A New Resource for International Emissions Inventory Development and Data Retrieval: A Proposal

Brooke L. Hemming
AAAS/US EPA Environmental Science and Engineering Fellow
US EPA/Office of International Activities
MC: 2670R
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Stefan R. Falke
AAAS/US EPA Environmental Science and Engineering Fellow
US EPA/Office of Environmental Information
MC: 2831R
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Terry Keating
US EPA/OAR/ Office of Policy Analysis and Review
MC: 6103A
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Marc Levy, Greg Yetman, and Bob Chen
Center for International Earth Science Information Network
Columbia University
61 Route 9W
PO Box 1000
Palisades, NY 10964 USA

In partnership with:
Emissions Factors and Inventories Group
Emissions Modeling and Development Division
Office of Air Quality Planning and Standards
Office of Air and Radiation
US Environmental Protection Agency
Research Triangle Park, NC

ABSTRACT

We propose to form an international consortium of air pollutant emissions inventories, their developers and users. The goal of the consortium is to make inventory data easily accessible to the global regulatory and science communities, to assist in its use for policy and scientific analysis and to facilitate the development of the new inventories needed to fill local, regional and global data gaps. We present this proposal here for the

purpose of inviting those present at the US EPA International Emissions Inventory Conference to join us in this effort.

INTRODUCTION

A growing, unmet need exists for international air pollutant emissions inventory data. International air quality concerns including cross-border to long-range transport of criteria, toxic and persistent organic pollutants require modeling studies as part of policy development. Accurate emissions inventories are critical input for these studies.

Analysis of patterns and trends in emissions of atmospheric pollutants of all types, including greenhouse gases, depend upon the availability of high quality emissions inventory data. Analyses of these types play a central role in sustainable urban and transportation development planning. Furthermore, particular policy options, such as pollutant emissions trading programs, depend upon current, publicly available data on existing emissions levels. Finally, a public that is accurately informed about the current mass of air pollutants emitted can serve as a more able partner in the effort to clean up the global atmosphere.

At present, emissions inventories exist over a range of geographic and temporal scales, with many gaps and inaccuracies. Should a researcher wish to construct a data set that comprises geographically overlapping inventories, she or he faces several challenges:

- Identifying existing data
- Obtaining the data
- Keeping the data current, if part of an on-going effort
- Identifying the data format and transforming it to fit with other datasets
- Integrating and comparing with other datasets
- Filling in gaps by appropriate extrapolation

Each of these tasks is associated with a set of particular problems for the individual researcher or air quality management team. Successful integration of data has been impeded by incompatibilities in formats and standards, access and processing tools, and organizational structures. (National Research Council, 1998)

Much of the critical data missing from the global data set corresponds to emissions from developing countries. For those undertaking new inventory projects, determining the best data format conventions and methodologies for calculating emissions can be a challenge, especially for workers in developing countries. US EPA has provided technical support and assisted in building the capacity for inventory development in Mexico, and is undertaking similar efforts in India and other developing countries. However, the logistics associated with conducting such projects can be daunting. Funding must be obtained, and international memoranda of understanding must be formulated. These financial and bureaucratic obstacles may be enough to slow or even halt a nascent inventory development effort. If the necessary information along

with a supportive community of other data managers were freely accessible on the web, inventory development projects in resource poor regions may stand a better chance of success.

Herein, we propose to develop a global consortium of emissions inventories, and their users. This community will, furthermore, be served by a website that will provide a portal that offers access to the data contained in the member inventories and a toolkit that will simplify the merging, reconciliation, manipulation and GIS-based mapping of ensembles of inventory data. To assure ready access to the most up-to-date inventory data, we intend to make use of emerging Internet-based distributed data systems. To encourage the development of inventories needed to fill in international data gaps, we intend to link this portal to technical resources, tutorials and a discussion forum devoted to inventory methodologies.

In addition to convenient data access and manipulation, we expect the following benefits to the air quality management and global atmospheric chemistry communities to arise from the existence of this consortium and web-based facility:

Sharing data and interactions between its users and its providers will facilitate inventory error correction and methodological reconciliation. For example, large-scale inventories are prepared in a "top-down" manner, where gross estimates must be made regarding activity and emissions factors. Inventories with higher spatial and temporal resolution, such as those prepared for urban air-shed modeling, and which contain city-specific activity and emissions factors, can be used to improve the estimates used in large-scale inventory preparation. Conversely, the information used for estimating global and regional scale inventories can support the further development of local scale inventories when new pollutant categories and a larger geographic extent are needed. Thus, collaboration between the keepers of large versus small-scale inventories can result in overall greater data quality. Furthermore, the more accessible data are, the more likely that they will be put to use. As the data sets available through the consortium are used, errors and critical gaps will be identified.

We also anticipate that a consensus will emerge over time as to the "best practices" for inventory preparation, as well as a common scheme for denoting source categories and process-level activities. Incompatibilities among inventories due to differences in source coding conventions can be better addressed with the involvement of a wide cross-section of inventory developers. For example, the US, Canada and Europe are presently involved in negotiations regarding the sharing of emissions inventory data as required under the Long-range Transport of Air Pollutants (LRTAP) Convention. The requirement has proven difficult to fulfill for the US and other parties due to incompatibilities in the manner in which sources and process-level activities are coded. An international system must be devised to resolve the present difficulty as well as to serve the emerging global need for such a system. The involvement of inventory developers across the range of geographic scales, i.e. urban to global, will enrich and better inform to development process. The forum proposed here is perfectly suited for beginning these international discussions.

The existence of a centralized resource including discussion forums and up-to-date information on standards and best practices for inventory development will support the development of new inventories in otherwise resource-poor regions.

BODY

Proposed Activities

- Recruit keepers of inventories into an international consortium

Of central importance to this project is the development of a large community of inventory developers and users. This community should traverse all sectors of the developer/user spectrum, from local air quality managers to academic researchers working on the global scale. The GEIA emissions inventory will be included, as will US EPA inventories such as the RAPIDS inventory, which catalogs toxic pollutant releases in the US-Canada Great Lakes region, and the US National Emissions Inventory.

Recruitment efforts will extend beyond those active in the scientific community and at the US national level to state, province and local inventory developers, nationally and internationally. Connections will be forged with Europe, Canada and Mexico through existing US EPA collaborations. The World Bank and other agencies participating in international environmental remediation and protection activities will be approached for support and participation in this effort.

- Provide forums for discussion, collaborative interaction, technical resources and updates, tutorial support for those undertaking the development of new inventories especially those in developing countries.

Information resources in support of inventory development will be made easily accessible, either by way of links to existing resources such as those available on the US EPA Emissions Factors and Inventories Group website, the new website presently being developed by the Air Canada, or through libraries and tutorials on web pages specifically formulated for the Consortium.

An issues-oriented set of discussion forums, based at the portal website, will be created, and promoted within the inventory development and users communities.

- Provide convenient access to the various inventories through Web-portal

Web-based technologies are changing the way in which environmental data analysis is conducted. The potential of the Web provides opportunities to develop advanced capabilities for emission inventories, beyond simply downloading data. The general trend in data dissemination and analysis is toward open, distributed information

systems where information is shared and exchanged among multiple data sources. The work proposed here uses Web-based information systems for attaining a system of shared emission inventory information and applications within a distributed environment.

Inventories are will be distributed over the Internet, stored and maintained by their individual developers, while access is seen by the portal user as "global" and integrated. Participation in the EI portal will involve minimum burden on the individual inventory manager. Each manager can continue to maintain their inventory using their preferred practices. Web-interfaces will be made available as part of the portal toolkit that will translate the existing format into alternative formats as needed.

A large, international effort is presently underway to establish data formatting standards. The term used to describe the data fields within a given format is "metadata." The development of a convention for geospatial metadata has received substantial attention and technologies have been implemented to serve and deliver geospatial data over the Web. Standards organizations such as Federal Geographic Data Committee (FGDC), International Organization for Standardization (ISO), and the Open GIS Consortium (OGC) are developing standards and specifications for sharing data and interoperating applications (Visser et al., 2001). Federal agencies are reassessing their infrastructure to incorporate these new developments (National Research Council, 2001).

Interoperable, easily distributed methods to describe environmental data and standard interfaces enable development of applications for data processing and integration that facilitate the development of knowledge suitable for decision-making. A key aspect in the pursuit of interoperable information systems is the partnering between federal, state, local governments, business, and universities. These partnerships help reduce unnecessary data redundancy, reduce the costs associated with building and maintaining databases, improve data access, and improve data quality (National Research Council, 2001).

This international inventory effort will make use of established data and interoperability standards. A goal of the integrated emission inventory is to partner with other, related environmental information communities, such the FGDC Geospatial One-Stop (FGDC, 2002). These partnerships will enhance the EI community's access to the most recent input and surrogate data, such as activity and population data, for estimating accurate emission inventories.

- <u>Provide software tools for data manipulation</u>

The EI portal will include tools for browsing and analyzing emission inventories. These tools will allow both tabular and GIS-based access and analysis. Browsing tools will be provided that give a visual display of inventories in tabular, map, time series, and other formats. The standard data format proposed will allow side-by-side comparison or superimposed overlays on maps. Online operators will aggregate the data according to space, time, or other dimensions, allowing convenient comparison. Other web-based operators will be developed for a variety of tasks including mathematical operations, i.e.

subtraction, division, etc., and interpolation/extrapolation to fill data gaps. The members of the EI consortium will be surveyed to identify the most relevant and needed tools for inclusion in the EI portal.

Proposed Facility

The Center for International Earth Science Information Network (CIESIN), part of the Columbia University Earth Institute, was founded for the purpose of archiving environmental and related data and presently serves as an international focal point in activities surrounding the implementation of distributed data access using the Open GIS standard. It presently maintains a number of online data catalogs compliant with the international Z39.50 information retrieval protocol and various national and international metadata standards. Among its responsibilities are the operations of the Socioeconomic Data and Applications Center for the NASA Earth Observing System and the World Data Center for Human Interactions in the Environment for the International Council of Science. Furthermore, CIESIN participants in a range of national and international networks and programs, including the NASA Distributed Active Archive Center Alliance, the ICSU World Data Center System, and the United Nations Geographic Information Working Group.

The CIESIN staff comprises more than 40 staff members including experts on remote sensing, Geographic Information Systems, industrial ecology, land use/cover change, spatial data management and interoperability, and database development. The staff is already providing training on spatial data management to both U.S. and international data managers through a cooperative agreement with the U.S. Federal Geographic Data Committee (FGDC).

CIESIN also has strong national and international partnerships, including formal and informal links with the U.S. National Research Council, the International Institute for Applied Systems Analysis, the Chinese Academy of Sciences, and the World Bank.

Given its mandate and existing suite of national and international activities involving data integration and in operating online, interactive data and information resources in support of applications and decision making, CIESIN ideally suited to operate and house the emissions inventory resource proposed here.

CONCLUSIONS

We have described, here, a plan to develop an international consortium of emissions inventories, developers, data managers, and data users. The goals of this consortium include facilitating data access, usability, quality assurance and control, and in facilitating the development of new inventories needed to fill data gaps across geographic scales.

We issue an invitation to the participants of this conference to join us in this effort to forge a community that can fulfill these goals.

REFERENCES

Federal Geographic Data Committee (FGDC), *Geospatial One-Stop Office of Management and Budget Capital Asset Plan (Exhibit 300),* (online document: http://www.fgdc.gov/geo-one-stop/one_stop_300.doc, 2002)

NARSTO, *Data Management Handbook*, (online document: http://cdiac.esd.ornl.gov/programs/NARSTO/narsto.html, 2002)

National Research Council, *Distributed Geolibraries: Spatial Information Resources*, (Washington, DC: National Academy Press, 1998)

National Research Council, *National Spatial Data Infrastructure Partnership Programs: Rethinking the Focus*, (Washington, DC: National Academy Press, 2001)

Open GIS Consortium (OGC), http://www.opengis.org

U. Visser, U, H. Stuckenschmidt, H., Wache, H.; and T. Voegele, "Using Environmental Information Efficiently: Sharing Data and Knowledge from Heterogeneous Sources," in C. Rautenstrauch and S. Patig, ed., *Environmental Information Systems in Industry and Public Administration*, (Hershey, PA: Idea Group Publishing, 2001) pp. 41-73.

Windsor Technologies, *RAPIDS User's Guide Version 2.0*, (online document: http://www.glc.org/air/rapids/distribution/2_0/manuals/usrguide.pdf, 2001)

KEYWORDS

Global consortium; GIS; international emissions data; geospatial data; Web-based portal; Web-based tools; interoperability; distributed information systems; LRTAP; CIESIN