What is an Emission Inventory?

Roles of an emission inventory

Given the current rapid rate of economic development in East Asia and the degradation of air quality in the future likely to result from this, it becomes necessary to make use of all the scientific tools available for the management of the atmospheric environment. One of these tools is the air pollutant emission inventory.

What quantities of air pollutants are emitted and where do they come from? The best way to answer these questions is to prepare an air pollutant emission inventory. Emission inventories are now regarded as indispensable tools for a wide range of environmental measures such as management of chemicals as well as the prevention of air pollution.

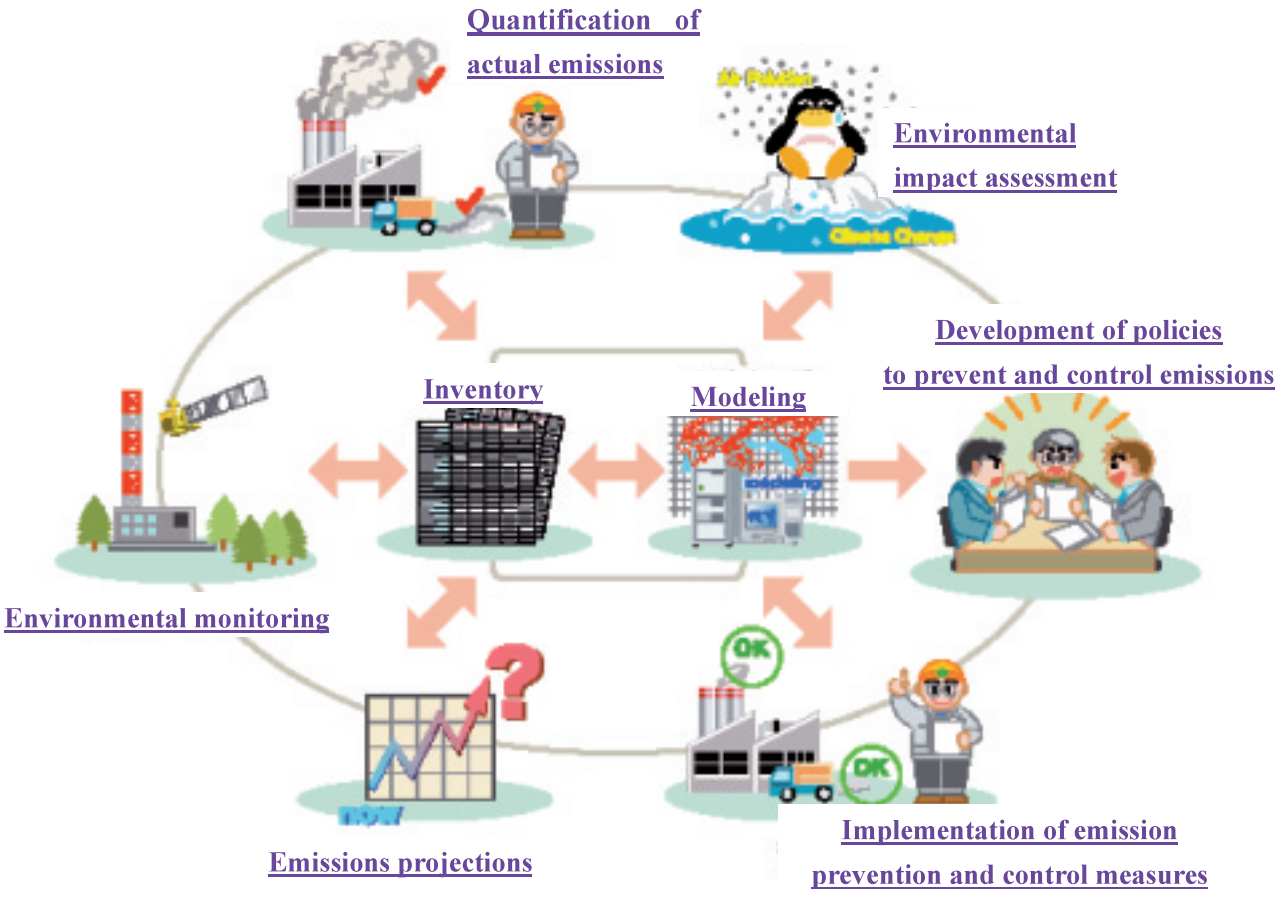
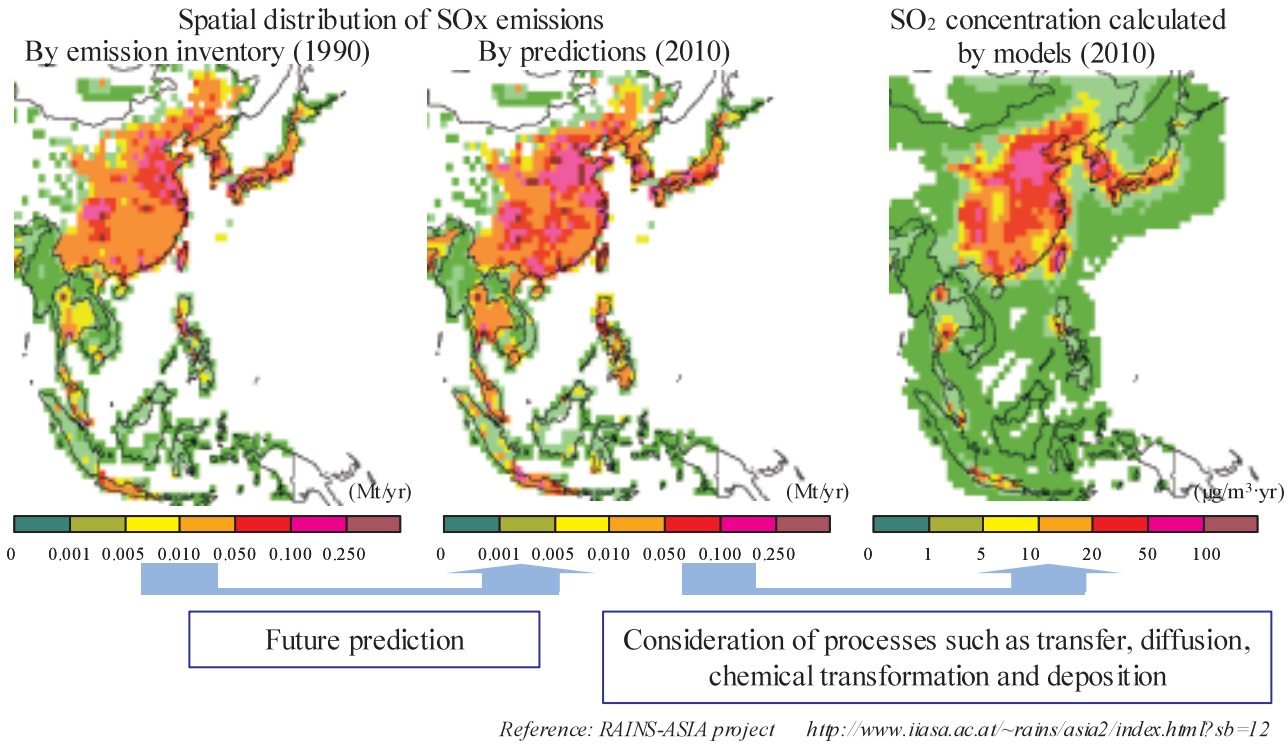


Fig. 1 Roles of the emission inventory for air quality management

An emission inventory can be utilized for the following purposes.

◎Quantitative understanding of actual emissions

The quantitative emissions estimates provided by an inventory promote a better understanding of the actual emissions and help to raise the awareness of both policy makers and the general public. Through this process, the major emission sources can be identified, priorities for emission reduction defined and any data gaps requiring further work are revealed.



Reference: RAINS-ASIA project http://www.iiasa.ac.at/~rains/asia2/index.html?sb=12

Fig. 2 Examples of application of an emission inventory

◎Use for modeling activity

Emissions data allocated geographically and temporally can be used as input data for atmospheric transport and deposition models. The resulting air concentration and deposition estimates obtained by modeling, after verification with monitoring data on the ground and/or data from satellite observations, will be important information for air quality management decision-making. Further useful information can be provided by estimates of the likely adverse impacts (to humans, animals, crops and natural ecosystems), which may be assessed from the modeled deposition and concentration of pollutants.

◎Use for future projections and setting of targets

A current emission inventory can be used as the basis for estimating future emissions according to projected likely changes in socio-economic indices (e.g. population growth, economic growth, changes in energy use per unit activity), lower emission factors (e.g. by introduction of better control measures), fuel switching and so forth. Estimated future emissions provide important information for setting emissions targets.

◎Use for the consideration of possible reduction measures

An emission inventory enables the likely effects of introducing various prevention and control measures within different source sectors to be assessed and compared, both now and in the future. Combined with knowledge of costs of the different options, this also enables the most cost-effective emission reduction measures to be identified.

◎Use for planning of policy and measures and their follow-up

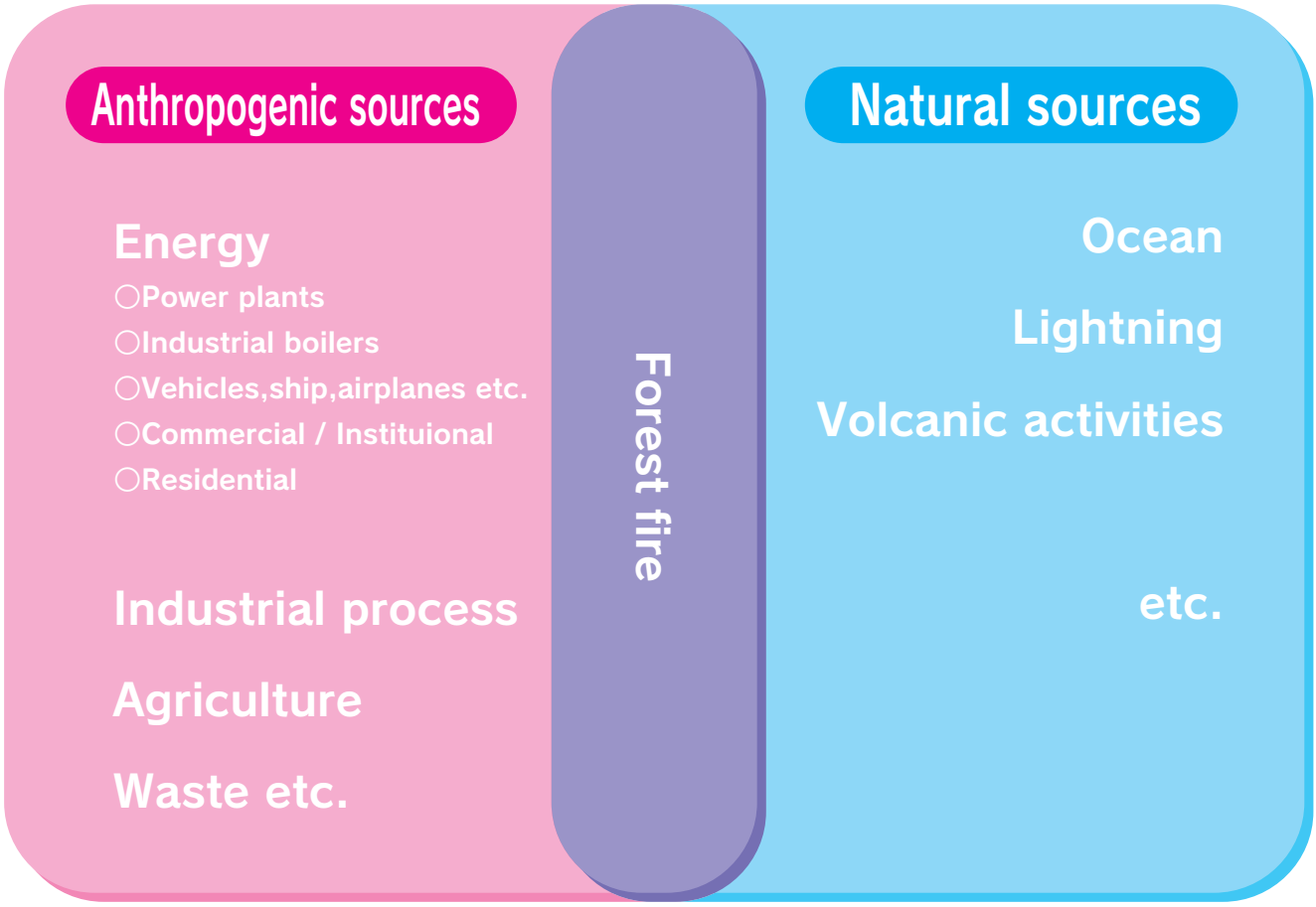
Emission inventory data can be regarded as an index similar to the various indices used for gauging changes in economic activity. The trend of such an index allows us to judge whether we should introduce or reinforce regulations, economic measures or technical measures to control air pollutant emissions.

◎Cooperation in preparing inventories in East Asia

Analyses based on emission inventories and atmospheric transport modeling are crucial when dealing with long-range transport of air pollutants. Such analyses would be made easier and more fruitful if the methodologies used were harmonized across all countries in a region. Cooperation in preparing inventories also could promote capacity building in the measurement of emissions, developing emission factors and on the use of inventories and models. The resulting increased capacity will contribute to the development of pollution control strategies in each country leading to a reduction in transboundary air pollution.

Emission sources of air pollutants in inventories

The emission sources of air pollutants are divided into anthropogenic (human-made) and natural sources.



Examples of air pollutants considered in inventories: SO_2, NOx, VOCs, NH_3, CO, BC, OC, PM_{10}, Hg, etc.

Fig. 3 Conceptual scheme showing emission sources of air pollutants

Burning of fossil fuels is often the most important emission source. On the other hand, in Asia sources such as the domestic use of biomass fuel and incineration of agricultural residues are also very important. Emissions from vehicles are also increasingly important since vehicle use is growing rapidly in most Asian countries.

Method for developing inventories

In general, anthropogenic emissions of air pollutants are estimated by the following basic formula for each source, when it is difficult to measure it directly.

Emission = Emission Factor x Activity Data

Examples:

- SOx emission per the amount of fuel burnt, calculated based on the sulfur content of fuel, the sulfur retained in the ash and the reduction achieved by emission control technology (fuel combustion)
- NOx emission per distance (exhaust gas emissions from vehicles)
- SOx emission per the amount of copper smelted (copper smelting)

- the amount of fuel burnt (fuel combustion)
- the distance of vehicle travelled (exhaust gas emissions from vehicles)
- the rates of the production of the commodity (industrial process without combustion)

◎ Emission factors

Emission factors are the average rate of emission of a pollutant per unit of activity data for a given sector.

When there is no emission factor reflecting the actual local situation, default values in manuals are used. However, if the default factor is considered to be inappropriate, it is preferable to obtain an emission factor that reflects the real situation by direct measurement.

The rates of reduction and propagation of technical measures have to be reflected in the factor or the formula, because introduction of countermeasures reduces the emission.

◎ Activity Data

Activity data give a measure of the scale of activity causing the emissions.

The necessary data basically can be collected from statistics and surveys

Inventory Manuals

EMEP/CORINAIR Atmospheric Emission Inventory Guidebook	This manual provides suggested methods for estimating emissions of air pollutants such as SO_2, NOx, NMVOC, CH_4, NH_3 and CO. It is applied for reporting the national inventory under the Convention on Long-range Transboundary Air Pollution (CLRTAP).
IPCC (Intergovernmental Panel on Climate Change) Guidelines	This manual provides suggested methods for estimating emissions of the 6 direct greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) as well as the precursors, NOx, CO, NMVOC and SO_2. It is applied for reporting national inventories under the UNFCCC and Kyoto Protocol.
UNDP/UN DESA Manual	This manual has been prepared by the Stockholm Environment Institute under a UNDP and UN DESA project for transboundary air pollution for Northeast Asia. The types of air pollutant emissions covered are SOx, NOx, NMVOCs, CO, NH_3, PM_{10} and $PM_{2.5}$.
The Global Atmospheric Pollution Forum Air Pollutant Emissions Inventory Manual	The Forum manual was based on a similar manual being applied within the MaléDeclaration countries of South Asia which, in turn, grew out of the above UNDP/UN DESA manual. The Forum manual also covers emissions of SOx, NOx, NMVOCs, CO, NH_3, PM_{10} and $PM_{2.5}$ and is suitable for use by developing countries in any region of the world. An Excel-based workbook accompanies this manual.

Reporting of inventories

For instance, under the Convention on Long-range Transboundary Air Pollution, reporting of emissions is implemented based on the emission reporting guidelines as shown below.

Principles	○National emission inventories should be transparent, consistent, comparable, complete and accurate. (3) ○Emission estimates should be prepared using the applicable methodologies agreed upon. (4)
Scope	○Each Party must report on emissions for the base year and every year starting with the year of entry into force. (9) ○Parties should report projected activity data and projected national total emissions for the years 2010, 2015 and 2020. (10)
Methods	○Parties should use the Guidebook to estimate emissions. (11) ○It is preferable that each Party should use its own national emission factors. (13) ○The Task Force regularly updates the Guidebook. (14) ○Where the methodology has changed, each Party should recalculate all inventory data to ensure consistency of the time series. (15)
Reporting	○For every fifth year, each Party should report total and sectoral emissions for the EMEP grid squares. (22) ○For the year 2000 and every fifth year, Parties should provide the data on large point sources (type of source, latitude, longitude, emission quantities and effective chimney height). (23) ○Each Party should use the reporting format and submit the information preferably in electronic form. (34) ○Parties are encouraged to submit an informative inventory report. (38) ○Each Party should publish their emission data and inventory reports. (39)

Numbers in parentheses indicate the paragraph numbers.
Source: United Nations / Economic Commission for Europe (2003), Emission Reporting Guidelines

Emission inventories in Asia and the World

RAINS·GAINS
This database is developed by International Institute for Applied System Analysis (IIASA) to estimate emission of air pollutants including greenhouse gases.

EDGAR
EDGAR database is developed by National Institute for Public Health and the Environment (RIVM) to estimate emission of air pollutants and greenhouse gases.

GEIA
As part of International Geosphere - Biosphere Programme (IGBP), GEIA has been developing inventories of global gas and aerosol emissions.

LTP
LTP is a joint research program among China, Japan and Korea. Its purpose is the monitoring/modeling of Air pollutants to improve understanding of transboundary air pollutants in Northeast Asia.

ACESS
ACESS is developed by Argonne National Laboratory to support the Aerosol Characterization Experiments and Transport and Chemical evolution over the Pacific Experiments.

REAS
REAS is developed by Frontier Research Center for Global Change and National Institute for Environmental Studies to understand the role of trace constituents in the atmosphere.

EA-Grid
EA-Grid is developed by the Ministry of the Environment in Japan to understand transboundary air pollutants in Northeast Asia.

Although some countries in East Asia has prepared inventories, the detailed information they contain is difficult to share in the region because 1) they are prepared only for a domestic use , 2) the tasks are divided among different departments such as domestic affairs, international cooperation, and human health-related departments and 3) there is no reporting system for such inventories.

Substances targeted by inventories

		SOx,SO_2	NOx	VOC	NH_3	CO	BC	OC	PM_{10}	Hg	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
UNFCCC		○	○	○		○					○	○	○	○	○	○
RAINS・GAINS		○	○	○	○	○	○	○	○		○	○	○			
EDGAR		○	○	○	○	○					○	○	○	○	○	○
GEIA		○	○	○	○	○	○	○		○	○	○	○			
LTP	China	○	○	○	○											
	Japan	○	○	○	○	○			○							
	R.of Korea	○	○	○	○	○			○							
ACESS		○	○	○	○	○	○	○			○	○				
REAS		○	○	○	○	○	○	○			○	○	○			
EA-Grid		○	○	○	○	○			○	○						

Main characteristics of inventories

Inventory		Area	Years	Categories	Spatial resolution	Temporal resolution
UNFCCC		Global	mainly 1990～ or 1994～ depends on the country	anthropogenic	Country	annual
RAINS・GAINS		Global	1990～2030	anthropogenic	Country・Administrative unit (China・India・Russia)	annual
EDGAR		Global	depends on the compound	anthropogenic/natural	Country, Region 1°×1°	annual
GEIA		Global	depends on the compound	anthropogenic/natural	1°×1°	annual (season, monthly)
LTP	China	China	mainly 1998	anthropogenic/natural	mainly 1°×1°	annual
	Japan	Japan	mainly 1998	anthropogenic/natural	mainly 1°×1°	monthly, annual
	Korea	Korea	mainly 1998	anthropogenic/natural	mainly 1°×1°	annual
ACESS		South Asia, Southeast Asia, East Asia	2000	anthropogenic/natural	Country, Region (China, Japan, Korea) 1°×1°	annual
REAS		South Asia, Southeast Asia, East Asia	1980～2020	anthropogenic/natural	0.5°×0.5°	annual
EA-GRID		China, South Korea, North Korea, Taiwan, Mongolia, Japan	2000	anthropogenic/natural	0.5°×0.5°	biogenic sources : monthly other emissions : annual

Conclusion

In Europe and North America, a methodology for preparing emission inventories of air pollutants has been developed within the framework of the Convention on Long-range Transboundary Air Pollution (CLRTAP). This methodology has also been used by many counties to compile their greenhouse gas emission inventories. Discussions on the hemispheric transport of air pollutants are also starting to include the application of emission inventories and atmospheric transport models.

In East Asia, governments and researchers have prepared several emission inventories including global ones. However, a harmonized system to compile inventories that are transparent and comparable enough to be agreed among East Asian countries has not yet been established.

In order to deepen an understanding of the state of regional air pollution in East Asia and develop capabilities of the countries on atmospheric environmental management, it will be necessary to establish such a system in which inventories can be improved continuously in cooperation with administrative agencies and inventory experts in East Asia.

Experience elsewhere has demonstrated the importance of cooperation for enhancing capacity in the preparation of inventories within all countries of a region.

Understanding and awareness about the urgent need for good quality emission inventories also need to be promoted in East Asia. It is intended that this pamphlet will assist in this process.

Web sites of relevant manuals and inventories

	Manual/Inventory Name	Web site
Manual	EMEP/CORINAIR	http://reports.eea.europa.eu/EMEPCORINAIR4
	IPCC	http://www.ipcc-nggip.iges.or.jp/public/public.htm
	UNDP/UN DESA Manual	http://www.sei.se/dload/2005/TAP_Inventory_Manual_FD_web.pdf
	The Global Atmospheric Pollution Forum Air Pollutant Emissions Inventory Manual	http://www.gapforum.org/project-details.php
Inventory	UNFCCC	http://unfccc.int/2860.php
	LTP	http://www.temm.org/docs/banner/ltp.html
	ACESS	http://www.cgrer.uiowa.edu/ACESS/acess_index.htm
	REAS	http://www.jamstec.go.jp/frsgc/research/d4/emission.htm
	EA-Grid	http://www-cger.nies.go.jp/cger-e/db/enterprise/eagrid/eagrid_index_e.html
	RAINS GAINS	http://www.iiasa.ac.at/rains/ http://www.iiasa.ac.at/gains/
	EDGAR	http://www.mnp.nl/edgar/
	GEIA	http://geiacenter.org/

◎Ministry of the Environment of Japan
◎Cooperation: Acid Deposition and Oxidant Research Center (ADORC)
Mitsubishi-UFJ Research & Consulting
Tomoyuki Aizawa, National Institute for Environmental Studies (NIES)
Hajime Akimoto, Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
Toshimasa Ohara, National Institute for Environmental Studies (NIES)
Akiyoshi Kannari, Independent Rseacher
Kiyoto Tanabe, Institute for Global Environmental Strategies (IGES)
Hideaki Nakane, National Institute for Environmental Studies (NIES)
Toshihiko Masui, National Institute for Environmental Studies (NIES)
Harry Vallack, Stockholm Environment Institute (SEI)

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