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Building basic bottom-up emission data for air dispersion models based on top-down emission inventory for cities in Asia

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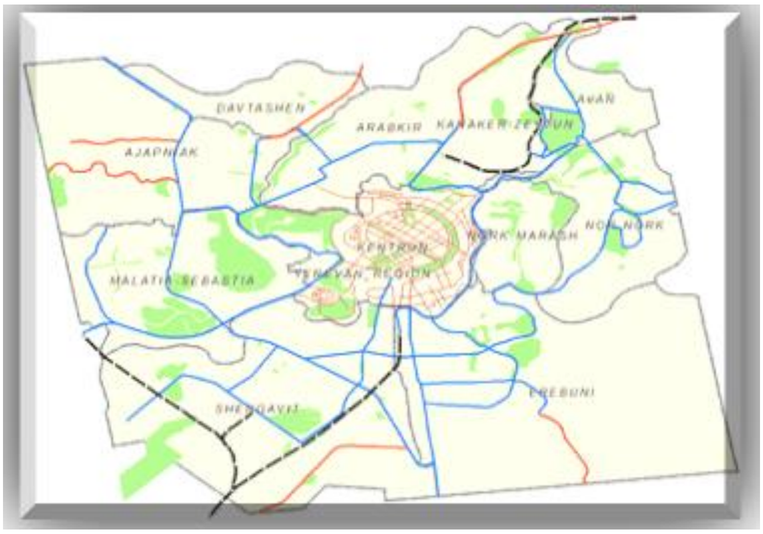

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Contents

Building basic bottom-up emission data for air dispersion models based on top-down emission inventory for cities in Asia

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Abstract:
One of the main purposes of developing emission inventories is to create input data for dispersion models. The emissions inventory becomes a continuous work as the emission data need frequently to be updated. Many cities in Asia have started to prepare the basic input for air quality management planning and have needed to start collecting source information and prepare the emission data for modeling purposes. For this purpose it is needed to prepare bottom-up emission inventories.

As a starting point simpler top-down emission information has been used to identify sources and source areas. Information has been available from various land use maps of the area, population distribution maps, statistic year books or energy consumption statistics. Following the simple top-down emission estimates traffic counting, questionnaires and consumption/production data have been used to establish the GIS based bottom-up emission inventory. These approaches have been applied by NILU in cities in Asia such as e.g. Hochiminh, Vietnam; Ulaanbaatar, Mongolia and in Shanxi, China.

Basic emission data have been imported to the dispersion models together with data from air quality and meteorological measurements. Model estimates have produced a general idea of the air pollutant concentration distributions over the specified modeling area. The results have been used to evaluate the effects of possible actions identified in order to reduce the air pollution exposure.
Updated emission inventories have been established to improve the model results. Examples of using these approaches have been demonstrated for Hochiminh, Vietnam and for Ulaanbaatar, Mongolia.
The source and emission data have also been used to estimate the relative importance of greenhouse gas emissions from the different sources.

1 Combined top-down and bottom-up emission inventories

Top-down emission inventories have been used in a number of land-studies. This type of emission inventories are often based on statistical data on fuel consumption, industrial production numbers and total traffic density flows in a given area, region or country. The results are most often presented by sectors for the total area.

The bottom-up emission inventory is more detailed in the sense that information is usually presented on a GIS based database. For the bottom-up emission inventory details on individual sources are needed in order to identify positions, stack heights, road links etc. The bottom-up emission data thus enable the results to be input for dispersion models aimed at calculating concentrations and concentration distribution in the given area.

NILU is presently applying a combination of a simplified top-down emission inventory and a more detailed bottom-up inventory. The latter one is especially needed for modelling of exposure and evaluating local health impacts. It has been used in many projects to identify the most cost effective mitigation measures. Many cities in Asia have prepared the basic input for air quality management planning and have needed to start collecting source information and prepare the emission data for modelling purposes. The planning tool used by NILU for this purpose has been based on the NILU developed AirQUIS system, where source data and consumption/ production data are collected in Excel based templates and inserted into the emission modeling system. (AirQUIS 2007).

Information concerning detailed bottom-up emission inventories has been available from various land use maps of the area, population distribution maps, statistic year books or energy consumption statistics. Sources have been divided into point-, line- and area sources, designed for modelling purposes. These approaches have been applied by NILU in several cities in Asia such as e.g. Hochiminh, Vietnam; Ulaanbaatar, Mongolia, Shanxi, China and Abu Dhabi UAE. NILU is presently working on similar studies in Dhaka, Bangladesh as shown below.

2 Top-down approached for GHG emission estimates

Input data for top-down emission inventories are often taken from much of the same sources as for bottom-up inventories. However, the detailed information concerning individual sources is not needed.

Some of the available information available when starting the top-down emission inventory may be:

- **General source data**
  Presentations, reports on internet, local websites
- **Geographical data**
  Tourist map, Yearly statistic book (population, fuel consumptions,...)
- **Traffic Dynamic Data**
  Briefly estimated traffic counting, vehicle status, vehicles distribution
- **Area emissions**
  Yearly statistic book (population distribution, fuel consumptions,...)
- **Point source emissions**
  Identify main point sources (power plants, industries...)
- **Meteorology**
  Local weather stations, climatological data, WMO data

Top-down emission inventories for CO and PM_{10} have been performed using the GAINS model (Greenhouse Gas -Air Pollution Interactions and Synergies). This model was developed by International Institute for Applied Systems Analysis (IIASA).

3 Simple interactive models

For estimating emissions for a specific area NILU has also applied simple integrated approaches as in the Simple Interactive Model for Better Air Quality (SIM-AIR) presented by the World Bank (Shah and Saikawa, 2005). Where detailed emission inventory is not available, estimates of emissions are performed as a top down approach.

In approaches used by NILU, the emissions have been estimated for a defined gridded domain, with user defined resolution, covering the area being studied. Input data for the modeling system included; 1) Population data, 2) Meteorological data, 3) Emission data, 4) Emission factors for source categories, 5) Dose response functions and 6) Cost estimates.

An example is given for the results of using this SIM-AIR model in Hanoi, Vietnam (Sivertsen and Dudek, 2006).

4 Bottom-up emission inventories

The AirQUIS planning tool has been developed by NILU to handle a number of air pollution tasks and challenges (AirQUIS, 2007). It is based on a GIS platform and includes monitoring data, emission inventory tools and models. The main objective has been to enable direct data and information transfer to perform user friendly emission data collections and to enable impact assessment using dispersion and exposure models.

Examples are given for estimates of PM_{10} concentration distributions in Ulaanbataar, Mongolia based on detailed bottom-up emission inventories.

Also some scenario analyses performed for air pollution in Hochiminh city (HCMC) was based on bottom-up emission data. It was evident from our estimates that the most effective measures to implement in order to reduce the air pollution impact in HCMC would be to look at the emissions from motor bikes and light trucks. (Sivertsen and Vo, 2007). Three scenarios were studied with different emission standards for NO_x . The baseline pre 2004 emission conditions have been based on previous studies reported in Asia (Sivertsen and Dudek, 2006; Suksod, 2001). One challenge in setting emission factors is that these factors used in the different studies in Asia may vary considerably (Khaliquzzaman, 2005). Also the vehicle class distribution may vary. Our baseline numbers are taken from field studies and traffic counting performed in HCMC (Sivertsen and Vo, 2008).

5 Combined emission inventory approaches in Co-control

NILU is presently conducting projects aimed to handle an integrated approach assessing the combined effects of mitigation measures impacting both on local impacts (health) and global GHG and climate effects. Interactions between mitigation measures implemented on a local scale with action undertaken in order to reduce climate change issues will be an integrated part of the analyses.

The control of air pollution and emissions of greenhouse gases (GHG) according to co-control principles should be guided by national policy guidelines and regulations. However, local conditions and the local situation regarding the main economic sectors and their environmental impact will influence the process of control implementation according to co-control principles. Depending on which sectors dominate emissions and exposures in the particular area and what are the costs and benefits, the resulting ranking and recommendations will differ.

6 References

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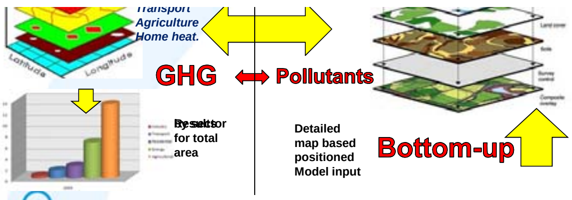
Shah, J. and Saikawa, E. (2005) Interactive Database for Emission Analysis (IDEA-Hanoi) Version 1. (Developed in the East Asia Region of the World Bank).

Appendix A

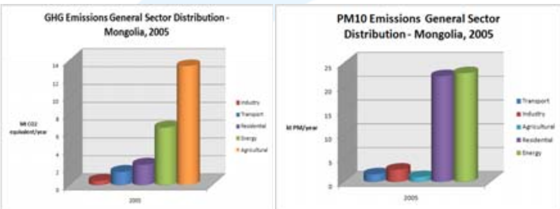
Emissions

up emission inventory



Top-down emission estimate

Mongolia: GHG and PM_{10} emissions



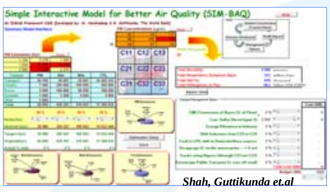
Ref: The GAINS-Asia model

Input data for top-down and bottom-up

Easily available information

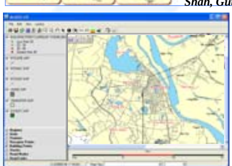
- **General source data**
  Presentations, reports on internet, local websites
- **Geographical data**
  Tourist map
  Yearly statistic book (Population, Fuel consumptions,...)
- **Traffic Dynamic Data**
  Briefly estimate Vehicle Status, Vehicles Distribution
  Traffic countings (Manually or by digital camera)
- **Area emissions**
  Yearly statistic book (population, fuel consumptions,...)
- **Point emissions**
  Identify main point sources (power plants, industries...)
- **Meteorology**
  Local Weather Stations
  WMO stations/data

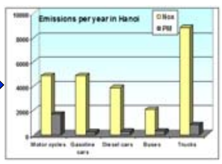
Simple interactive models



-a first estimate of emissions

SIM-Air for Hanoi

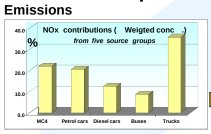




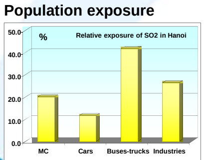
SIM-Air for Hanoi

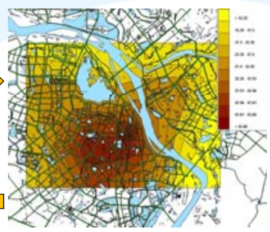
Used to generate emission data
Input to dispersion models

Emissions

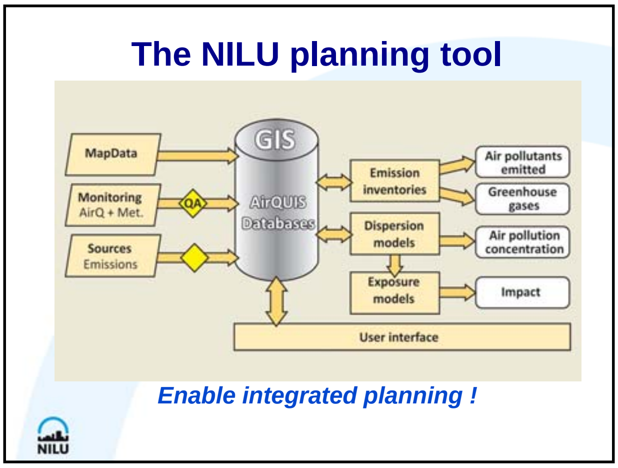


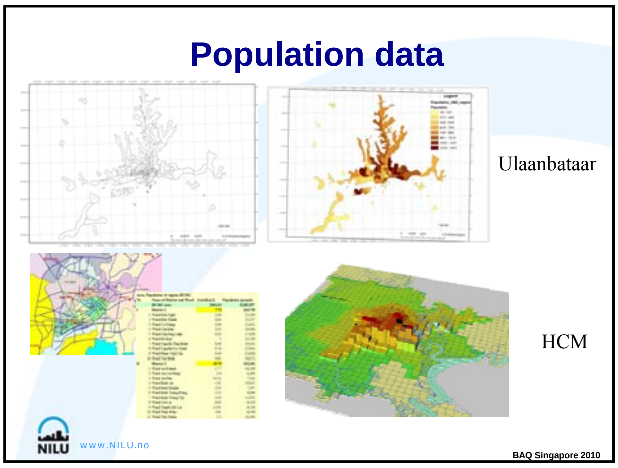
Population exposure

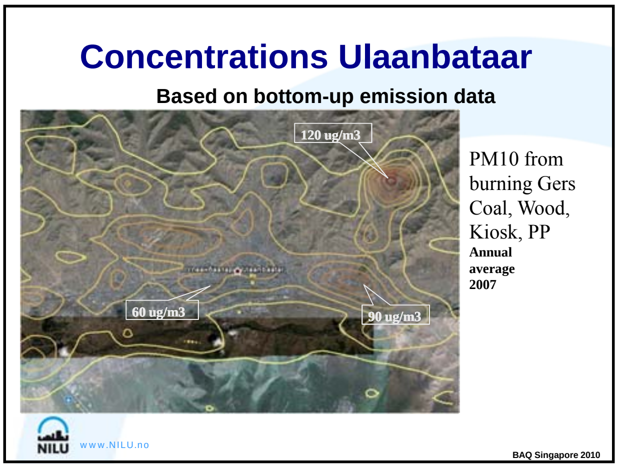


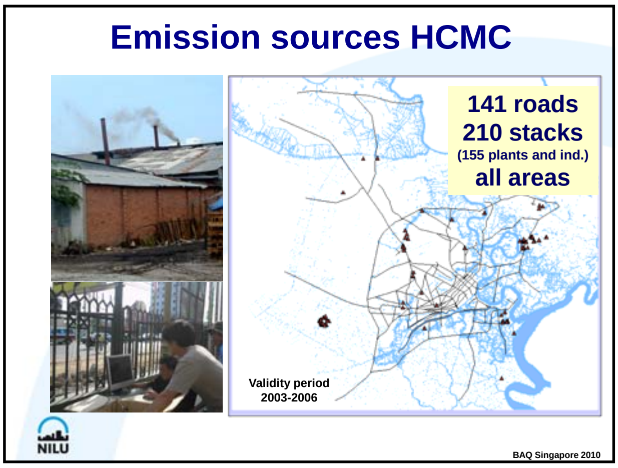


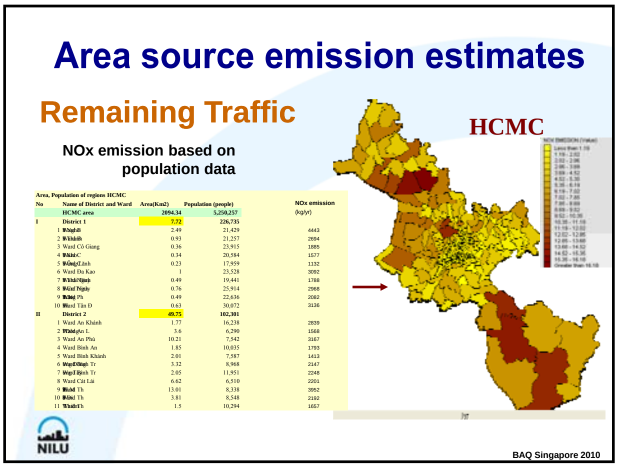
Concentration distribution due to emissions from all types of vehicles in Hanoi, 2005

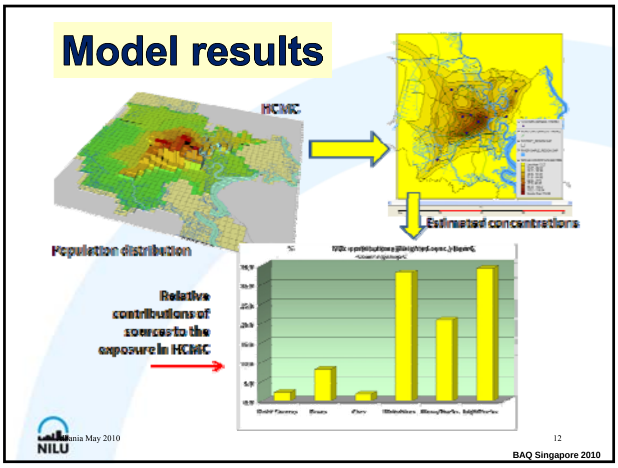

The NILU planning tool
MapData
Monitoring
AirQ + Met.
QA
Sources
Emissions
GIS
AirQUIS
Databases
Emission
inventories
Dispersion
models
Exposure
models
Air pollutants
emitted
Greenhouse
gases
Air pollution
concentration
Impact
User interface
Enable integrated planning !
NILU

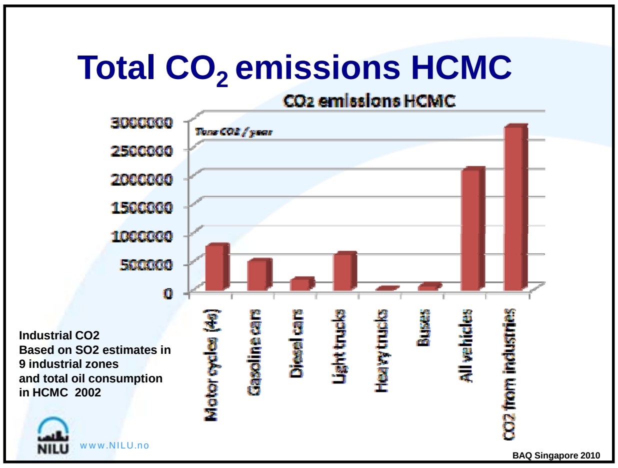

Population data
Ulaanbataar
HCM
NILU
www.NILU.no
BAQ Singapore 2010

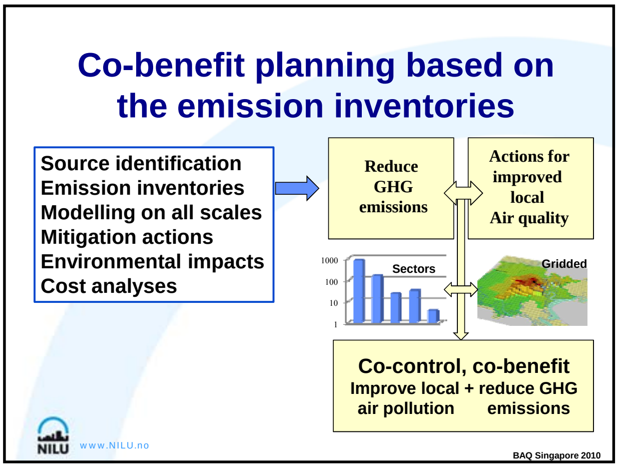

Concentrations Ulaanbataar
Based on bottom-up emission data
120 ug/m3
60 ug/m3
90 ug/m3
PM10 from
burning Gers
Coal, Wood,
Kiosk, PP
Annual
average
2007
NILU
www.NILU.no
BAQ Singapore 2010


Emission sources HCMC
141 roads
210 stacks
(155 plants and ind.)
all areas
Validity period
2003-2006
NILU
BAQ Singapore 2010


Area source emission estimates
Remaining Traffic
NOx emission based on
population data
HCMC
NILU
BAQ Singapore 2010


Model results
HCMC
Population distribution
Estimated concentrations
Relative
contributions of
sources to the
exposure in HCMC
NILU
BAQ Singapore 2010


Total CO_2 emissions HCMC
CO2 emissions HCMC
Tons CO2 / year
3000000
2500000
2000000
1500000
1000000
500000
0
Motor cycles (4s)
Gasoline cars
Diesel cars
Light trucks
Heavy trucks
Buses
All vehicles
CO2 from industries
Industrial CO2
Based on SO2 estimates in 9 industrial zones
and total oil consumption in HCMC 2002
NILU
www.NILU.no
BAQ Singapore 2010


Co-benefit planning based on the emission inventories
Source identification
Emission inventories
Modelling on all scales
Mitigation actions
Environmental impacts
Cost analyses
Reduce GHG emissions
Actions for improved local Air quality
Sectors
Gridded
Co-control, co-benefit
Improve local + reduce GHG
air pollution emissions
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