same height above ground
- Avoid buildings
- Away from local sources
- Away from vegetation canopies



Sites and Locations

Traffic and road side stations


DOSTE


Thong Nhat


Binh Chanh


Hong Bang

Urban background and residential sites


Zoo, D1


District 2


Tan Son Hoa


Quang Trung

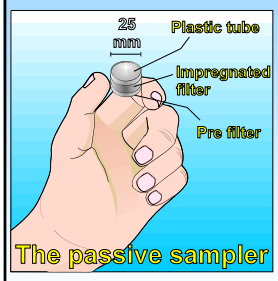

Thu Duc (res/ind)

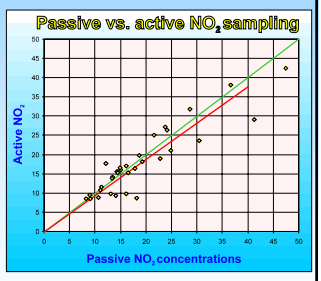
Siting studies

- ✓ Define site locations
- ✓ Evaluate sources and possible impact
- ✓ Perform simple "model estimates"

- Investigate the area
- Select relevant indicators
- Complete report covering
  - Instruments
  - Sites
  - Components

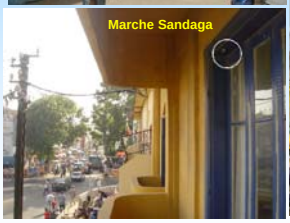
Passive samplers for screening studies



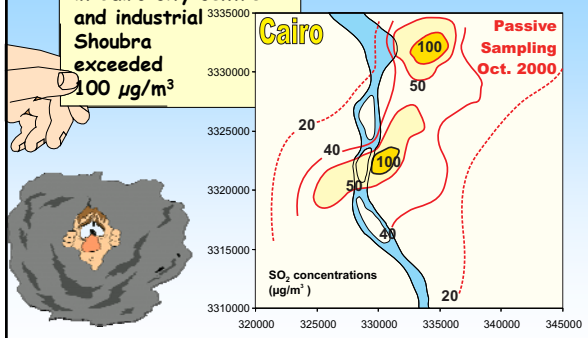


The passive samplers

Sites



SO_2 in Cairo city centre and industrial Shoubra exceeded 100 µg/m³



Instruments

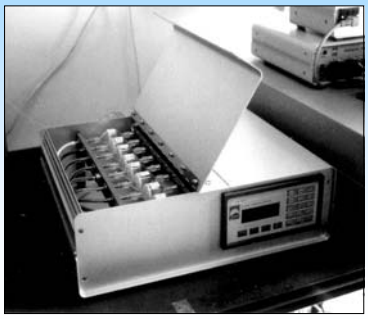
Many kinds:

- Simple passive samplers
- High volume samplers
- Sequential samplers
- Automatic Monitors (in situ)
- Monitors for remote measurements
- Mobile stations
- Automatic weather stations

Different Types of Instruments, Their Abilities and Price

Instrument type	Type of data collected	Data availability	Typical averaging time	Typical price (US $)
Passive sampler	Manual, in situ	After lab analyses	1-30 days	20
Sequential sampler	Manual/ semi-auto, in situ.	After lab analyses	24 h	3000
Monitors	Automatic Continuous, in situ.	Directly, on-line	1h	>15 000
Remote monitoring	Automatic Continuous, path integrated	Directly, on-line	< 1 min	>100 000

Sequential sampler for SO2 and NO2



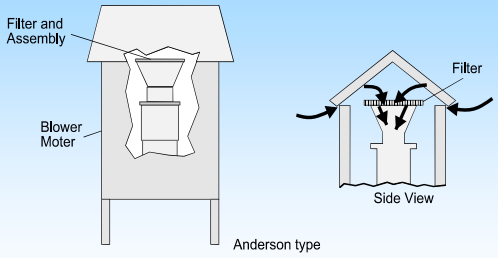
Simple instruments for PM_{10} and $PM_{2,5}$

Minivol sampler

Kleinfilter
SEQ sampler

Dust track

High volume sampler



TSP (total suspended particles) Flow :1-2 m^3/min

PM_{10} with size cut-off hood

Air quality Monitors

SO_2	➡	fluorescent signal exiting SO_2 with UV
NO, NO_2	➡	chemiluminiscent reaction NO/O_3
O_3	➡	UV absorption analyser
CO	➡	non-dispersive infrared photometer

Reference instruments !

PM_{10} : ➡ Measurement on filter tape using the principles of beta attenuation

Before final decisions:

Discuss monitoring objectives

- ✓ Mapping the air quality
- ✓ To judge compliance with ambient air quality standards;
- ✓ To observe pollution trends throughout the region;
- ✓ To evaluate progress made towards meeting standards;
- ✓ To provide a data base for research evaluation of effects;
- ✓ A database for urban, land-use, and transportation planning;
- ✓ Basis for development and evaluation of abatement strategies;
- ✓ Data as input to and development and validation of models;
- ✓ To activate emergency control procedures that prevent or alleviate air pollution episodes.

Objectives
⬇
Requirements
⬇
Permanent network !

Should map:

1. Highest concentrations and hotspots;
2. Representative concentrations in areas of high population density;
3. Impact from significant sources or source categories;
4. General background concentration levels.

All air quality monitoring programmes include

Meteorological measurements

- Wind speed (3-dim)
- Wind direction
- Temperature (two levels)
- Relative humidity
- Precipitation
- Turbulence
- Net radiation
- Pressure

NILU automatic weather station

u_{36}, dd_{36}, T_{36}, $\sigma_{\theta 36}$

36m

$dT_{36\text{-}10}$

$\sigma_\theta = \frac{\sum (DD'-\overline{dd})^2}{N}$

10 m

2 m

T_2, RH_2

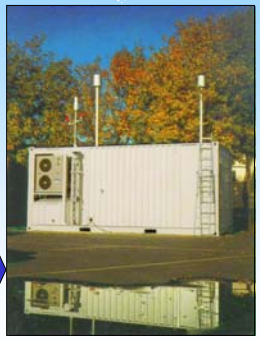
Every 5 min online

Meteorological station at DOSTE

Instrument shelters for complete monitoring

NILU prepare and design complete monitoring programmes for international organisations and authorities

"Containers" developed for Urban areas and for WHO Emergency respons support



A typical monitoring station

QA/QC !

Urban background site in HCMC

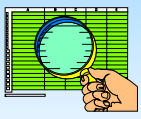
QA/QC system

to assure a predefined quality of all data

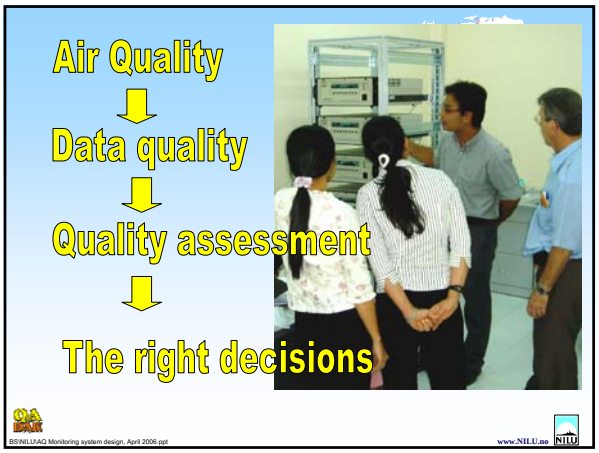
1. Quality Assurance
2. Quality Control
3. Quality Assessment

Define objectives ⇨ Follow-up controls ⇨ Verify Audit

Reference laboratory functions



- ✓ Assure quality and consistency
- ✓ Calibrate all monitors before installed in field
- ✓ Keep standards and distribute standard gases
- ✓ Perform Audits to the monitoring sites
- ✓ International comparisons and tests


Air Quality
Data quality
Quality assessment
The right decisions
BS\NILU\AQ Monitoring system design, April 2006.ppt
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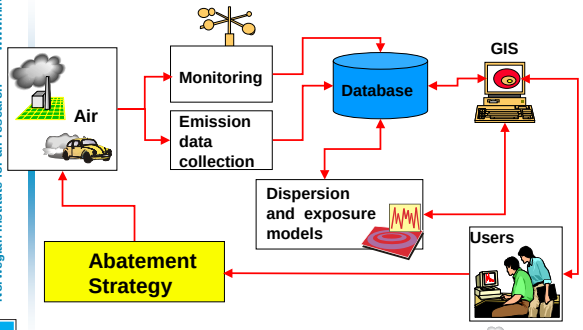
Norwegian institute for air research www.nilu.no

IT-solution for Air Quality Management System AirQUIS in HCMC

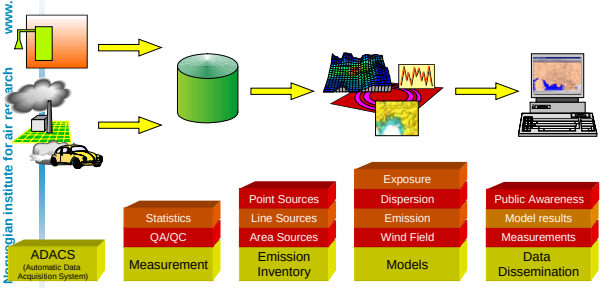
Presented by
Mr. Nguyen Thanh The
Norwegian Institute for Air Research (NILU)

AirQUIS www.airquis.com

The elements of a modern Air Quality Management System (AQMS)



A modern and Integrated Air Quality Management System Developed by NILU



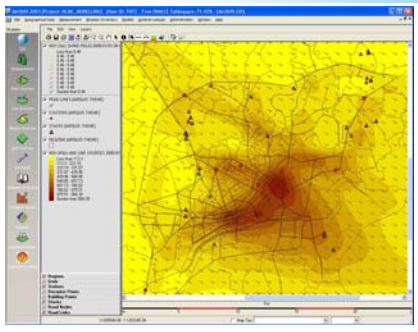
AirQUIS Software Platform

AirQUIS Server
- ✓ Windows Server OS
- ✓ Oracle Database server
- ✓ AirQUIS database

AirQUIS Client
- ✓ Windows XP OS
- ✓ Oracle client
- ✓ AirQUIS application (MS Visual Basic)
- ✓ GIS (ESRI MapObjects)

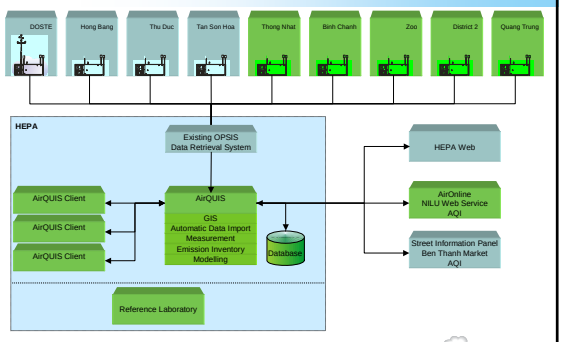
AirQUIS AirOnline (Data Dissemination)
- ✓ Windows Server OS
- ✓ Macromedia MX ColdFusion
- ✓ Macromedia MX Flash
- ✓ Oracle Database server
- ✓ AirQUIS database

.NET Technology

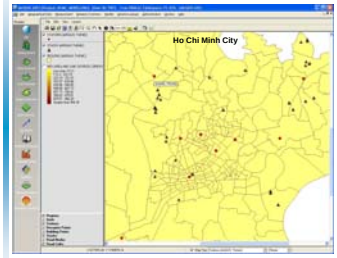


AirQUIS in HCMC

IT-solution



AirQUIS - GIS



- ✓ Geographical Information System (GIS) – Dynamic
- ✓ Import of GIS data by Excel Templates

Customized Data Retrieval Solution

- ✓ OPSIS Data logger and Data Retrieval System by modem – Daily or when needed
- ✓ AirQUIS Automatic Data Import with Basic Quality Control Flag or Manual Import of measurement data by Excel Templates

AirQUIS Measurement

- ✓ Automatic calculation of Air Quality Index (AQI)
- ✓ Final Quality Control of data
- ✓ Statistics
- ✓ Reports

AirQUIS Emission Inventory

Establishment of Emission inventory

- ✓ Emission data from Point, Line and Area Sources
- ✓ Emission Factors

by Excel Templates

AirQUIS Modelling

Perform Dispersion and Exposure Scenario Calculations based on

- ✓ Meteorological Data
- ✓ Measurement Data
- ✓ Emission Data
- ✓ Population Distribution

AirQUIS Data Dissemination - AirOnline

Presentation of Air Quality Data using Internet Platform Powered by NILU

Norwegian institute for air research www.nilu.no

HEPA - AQI on web

www.hepa.gov.no

AirQUIS www.airquis.com

Norwegian institute for air research www.nilu.no

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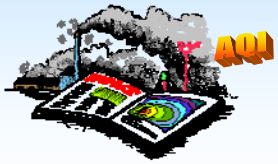
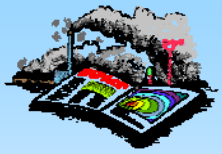
AirQUIS www.airquis.com

AQ reporting and future work

Bjarne Sivertsen, NILU



Reporting requirements



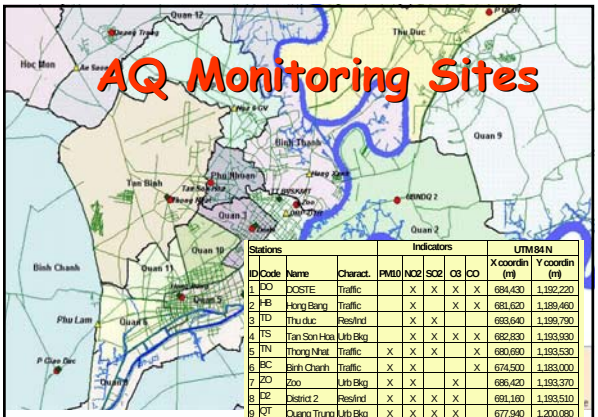
- ✓ Daily (AQI)
- ✓ Weekly (printouts)
- ✓ Monthly (data summary results)
- ✓ (6-months summary?)
- ✓ Annual report (status, assessment)

Monitoring programme operations

- ✓ Data collections
- ✓ Calibrations
- ✓ Data QA/QC
- ✓ Verification
- ✓ Data assessment
- ✓ Data reporting

With good quality data ⇨ Correct decisions

AQ Monitoring Sites

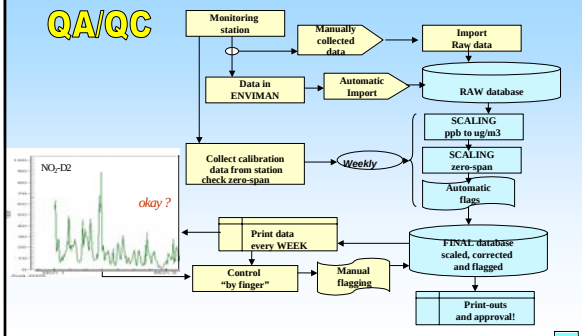


Stations				Indicators					UTM 84 N	
ID	Code	Name	Charact.	PM10	NO2	SO2	O3	CO	X coordin (m)	Y coordin (m)
1	DO	DOSTE	Traffic		X	X	X	X	684,430	1,192,220
2	HB	Hong Bang	Traffic		X		X	X	681,620	1,189,460
3	TD	Thu duc	Res/ind		X	X			693,640	1,199,790
4	TS	Tan Son Hoa	Urb Bkg		X	X	X	X	682,830	1,193,930
5	TN	Thong Nhat	Traffic	X	X	X		X	680,690	1,193,530
6	BC	Binh Chanh	Traffic	X	X			X	674,500	1,183,000
7	ZO	Zoo	Urb Bkg	X	X		X		686,420	1,193,370
8	D2	District 2	Res/ind	X	X	X	X		691,160	1,193,510
9	QT	Quang Trung	Urb Bkg	X	X	X	X		677,940	1,200,080

30 instruments !

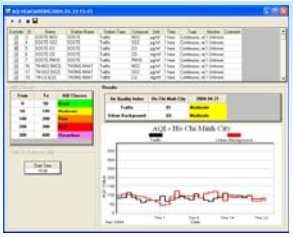
Data flow, scaling and corrections

QA/QC



Air Quality Index (AQI)

- ✓ Generated automatically every day
- ✓ Displayed on board at Benh Thanh
- ✓ Presented daily on Internet



A.Q. Index for HCMC (AQI)

Hourly AQI(h): $AQI(h,j) = Max_h\ (C(h,i,j)/S(h,i))*100$

The daily air quality index will be selected as the higher of the two (hour and day) indexes:

Max((AQI(h,j),AQI(d,j))

Sites:
1 = DOSTE
2 = Hong Bang
3 = Tan Son Hoa
4 = Thu Duc
5 = District 1 Zoo
6 = Quang Trung Software City
7 = District 2 PC
8 = Thong Nat Hospital
9 = Binh Chanh Educ Centre

Traffic:
AQI(traffic) = (AQI(1)+AQI(2)+AQI(8)+AQI(9))/4
Urban/residential:
AQI(urban/residential) = (AQI(3)+AQI(5)+AQI(6))/3

Daily: Air Quality Index (AQI)

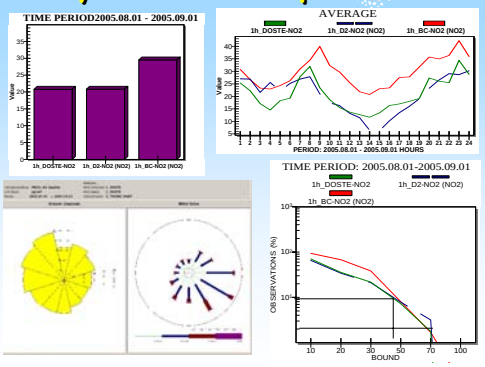
$$AQI = \frac{\text{Pollutant concentration}}{\text{Pollutant limit value}} \times 100$$

The daily index, AQI^d_j, is calculated as:

$AQI^d_j = Max_i(C^d_{i,j} / S^d_i) * 100$

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

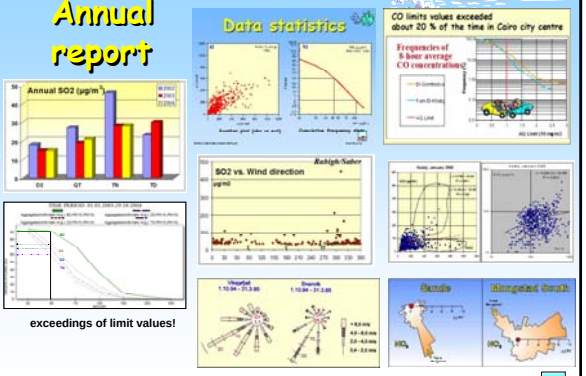
Monthly and annual reports



Annual report

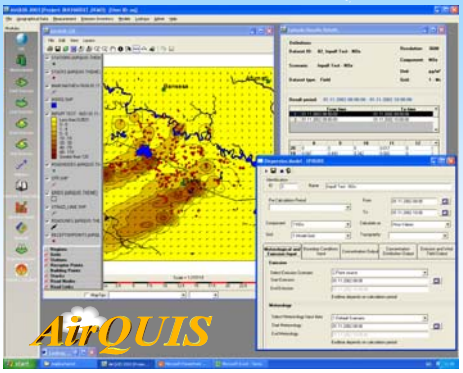
- ✓ Average concentration levels
- ✓ Exceeding of standards
- ✓ Trend analyses; is it better or worse than before?
- ✓ Statistics on Air Quality Index values
- ✓ Air quality versus meteorology, identify adverse meteorological conditions.
- ✓ Major source impact evaluations
- ✓ Discussions on source contributions
- ✓ Estimate of exposures if possible

Annual report



exceedings of limit values!

Modelling with AirQUIS

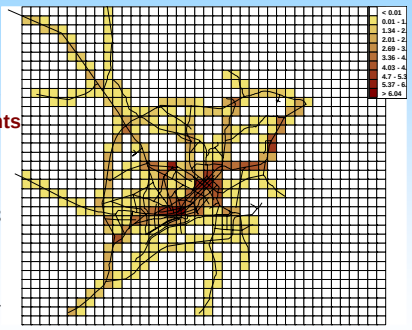


HEPA: Modelling air pollution

Need input data:
- ✓Emissions
- ✓Meteorology
- ✓Measurements

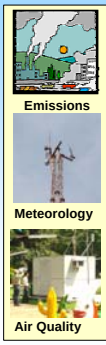
Emission of NOx along 118 roads

- area sources
- point sources
- industries etc.

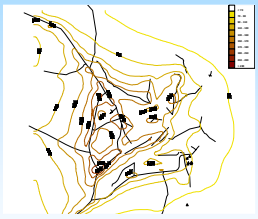


Total = 14 692 tons/yr

Model test and verification



model test verification



Operational dispersion model

Future development and assessments

- ✓ Improve QA/QC procedures
- ✓ Follow-up instrumentation (spares)
- ✓ Complete emission inventories
- ✓ Meteorological data for assessment
- ✓ Test the models for HCMC
- ✓ Perform dispersion modelling
- ✓ AQ assessment and source impacts
- ✓ Prepare reports
- ✓ Prepare abatement plans
- ✓ Information dissemination (Internet)

Modelling

Further work is needed

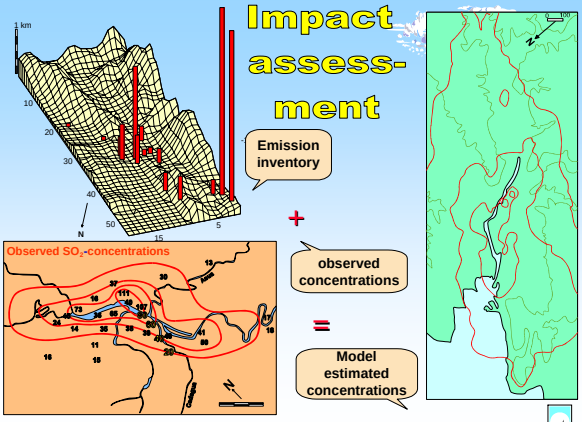
- ✓ Improve input meteorology
- ✓ Stability formulation for HCMC
- ✓ Emission factors for motor bikes in HCMC
- ✓ Complete emission inventory

Air Quality Management

When all data have been verified and the model works for HCMC then HEPA is ready to develop

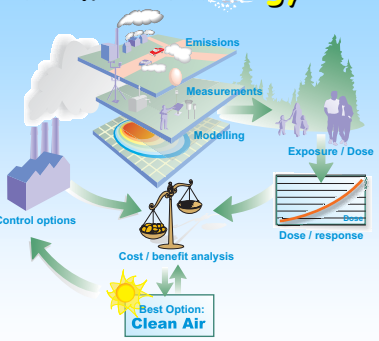
Plans for better Air quality

Impact assess-ment



Optimal Abatement Strategy plan

Identify actions to improve air quality



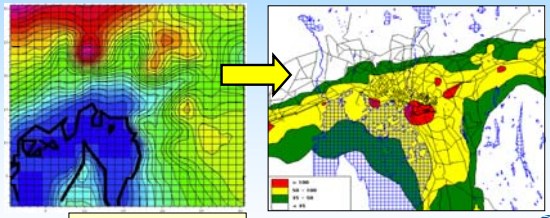
most cost-effective options

Air quality forecast

1. HIRLAM 50 (Atlantic ocean north of 20 deg)
2. HIRLAM 10 (North Western Europe)
3. MM5 (regional scale 3 km res.) (inner city, local 1 km res.)

24 h prognoses - 1,25 hours at CRAY T3E

"Better city air" -



Important parameters:
- Topographical and surface features
- net radiation - surface temperatures
- clouds and snow cover
  Uses NOAA Satellite data

NO_2 ($\mu g/m^3$) 24h forward

DNMI

Air Quality Management Training needs

- ✓ Air Quality Assessment
- ✓ Environmental Damage Assessment
- ✓ Abatement Options Assessment
- ✓ Cost Benefit Analysis or Cost Effectiveness Analysis
- ✓ Abatement Measures
- ✓ Optimum Control Strategy

Training

Summary for future possibilities

- ➢ Air quality assessment and planning
- ➢ Air pollution and health study in HCMC
- ➢ Air pollution cost/effective abatement
- ➢ More information to the public (Internet)

Norwegian Institute for Air Research

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Dissemination and presentation of air quality data

Britt Ann Kåstad Høiskar
NILU

27 April 2006

Such solutions can give

- Information to public
  - Direct AQ-status with health warnings
  - Forecasts/episodes
  - Relevant facts
- Information to non-expert managers
  - Comparisons between cities/areas
  - Overviews towards regulations
  - Trends
- Support tools for AQMS managers
  - Status for network
  - Easy overviews of all latest measurements
  - Advanced messaging systems (SMS, MMS etc.)

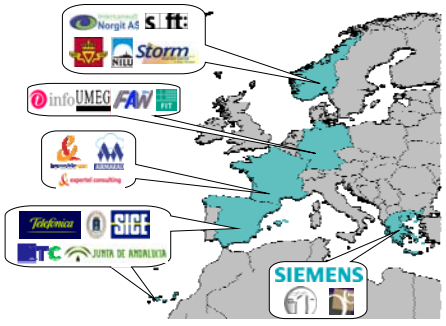
ID&P stages

ID&P = Information Dissemination and Presentation

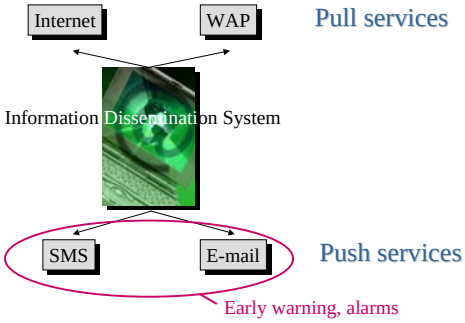
1. ID&P correctly AQ status and forecasts
2. ID&P so that people use the information
3. ID&P with purpose of reducing health impacts
4. ID&P to reduce pollution episodes

Research lessons

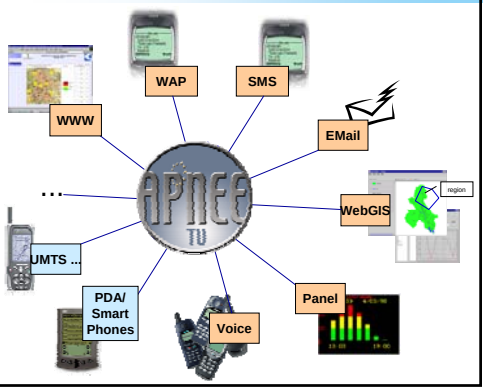
APNEE - Air Pollution Network for Early warning and on-line information Exchange in Europe



Dissemination options



Studies into new options



Objectives APNEE Field trials

- Test and validate the adjusted dissemination solutions, covering
  - all the adapted new technologies
  - fine-tuning of the various contents towards end-users
- This means that we tested all possible ways of giving the public information on air quality they can grasp and understand,
- and evaluated
  - which methods worked best
  - under which conditions it worked or did not work
- Fine-tuning towards efficient information dissemination to citizens
  - They will use the services
  - They will understand Air Quality information
  - They will gain knowledge (as basis for individual actions)

What tested

	France	Germany	Greece	Norway	Spain
Status	X	X	X	X	X
Forecasts	X	X	X	X	X
AQI	X	X	X	X	X
History	X	X		X	X
Statistics				X	X
Articles/Links	X	X	X	X	X
UV		X		X	X
Pollen	X				X

What tested

	France	Germany	Greece	Norway	Spain
Text/No.	X	X	X	X	X
Sound	X				
Colours/Icons	X	X	X	X	X
Maps		X	X	X	X
Graphs		X	X	X	X
Animations		X		X	X
Photos			X		X

What tested

	France	Germany	Greece	Norway	Spain
Internet		X	X	X	X
WAP	X	X	X	X	X
PDA		X	X		X
E-mail			X	X	X
SMS	X	X	X	X	X
MMS				X	X
Voice	X				
St. panels					X

In addition France and Norway tested geolocalization

5 key issues evaluated

1. Extensive use of on-line data
2. Use of forecasts
3. Geographical referenced content
4. Concept of push services
5. Use of new dissemination techniques

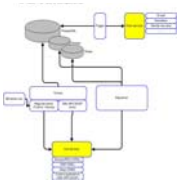
Technical implications
Content implications
Evaluation based on end-user feedback

Extensive use of on-line data

Norwegian institute for air research www.nilu.no

Technical needs

- Professional databases
- Powerful processing
- Automatic QA/QC
- Efficient data exchange



Content needs

- Health related information
- Understandable effect descriptions for non-experts for all data

Pollution level
- Little
- Some
- A lot
- Very much

Extensive use of on-line data

Norwegian institute for air research www.nilu.no

End-user feedback

- Very positive responses to AQI's
- Visualisations well received

Conclusions

- Use of on-line data on air quality is really important in order to enhance the understanding and knowledge of air quality.
- It is technically possible to build efficient, stable and advanced dissemination systems using on-line data
- It is possible to make the end results useful and interesting for the general public as well as expert users.

Use of forecasts

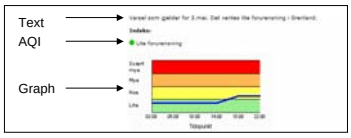
Norwegian institute for air research www.nilu.no

Technical needs

- Air Quality Management System or Modelling solution as basis
- Powerful processing
- Efficient data exchange

Content needs

- Many different visualisations possible

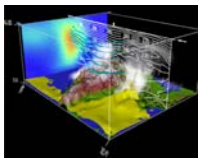


Use of forecasts

Norwegian institute for air research www.nilu.no

End-user feedback

- The most appreciated function
  - Especially for allergic people



Conclusions

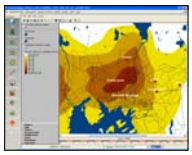
- Forecasts are the most interesting piece of information on air quality in urban areas for the general user in Europe.
- Forecasts have been proven to be made by many different technical set ups
- Forecasts can be disseminated effectively in many different ways, which are all useful for the end-users.

Geographical referenced content

Norwegian institute for air research www.nilu.no

Technical needs

- Modelling system as basis
- Mapping tool
- Pull solution suitable



Content needs

- Maps
- Geographical areas for subscription
- Good Geo-ID database

Geographical referenced content

Norwegian institute for air research www.nilu.no

End-user feedback

- Simple maps/location services well received
- Some interest in more advanced map use
- Experts more interested

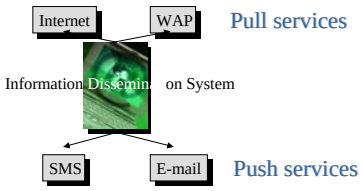
Conclusions

- It is feasible to make advanced use of geo-referenced content for the various dissemination techniques
- Expert user might get an extra value of the services when they have interactive maps
- It is questionable value for the general public from interactive maps

Concept of push services

Technical needs
- Many triggers and logs
- Subscription modules

Content needs
- Nothing in particular
- Adjusted to service



Concept of push services

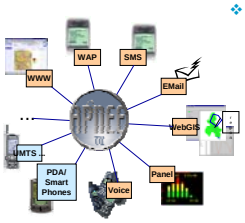
End-user feedback
- Very well received
- Keep it simple
- Only when peak episodes

Conclusions
- Push services is a very efficient add-on information distribution channel and works very well towards specific interest groups of the population (like people sensitive to air pollution).
- The push techniques have proven to be working well and the concept is very well received for those likely to be interesting in such services.

Use of new dissemination techniques

Technical needs
- Many possible set-ups
- Rather easy if data generating is working

Content needs
- Very different content suitable for different techniques
- Simple text and colours always work, and often enough



Use of new dissemination techniques

End-user feedback
- Very positive to the different solutions tested
- SMS the clearly preferred solution

Conclusions
- The new electronic dissemination techniques are very suitable for disseminate and present air quality information.
- For **pull techniques, Internet** is the necessary solution while WAP can be of interest in some countries.
- For **push services, SMS** is clearly the preferred solution.
- The interest in receiving information through such services varies greatly among users in the different countries.

Conclusion

- New techniques enhances information effect
  - Internet, SMS + e-mail good pull/push combination
  - MMS in some years time – too expensive now
  - Variations between countries
- On-line data needs to be max 1-2 hours old
- Georeferenced data might be positive
  - Interactive maps only for experts
- Forecasts the most valuable content
- Simple text and colour symbols always work

"Planned" next steps in Norway

Next plans in Norway

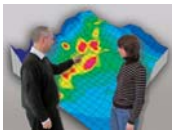
- Goals: People use the solution and health impacts reduced
  - Use regularly
  - Used by effected people
  - Helps avoiding exposure
- Key: personalised information
  - My web (combined weather)
    - Personalised selected information
    - Public transport facts
    - Area specific facts
  - Subscriptions e-mail, SMS, for free
- New dissemination features:
  - MMS
  - Geo-localisation
  - Information kiosks

Next levels

Research ideas for Personalised ID&P:

- Combine with legal regulations, car numbers, car types
- Combining with reduced public transport cost
- Combined with car specific data recording
- Combined with pricing, based on car type, persons in car, roads travel and pollution status
- Free SMS/MMS as health care

.



ID&P stages

ID&P = Information Dissemination and Presentation

1. ID&P correctly AQ status and forecasts
2. ID&P so that people use the information
3. ID&P with purpose of reducing health impacts
4. ID&P to reduce pollution episodes

New global dissemination solution

www.nilu.no

Currently running in

- **Durban, South Africa**
- **Ho Chi Mihn City, Vietnam**

New solution for Cyprus

In operation within a few weeks

Overview of Internet solutions developed by NILU

Norwegian institute for air research www.nilu.no

- Norway:
  http://www.luftkvalitet.info
- Durban, South Africa:
  http://www2.nilu.no/AirQuality/Durban/
- Ho Chi Mihn City, Vietnam
  http://www2.nilu.no/AirQuality/HCMC/
- Haifa, Israel
  http://www.aironline.info/haifa
- Cyprus (to be opened in May 2006)
  www.airquality.gov.cy

Contact information:

Senio Scientist

Britt Ann Kåstad Høiskar
bak@nilu.no,
☎: +47 63 89 81 79

www.nilu.no

NILU software solutions

Geir Endregard
NILU

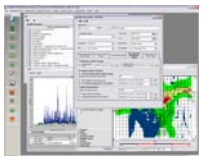
27 April 2006

www.nilu.no

NILU's ICT solutions

Norwegian Institute for Air Research www.nilu.no

- Database solutions
- Scientific coordination
- Management tools
- Education



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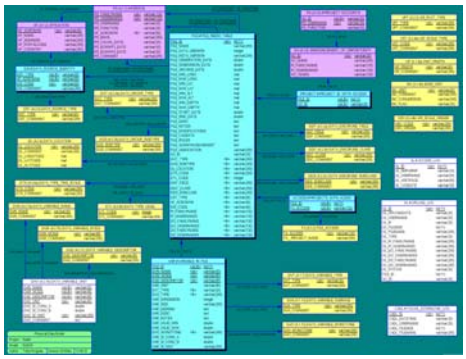

Coordinating scientific work

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Profiling projects



Information dissemination




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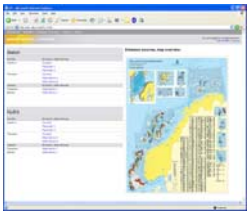
NILU NIVA NINA STATOIL



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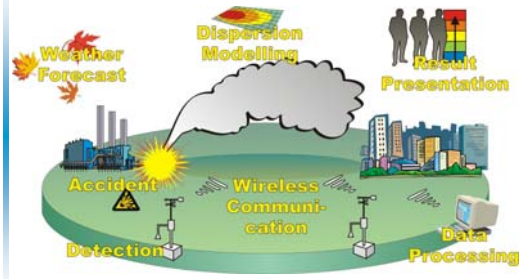
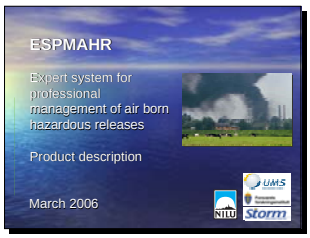


Risk management software

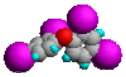


Education

www.nilu.no

The United Nations decade of education for sustainable development

The Arctic POPs project



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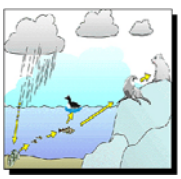

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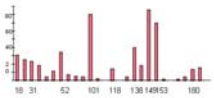

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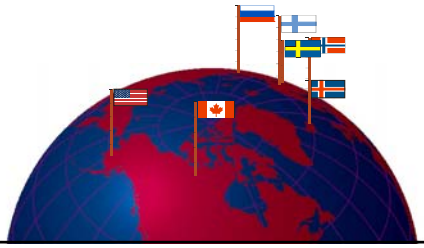
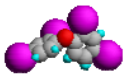


POPs investigated

- **Brominated flame retardants**
  (PBDE 47= 2,2',4,4'-tetrabromdiphenylether)



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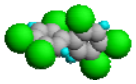

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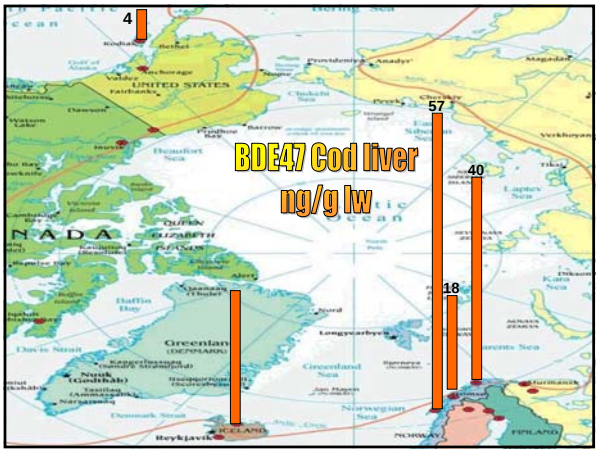
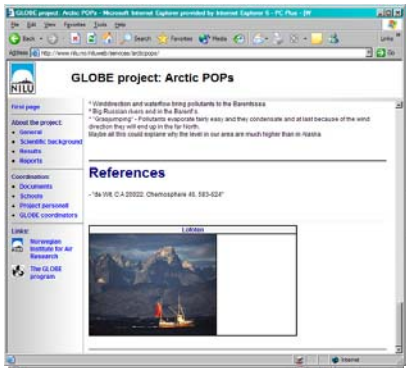


School results

Tendency :

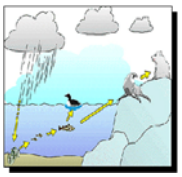
- European Arctic > American/Canadian Arctic
- Confirm other results in AMAP
  - Wind direction differences, river outlets,
  - Distance form source, different food webs (diets) etc.
- Our PCB153 and PBDE47 data for cod are in agreement with JAMP monitoring studies in Norway. Burbot and salmon are comparable with some data but much lower compared to lakes near local sources for pollution (Mjøsa, Lake Michigan)

The students made scientific reports



Arctic POPs project conclusions

- *Successful as an education program* – but very few schools involved
- *Contributed to the documentation* of new POPs in the Arctic, useful scientific results
- *Project execution worked rather well* but the project required quite much work, yearly workshops and follow up-systems
- *Costly as education program*, but not as research program



NILU want this because

- Schools can efficiently contribute to real science
- Students enhance their learning by hands on real work
- International collaboration enhances learning
- Such projects helps recruitment to higher education in natural science

Norwegian educational solutions

NILU
P.O Box 100
NO-2027 Kjeller
NORWAY

Phone: +47-63 89 80 00
Fax: +47-63 89 80 50

e-mail: nilu@nilu.no
Internet: www.nilu.no

Geir Endregard,
Innovation and Marketing Director
E-mail: gen@nilu.no,
☎: +47 63 89 81 10
☎: +47 958 46 220 (mobile)

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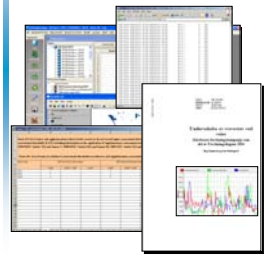
The AirQUIS productline

AirQUIS Reporting



This product ensures professional reporting to national and international bodies.

Either by utilisation of standard templates consistent with US-EPA, EU, EMEP, Airbase etc reporting requirements or options to set up different custom reports for client specific needs.

AirQUIS

NILU software solutions

Geir Endregard
NILU

27 April 2006

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NILU's ICT solutions

Norwegian Institute for Air Research www.nilu.no

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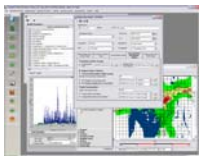

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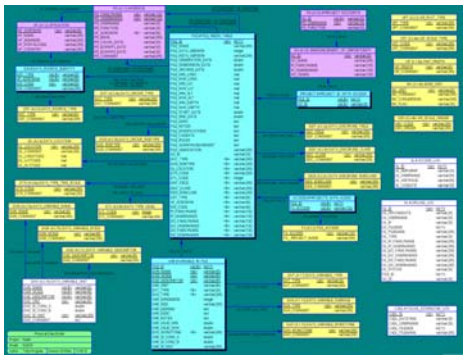

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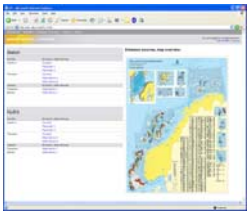
NILU NIVA NINA STATOIL



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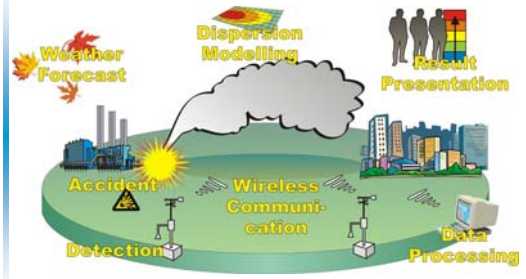

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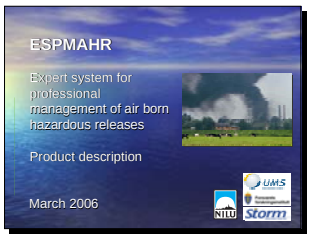

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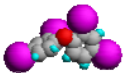

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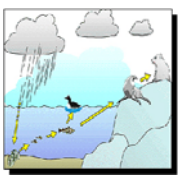

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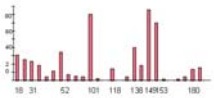

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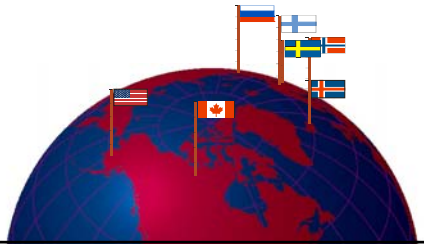

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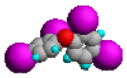

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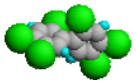

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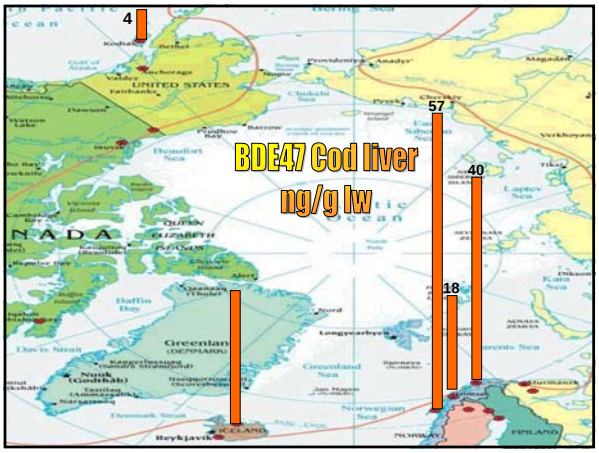

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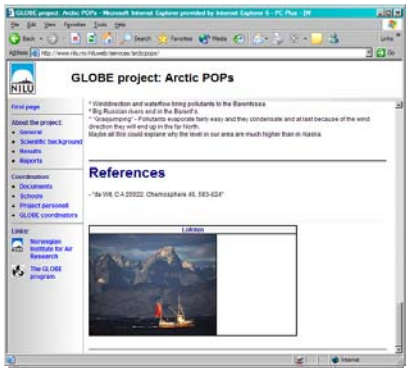
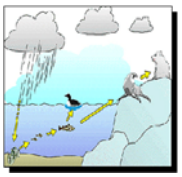
- European Arctic > American/Canadian Arctic
- Confirm other results in AMAP
  - Wind direction differences, river outlets,
  - Distance form source, different food webs (diets) etc.
- Our PCB153 and PBDE47 data for cod are in agreement with JAMP monitoring studies in Norway. Burbot and salmon are comparable with some data but much lower compared to lakes near local sources for pollution (Mjøsa, Lake Michigan)

The students made scientific reports



Arctic POPs project conclusions

- *Successful as an education program* – but very few schools involved
- *Contributed to the documentation* of new POPs in the Arctic, useful scientific results
- *Project execution worked rather well* but the project required quite much work, yearly workshops and follow up-systems
- *Costly as education program*, but not as research program



NILU want this because

- Schools can efficiently contribute to real science
- Students enhance their learning by hands on real work
- International collaboration enhances learning
- Such projects helps recruitment to higher education in natural science

Norwegian educational solutions

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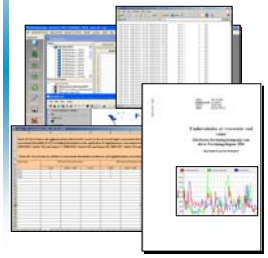
www.nilu.no

The AirQUIS productline

AirQUIS Reporting



This product ensures professional reporting to national and international bodies.

Either by utilisation of standard templates consistent with US-EPA, EU, EMEP, Airbase etc reporting requirements or options to set up different custom reports for client specific needs.

AirQUIS

MILJOLARE.NO
ET VERKTØY FOR BÆREKRAFTIG UTVIKLING

A support system for Education for Sustainable Development

Norwegian directorate for education and training

www.miljolare.no

Pupils/students must learn

www.miljolare.no

- Basic factual understanding of
  - Environmental issues
  - Economy
  - Social issues
- To observe the environment and society
- To analyse facts and figures
- To combine different parameters and disciplines in the evaluation
- To discuss and "conclude"

Directorate for Primary and Secondary Education

Field, classrom and computer work

www.miljolare.no

- Hands on training in the field
- Working with results in classroom
- All material, entering of data and working with data, available trough the Internett

Directorate for Primary and Secondary Education

Who is making this?

www.miljolare.no

- Departments:
  - Ministry of education and research
  - Ministry of environment
  - + 7 other ministries
- Executing responsibility:

Norwegian directorate for education and training

- Internet solution and editorial work:
  - University Bergen
  - Norwegian institute for Air Research
- Scientific advisors
  - Directorates
  - Scientific institutions

Directorate for Primary and Secondary Education

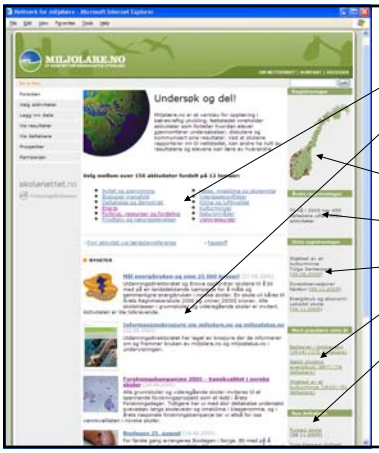
More than 150 activities

www.miljolare.no

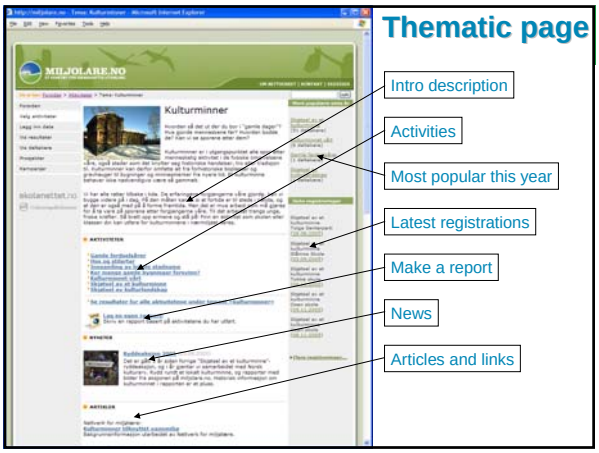
1. Biodiversity
2. Climate and air quality
3. Consumption and production patterns
4. Conflicts of interest
5. Cultural heritage
6. Energy
7. Health, inndoor climate and school environment
8. Land management
9. Outdoor life and nature experiences
10. Participation and democracy
11. Waste and toxic chemicals
12. Water resources

Directorate for Primary and Secondary Education

First page



- The 12 thematic issues
- News
- Overview of registrations
- Registrations this year
- Latest registrations
- Most popular this year
- New participants

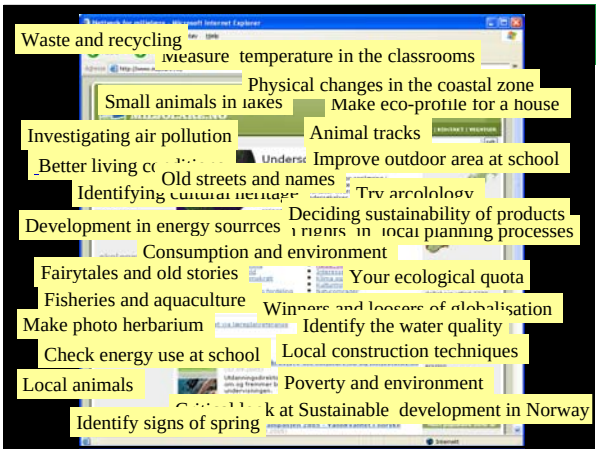


Activities

www.miljolare.no

- Purpose/objective
  - What should be learned
- Learning by doing – field work
  - Outdoor
  - At school
  - Different methodologies
- Working with observations – classrom work
  - Own observations/ measurements/investigations
  - Other students/schools data

Directorate for Primary and Secondary Education



Check a product from raw material to waste

www.miljolare.no

Purpose/Objective:
- Basic knowledge on the term sustainable development
- Study sustainability concepts for products
- Create students own understanding of their role as consumers in sustainable development

Learning by doing – the field work
- Identify product, collect a product from home/store
- Evaluate products based on questions given

Working with observations – classroom work
- Describe the sustainable aspects of the product, environment, social, economic
- Give total score
- Compare evaluation and scores with others results

Directorate for Primary and Secondary Education

When comes spring?

www.miljolare.no

Purpose/Objective:
- Learn about seasonal variations in nature
- Learn about local plants and animals
- Learn about meteorological observations

Learning by doing – the field work
- Observe daily blooming of birch
- Look for arrival of "Linerle"
- Extend to other species

Working with observations – classroom work
- Register all the findings
- Discuss the findings for this year
- Compare findings and scores with others results
- Evaluate yearly difference and/or area differences in Norway

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Check energy use at school

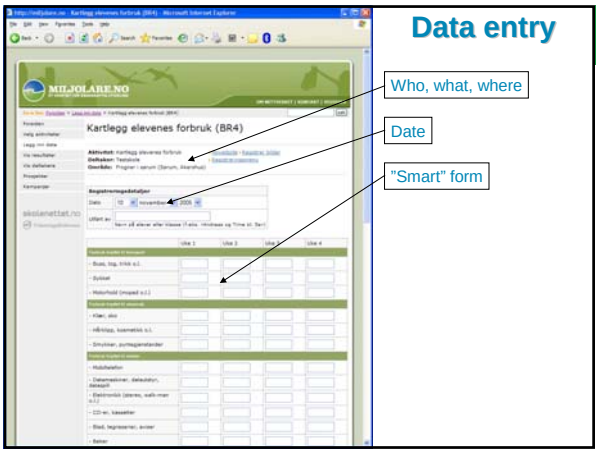
www.miljolare.no

Purpose/Objective:
- Learn definitions of energy, energy quality, fossil and renewable energy
- Study the energy use at school and find the energy sources
- Identify means to reduce energy use
- Knowledge of environmental impact of energy use

Learning by doing – the field work
- Measure the energy use (and outdoor temp) at school – weekly
- Plot data in graphs/tables

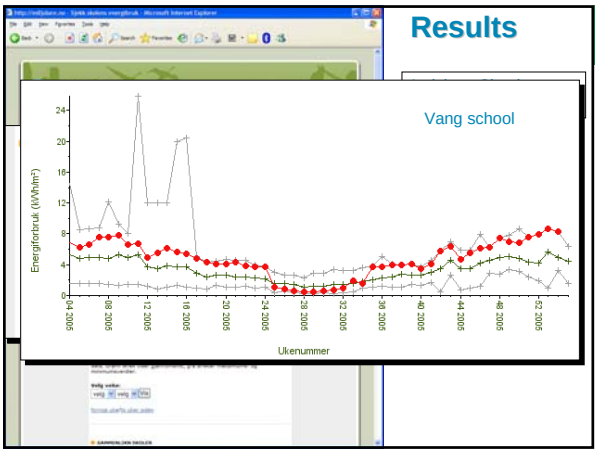
Working with observations – classroom work
- Study energy use patterns during the year – relative to temp/activity
- Find factors that decides the use of energy at the school
- Find examples on new renewable energy use that can be used at the school
- Compare energy use in different schools – why is there difference?
- Make plan for reduce energy at the school – test and verify

Directorate for Primary and Secondary Education

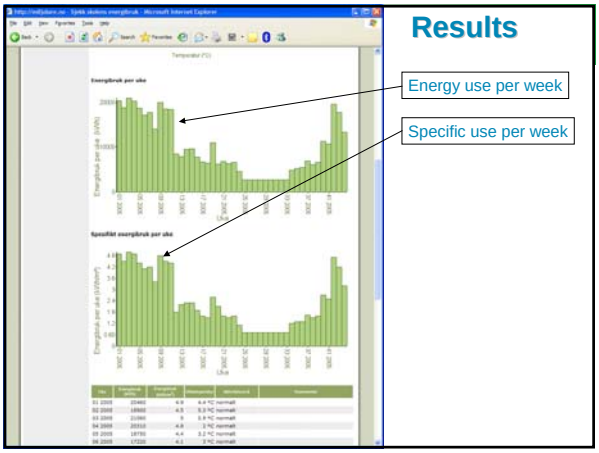


Data entry

- Who, what, where
- Date
- ”Smart” form

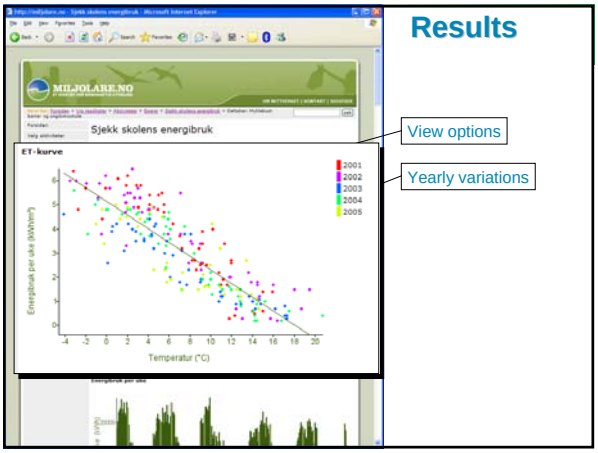


Results



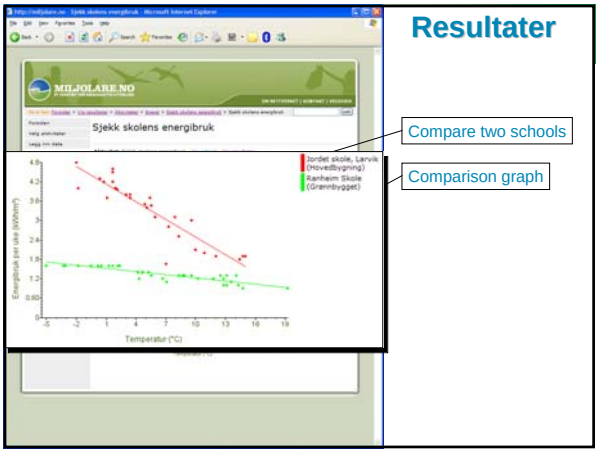
Results

- Energy use per week
- Specific use per week



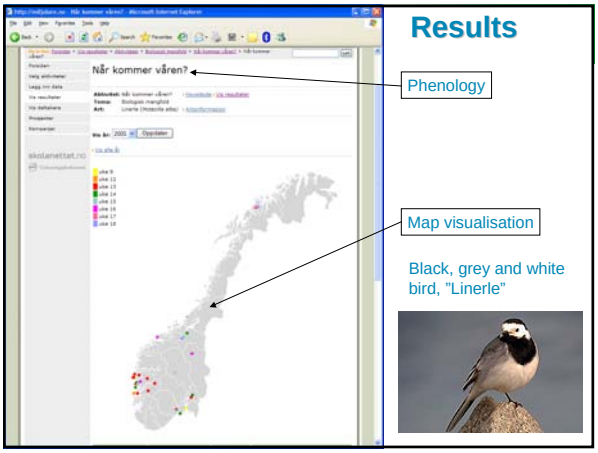
Results

- View options
- Yearly variations



Resultater

- Compare two schools
- Comparison graph

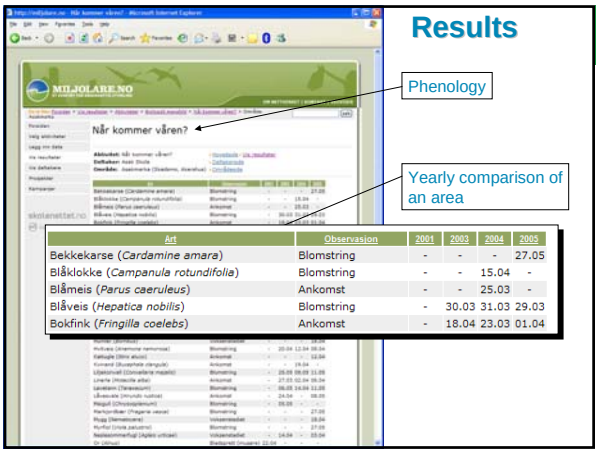


Results

- Phenology
- Map visualisation

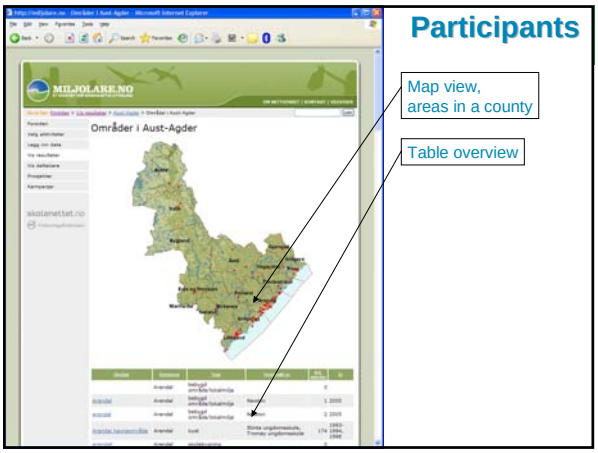
Black, grey and white bird, ”Linerle”

Results



Art	Observasjon	2001	2003	2004	2005
Bekkekarse (*Cardamine amara*)	Blomstring	-	-	-	27.05
Blåklokke (*Campanula rotundifolia*)	Blomstring	-	-	15.04	-
Blåmeis (*Parus caeruleus*)	Ankomst	-	-	25.03	-
Blåveis (*Hepatica nobilis*)	Blomstring	-	30.03	31.03	29.03
Bokfink (*Fringilla coelebs*)	Ankomst	-	18.04	23.03	01.04

Participants



Use in education

www.miljolare.no

Topics:

- Natural science
  - Physics
  - Chemistry
  - Biology
  - Environment
- Mathematics
- Social science
- Geografi
- Languages

IKT-educational tools

- Learning to use Internet
- Learning to use Interactive solutions
- Learning database principles

Working with projects

- Many activities
- Database of all results
- Reporting tool

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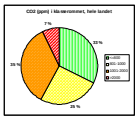
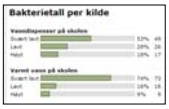
Campaign examples

www.miljolare.no

- Investigation of CO_2 in Norwegian classrooms
- Dust in air along school roads
- Bakteria in school water

150 – 700 schools





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Schoole as resource

www.miljolare.no

Municipality projects examples:

- Investigating watersheed in Bergen
- Investigating indoor climate at Ringerike
- Investigate childrens wherabouts locally in Oslo

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Lessons learned 1

www.miljolare.no

- Pupils experience that they are able to contribute something useful to society. They do “real work” and produce high-quality results.
- Impressive concrete results can be achieved when many schools join together
- Better learning and working environment when the school leadership, maintenance people, teachers and pupils co-operate.

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Lessons learned 2

www.miljolare.no

- The Network gives legitimacy to interdisciplinary, action-oriented teaching methods. Teachers and schools receive the support they need for these learning approaches.
- Co-operation with "heavy" ministries and research/scientific institutions lends credibility to the school's work.
- The network creates win-win situations between the schools and other parts of the society

Directorate for Primary and Secondary Education

www.miljolare.no/www.sustain.no

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www.miljolare.no

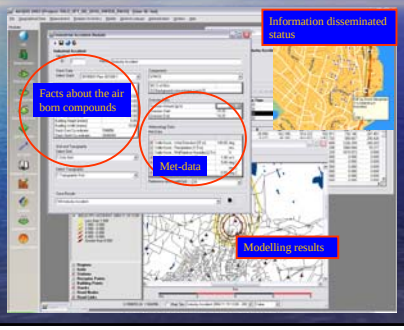
ESPMAHR

Expert system for professional management of air born hazardous releases

Product description

March 2006

Integrated interface



Areas of use

- Releases of outdoor air born hazardous compounds from
  - Accidents in industry
  - Accidents in transport sector
  - Terrorist triggered releases, wherever
- Suitable for
  - Industrial sites
  - Urban areas
  - Transport routes

Planned use

- During actual crisis
- Training and scenario simulation with first responders
- Evaluation and design of evacuation plans

Concept – enhancing existing systems

Existing	Espmahr
Crisis management software	Espmahr integrated software
Meteorology measurements	Weather on demand
Emission modelling	Advanced 3D modelling
Compounds information	Compounds facts database
Information dissemination solution	Area specific information solution

ESPMAHR core idea

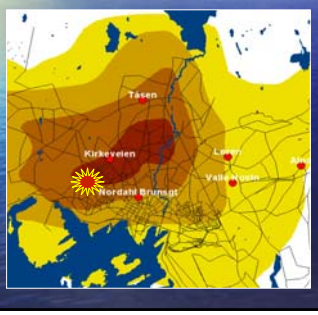
*ESPMAHR is **an add on** to existing solutions.*

*An add on that **enhances** existing solutions and provides better factual knowledge for decision making and better information dissemination solutions*

Information dissemination solution

Area specific information solution

Urban application



Input:
- Detailed weather status + forecasts
- Facts about source and release chemicals

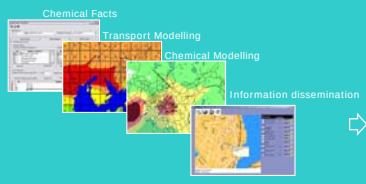
Output:
- Dispersion model results
- Population exposure results

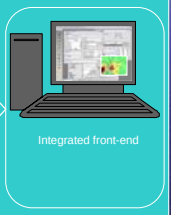
Integrated use:
- Informing people in different areas
- Evacuation support

Industry application

After: 8 hours

Risk Management Control System





Integrated front-end

Chemical Facts → Models → Planning / Evacuation

Risk Management Support System

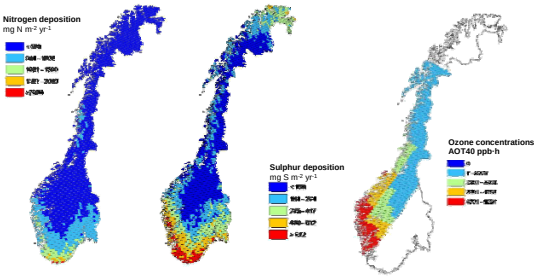
ESPMAHR

EIF-Air

Environmental Impact Factor for assessment of emissions to air

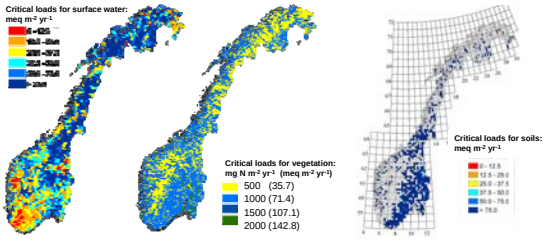
- Tool to find the environmentally best options for emission reductions
- Current policy
  - Total reduction per company/sector/…
  - Cost-effectiveness
- EIF-Air:
  - optimizing emission reductions at single installations
  - prioritizing between measures at different installations in different geographical areas
  - prioritizing between measures to reduce emissions to air and discharges to sea

Total deposition

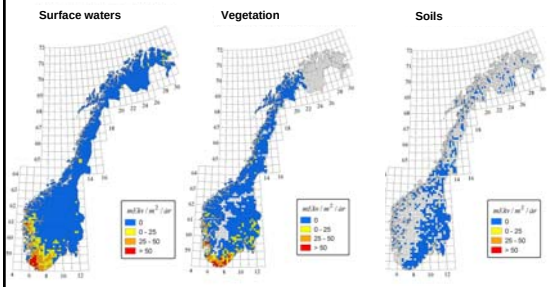


Source: Hole and Tørseth, 2002; Solberg, 2002

Critical loads



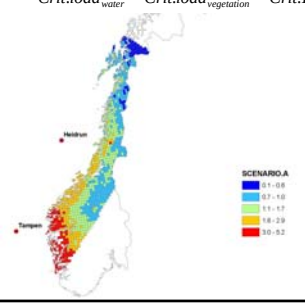
Exceedance of critical loads



Source: Larssen and Høgåsen, 2003

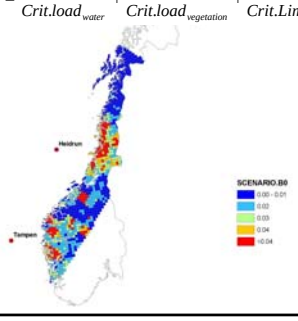
Integration of the different impacts under the current deposition: Exceedances of the critical loads and levels

$$GridCellValue_i = \frac{Tot.dep_{S+N}}{Crit.load_{water}} + \frac{Tot.dep_N}{Crit.load_{vegetation}} + \frac{Tot.conc_{O_3}}{Crit.Limit_{AOT\,40}} + \frac{Tot.dep_{S+N}}{Crit.load_{soil}}$$



Integration of the different impacts from the emission to be evaluated: Exceedances of the critical loads and levels

$$GridCellValue_i = \frac{Additnl.dep_N}{Crit.load_{water}} + \frac{Additnl.dep_N}{Crit.load_{vegetation}} + \frac{Additnl.conc_{O_3}}{Crit.Limit_{AOT\,40}} + \frac{Additnl.dep_N}{Crit.load_{soil}}$$



SUSTAIN.NO

An international support system for Education for Sustainable Development

Directorate for Primary and Secondary Education

www.sustain.no

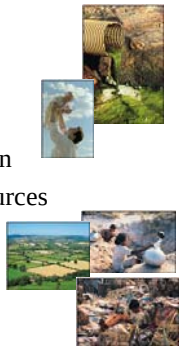
Builds on Norwegian web solution

www.sustain.no

Good mixture of thematic issues?

www.sustain.no

- Biological diversity
- Climate and air quality
- Consumption and resources
- Democracy and participation
- Energy and renewable resources
- Water issues



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Easy activity structure

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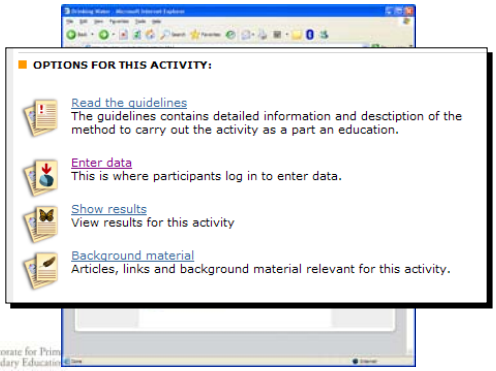
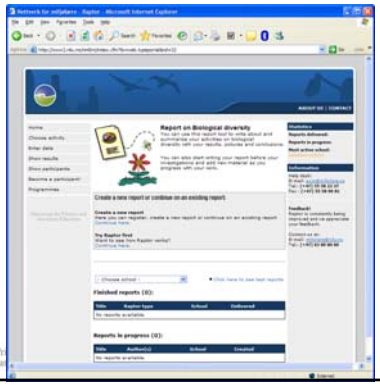


Reporting tool on each issue

www.sustain.no



Reporting tool on each issue

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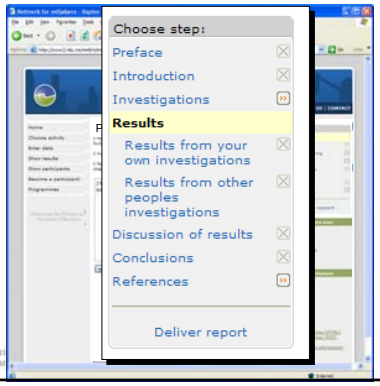
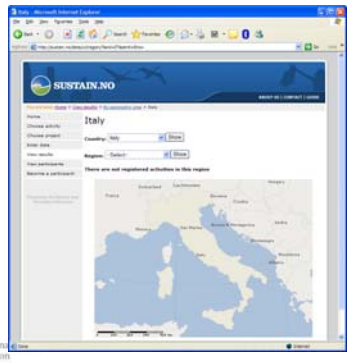


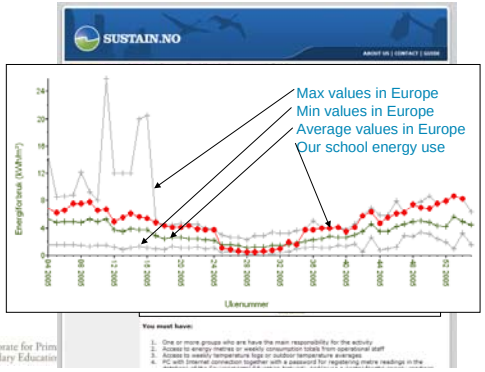
Mapping tool for data navigation

www.sustain.no



What is the international aspects

www.sustain.no



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NILU in media, information and public awareness

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Norwegian Institute for Air Research www.nilu.no

Good communications is essential in order to succeed with our:

Objectives
Our vision
Our national responsibility

Norwegian Institute for Air Research www.nilu.no

Good communications ensure NILU´s economy through:

New assignments from Norwegian, European and global companies.

Securing existing and even increasing funding from Norwegian/European/Global authorities

Norwegian Institute for Air Research www.nilu.no

Good communications ensure NILU´s future through:

Attracting new employees
Motivating existing employees

Norwegian Institute for Air Research www.nilu.no

What is good communications?

Ensuring that ”everyone” knows about the work NILU is doing, the quality of our work, and that they know what we can do for them.

Norwegian Institute for Air Research www.nilu.no

Communication channels:

Scientific publications (NILU scientists)
Assignment reports (NILU scientists)

Lobbying (towards authorities/politicians)

NILU newspaper (external and internal)
Internett
Internal internett (for employees)
Brochures
Annual report
Media

Norwegian Institute for Air Research www.nilu.no

The best way to present NILU to the outside world is through:

Media
(Nobody presents stories better)

For more information

www.nilu.no

www.nilu.no

Norwegian Institute for Air Research (NILU)

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Presentations from the seminars at NILU	NILU PROJECT NO. O-101143
AUTHOR(S) Edited by Bjarne Sivertsen e	CLASSIFICATION * A
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ABSTRACT
This report contains a collection of presentations given by NILU experts to three directors from Ho Chi Minh City, DONRE, Vietnam visiting Norway from 24 to 29 April 2006. The lectures at NILU were related to air quality monitoring, management and data dissemination as performed by NILU. Presentations were also related to the air quality management programme undertaken by the authorities in Ho Chi Minh City.

NORWEGIAN TITLE

KEYWORDS		
Air quality monitoring	Air quality assessment	Vietnam

ABSTRACT (in Norwegian)

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