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| National Library of Medicine |
| Examination of carbon dioxide emissions data sources for TOXMAP |
| Examination/Analysis of carbon dioxide emissions data source/s for TOXMAP |
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# Abstract

Electricity production, transportation and other industries emit large quantities of greenhouse gases which trap heat in the atmosphere, raising the temperature of the earth. This study examines greenhouse gas emissions datasets from the Environmental Protection Agency’s (EPA) Greenhouse Gas (GHG) Data and non-profit Center for Global Development’s Carbon Monitoring for Action, for inclusion in TOXMAP, a product of the National Library of Medicine (NLM). TOXMAP is a geographical information system which allows users the opportunity to visualize, analyze and understand datasets related to environmental and human health. Each dataset was reviewed using the TOXMAP data review questionnaire in order to provide in-depth information regarding the scope, quality, background source and ease or ability to integrate the dataset into the newest release of TOXMAP. NLM’s Specialized Information Services division (SIS) will use the reviews to draw conclusions about the data and determine if either dataset should be included in TOXMAP. The data reviewer recommends the EPA’s GHG Data dataset because it incorporates several greenhouse gases, covers several industries including electricity production, is updated yearly and is subjected to the EPA’s rigorous data review process.

# Background

The National Library of Medicine (NLM) Division of Specialized Information Services (SIS) maintains TOXMAP[[1]](#footnote-1) which is a geographical information system allowing users to visualize, analyze and interpret complex environmental data in the form of a map. The development of TOXMAP is intrinsically tied to the history of TOXNET[[2]](#footnote-2), which is the NLM’s collection of databases related to toxicology, hazardous chemicals, environmental health and toxic releases. Furthermore, the impetus behind TOXMAP’s development stems from the NLM’s mission to make biomedical information accessible to the public, including their collection of toxicological databases.

## Assessing environmental and human health

In 1984 a serious environmental and human health disaster struck the community of Bhopal, India, when a deadly cloud of methyl isocyanate was released from the Union Carbide-Dow Chemical facility and devastated almost the entire community. There was deep concern in the US because Union Carbide also had a facility in West Virginia using methyl isocyanate (EPA, 2013k). Many worried that this facility possessed the same potential for disaster if not properly inspected and regulated. Because of these events, the public experienced a growing interest in the amount and types of toxic chemicals released into the environment by US facilities.

In 1986, a few years after the Bhopal event, Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA) requiring the Environmental Protection Agency (EPA) to collect annual data on the releases and transfers of specific chemicals in industrial facilities within the US (EPA, 2013l). The information collected from 1987 to 1990 formed the beginning of the Toxics Release Inventory (TRI)[[3]](#footnote-3) dataset of chemicals released or disposed by US facilities which was created and currently maintained by the EPA. Congress passed the Pollution Prevention Act in 1990 which further strengthened data reporting efforts by the EPA through specifying approximately 650 toxic chemicals which US facilities were required to report when disposed or released into the environment (EPA, 2013k).

According to Hochstein and Szczur (2006), NLM partnered with the EPA in the early stages of the Internet to provide online subscribers with access to the TRI dataset. In addition to data on the release or disposal of chemicals, TRI tracks how chemicals are managed, either through recycling, recovery or treatment (Hochstein & Szczur, 2006).

While large datasets are useful for research, they are not always friendly to general users. In 2006 NLM decided to harness the power of geographic information systems (GIS) and allow users the ability to visualize large datasets through map technology. The NLM’s SIS division decided the TRI dataset was a good fit for the project because geographical coordinates, which are a requirement for GIS technology, were included for each US facility. SIS reviewed several environmental health GIS applications which were currently on the web in order to ensure their efforts would be valuable to users and unique to other efforts by governmental and non-governmental organizations (Hochstein & Szczur, 2006). The EPA had several GIS resources such as the TRI Explorer [[4]](#footnote-4) and EnviroMapper [[5]](#footnote-5). The United State Geological Survey had created the National Atlas[[6]](#footnote-6) and the National Cancer Institute had created Cancer Mortality Maps[[7]](#footnote-7).

After reviewing several applications SIS concluded that a GIS using EPA TRI data would be a valuable application because of the ability to link users to the wealth of information found in TOXNET’s many databases (Hochstein & Szczur, 2006). Using TOXMAP would allow users to search for and view chemical releases or facilities on a map. Users would then be provided with links to bibliographic and research information regarding chemicals and their effect on environmental and human health. TOXNET’s Hazardous Substances Databank (HSDB)[[8]](#footnote-8) is often the first database linked to from TOXMAP. The databank focuses on the toxicology of specific chemicals and includes topics such as human exposure, emergency handling procedures, and regulatory requirements. TOXMAP provides value through increased accessibility, comprehension and interpretation of TOXNET information.

## TOXMAP and current datasets

Since TOXMAP’s initial release in 2004, several datasets have been added. These include Superfund data from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)[[9]](#footnote-9) database in which the EPA collects data on hazardous and potentially hazardous waste sites in the US. TOXMAP also includes the National Priorities List (NPL), which is a list of “national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories (EPA, 2012i).” The EPA uses this list to decide which sites require further investigation and monitoring. Both the Superfund Site and National Priorities List data are mapped in TOXMAP.

In addition to the EPA data, the National Cancer Institute provides cancer mortality data from for inclusion into TOXMAP. This data is presented in various colors and can be overlaid to provide a thematic or choropleth map, or a map in which “areas are distinctly colored or shaded to represent classed values of a particular phenomenon (ESRI, 2012). Also available as a choropleth map overlay are US Census data from 1990 and 2000, and income demographics from the Bureau of Economic Analysis. Reference data such as cities, roads, state or county boundaries can be added or removed from the map according to the user’s needs.

## The future of TOXMAP

Several versions of TOXMAP have been deployed, each providing a richer, more vibrant version of TOXMAP for users to enjoy. In the spring of 2013, SIS will launch a pre-release of TOXMAP version 5. In anticipation of this release, SIS was interested in reviewing additional data for inclusion in TOXMAP.

Since the mid-2000s one particular area of interest to SIS was greenhouse gas emissions by US facilities. TOXMAP allows users through various datasets to analyze relationships between environmental issues and the conditions surrounding human health. Though the effects of greenhouse gas (GHG) emissions on human health are not as apparent as effects of chemicals such as mercury or lead, the long-term effects of global warming brought about by GHGs, are not without ramifications to human health. In addition to concerns about human health, TOXMAP is used to analyze the health of the environment. If GHG emission data were available by US facility, users could analyze the relationship between the emissions of power plants or landfills and their effects on the surrounding environment.

The EPA has tracked national trends in emissions and removals of greenhouse gas since 1990 through the US Greenhouse Gas Inventory Report. The report provides the official estimate of national greenhouse gas emissions (EPA, 2012d). EPA descriptions of the report indicate GHG emission totals by source, economic sector and GHG type are provided. This type of emissions data does not provide the level of granularity which SIS had hoped to find. The SIS division was interested in mapping emissions by facility and so they looked beyond the GHG Inventory Report to identify a dataset which would fulfill their need. In 2007, Colette Hochstein read a National Public Radio report on the Center for Global Development’s Carbon Monitoring for Action (CARMA) dataset which tracked carbon dioxide emissions from power generation on both a national and global scale. Data was included for all US facilities regardless of their size or the amount of yearly emissions.

The purpose of the NLM Associate Fellow Fall Project was to review data sources of carbon dioxide emission for possible inclusion in TOXMAP. The main dataset of interest, CARMA, had undergone a version change in July 2012 and the latest data was far improved from the early 2007 version (CARMA, 2012b). In addition, the EPA began monitoring and disseminating data for individual US facilities through the Greenhouse Gas (GHG) Data program which began in 2010, and this dataset was also identified and reviewed.

# Methodology

There were several steps to this project with each step building upon the skills or knowledge discovered in the previous step. Each step will be reviewed and elaborated upon below. In addition, Figure 1 is a Gantt chart that provides a visualization of the timeframe for each step.

The first step in the project was to review parameters and goals with the project leaders, Dr. Colette Hochstein, TOXMAP Project Officer and Darren Gemoets, Technical Lead. An in-person meeting was scheduled soon after the project was assigned. The project leaders provided a list of suggestions which were discussed and agreed upon by the Associate Fellow. The designated timeframe of approximately 40 hours of work spanning two months was reviewed and agreed upon, with the Associate Fellow providing updates and raising any questions through email or phone. Other meetings were scheduled based upon the needs of the Associate Fellow.

The second step was to become familiar with the currently deployed and in-development versions of TOXMAP, referred to here as “TOXMAP 4” and “TOXMAP 5.” SIS provided two TOXMAP sample teaching assignments which were designed for TOXMAP 4 but could also be completed in TOXMAP 5. A user name and password were provided so the Associate Fellow could access TOXMAP 5. The assignments allowed the Associate Fellow to gain familiarity with searching and viewing TRI and Superfund site data in the mapping tool, as well as understanding how chemicals in TOXMAP link out to TOXNET databases.

The third step was to review the original CARMA data review questionnaire completed in 2007 by Darren Gemoets. The two objectives of this step were to familiarize the Associate Fellow with the expectations for a data review and provide the Associate Fellow with a history of the CARMA dataset.

The fourth step involved investigating the Center for Global Development (CGD) which created and maintains the CARMA dataset. The project leaders emphasized that datasets from non-profit organizations must be thoroughly reviewed for any bias which could arise from their presentation or interpretation of the data, or their data gathering and curating techniques. The Associate Fellow also analyzed the parent organization to CARMA, CGD, so that their history and current initiatives were fully understood. This was accomplished by reading through the CGD’s active and completed initiatives, including their Climate Change Initiatives, of which CARMA is a part. Their founders, advisory group and financial supporters were reviewed, as well as publications by CGD on climate change.

## Figure 1. Gantt chart of Project Timeline

The fifth step involved investigating the CARMA dataset. The project leaders provided the Associate Fellow with a data review questionnaire that contained seven sections: Basics, Geography, Time, Quality, Usage, Chemical and Integration. Each section included three to five subsections which further refined the information. The integration section involved knowledge of specific software and was written in collaboration with Mr. Gemoets.

The sixth step was to investigate CARMA’s sources of data. These sources include the EPA’s Emissions and Generation Resource Integrated Database (eGRID), the EPA’s Clean Air Market’s Division (CAMD), and the Energy Information Administration (EIA). Several technical documents were reviewed for information related to the CARMA dataset, as well as to gain an understanding of how and why the data is gathered.

The seventh step was to find or investigate other sources of data. This was accomplished through several searches through the EPA.gov and Data.gov. Because the standard to compare the CARMA dataset with is a governmental dataset, the search began there. Several datasets were mentioned but only the GHG data were directly related and reviewed for this project.

The eighth and ninth steps were to write and revise the CARMA data review. The Associate Fellow completed a portion of the data review questionnaire and sent it to the project leaders’ for a content review. Once the Associate Fellow was assured to be on the right path, the rest of the data review was completed and sent for an editorial review by the project leaders. Changes and corrections were made according to the project leaders’ suggestions and a second draft was sent for any final adjustments. A third and final copy was provided to the project leaders at the conclusion of the project.

The tenth and eleventh steps were to write and revise the GHG Data review. A similar process was followed for the GHG Data review with the exception of the initial content review because expectations had already been established in the CARMA data review process. The GHG Data review questionnaire was completed and sent to both Project Leaders for an editorial review. Changes and corrections were made according to the project leaders’ suggestions and second draft was sent for any final adjustments. A third and final copy was provided to the project leaders at the conclusion of the project.

The final copy of both the CARMA and GHG Data reviews are available on the NLM Associate SharePoint site under these file names: “TOXMAP Data Review (CARMA) v4.docx”, and “TOXMAP Data Review (Greenhouse Gas Data) v4.docx”.

# Results

There were two datasets reviewed for this project: Carbon Monitoring for Action (CARMA) which is supported by the Center for Global Development (CGD) and Greenhouse Gas (GHG) Data supported by the Environmental Protection Agency (EPA). All datasets regardless of their origin must be reviewed for appropriateness according to the project in which they will be applied. A thorough review was completed for each dataset based on the data review questionnaire provided by the project leaders.

The main concerns of the project leaders regarding a data review can be summed up into a few areas: the background of the organization, the source and quality of the data, how the organization presents and ultimately uses the data, and the ability of the organization to curate the data. The project leaders emphasized the importance of thoroughly investigating non-governmental data before recommending the data for use in a governmental website.

The first area of interest is the background of the organization. The CARMA dataset was created in 2007 as the first global inventory of carbon dioxide (CO2) emissions for the energy sector and is maintained by the non-profit organization, CGD. CGD has thirteen initiatives for 2012 which will help “reduce global poverty and inequality through rigorous research and active engagement with the policy community (CGD, 2013b).” CGD Senior fellow David Wheeler and Research Assistant, Kevin Ummel, are considered the architects behind CARMA (CARMA, 2013c). David Wheeler is an internationally recognized expert on public information disclosure and environmental regulation in developing countries.

The second area of interest is the source of the organization’s data and the overall quality of the data. Data should come from accurate, trustworthy sources and there should be clear documentation regarding how the data were gathered. The high quality of the United States data in CARMA is supported by the fact that CARMA effectively reports Energy Information Administration (EIA) data, EPA Clean Air Markets Division (CAMD) data, and Department of Energy (DoE) coordinates directly for US facilities (Ummel, 2012b, p. 16).

The missions of these governmental organizations testify to their trustworthiness and quality. The EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment (EIA, 2013).The mission of CAMD is to improve human health and the natural environment through the evaluation of the “cap and trade” program. CAMD focuses on lowering outdoor concentrations of fine particles, ozone, mercury, and other significant air emissions (EPA, 2012g).

In cases where data is not disclosed or available for any reason, “CARMA relies upon statistical models that predict plant electricity generation and carbon dioxide(CO2) emissions using information about the size, age, fuel type, and engineering specifications of individual generating units (CARMA, 2013b). Kevin Ummel’s technical paper for the CARMA v3.0 dataset includes an extensive test of the model’s predictive skill. Ummel explains that “whenever plant-level carbon dioxide (CO2) emissions or electricity generation is disclosed by a verified, public source, it is CARMA’s policy to replace model estimates with the actual data (Ummel, 2012b, p. 16).”

A third area of interest was CARMA’s own presentation and use of the data. CARMA’s unique mission is to “equip individuals with the information they need to forge a cleaner, lower carbon future (CARMA, 2013b).” In order to accomplish this, CARMA uses mapping software to present their data so that users can view the location, ownership and emissions of all power plants in the world (CGD, 2013a). Visualizations of the data through mapping technology and the use of tables and graphs allows users to gauge both “clean” and “dirty” power producers based on the type of fuel used for power generation and by comparing the net power generation with the amount of carbon dioxide emitted. Facility names are run through the Geo-names database to determine and display the “parent” company as the ultimate owner for each facility. This unique feature of CARMA may fulfill a specific need for users. Typically the parent company defaults to the managing company of the plant rather than the ultimate owner because the hierarchies involved are often complex, with owners and managers difficult to differentiate.

The CARMA dataset covers all of the US and its territories, and includes global data, which amounts to 60,000 power plants and 20,000 power companies worldwide (CARMA, 2013a). Unfortunately CARMA does not provide data for all types of greenhouse gas emissions, only carbon dioxide. However, electricity production does account for 33% of all greenhouse gas emissions in the United States in 2010 and of those gases, carbon dioxide is the primary gas emitted during electricity production (EPA, 2012j).

A fourth area of interest is the data curating techniques of the organization. Importantly, CARMA does provide some documentation of issues and errors through the CARMA v3.0: Known Issues weblog. Kevin Ummel states “[his] ability to address errors quickly is limited (Ummel, 2012c).” There have been three releases of CARMA since 2007, which follow a pattern of an update every two years. There was little information about any planned future releases. In regards to updating or changing disputed data, Ummel explains that CARMA replaces model estimated data with data from a verified public source, whenever possible (Ummel, 2012b, p. 16), but once again the timeline for releasing the adjusted data was not clear.

In regards to the investigation of EPA’s Emissions and Generation Resource Integrated Database (eGRID), Senior Fellow David Wheeler explained to the curators of eGRID that the first iteration of CARMA used 2005 data from the eGRID as a base (EPA, 2012a, p. 7). eGRID is the preeminent source of air emissions data for the electric power sector and integrates data sources on power plants and power companies from several federal agencies such as the EPA, the EIA, the North American Electric Reliability Corporation (NERC), and the Federal Energy Regulatory Commission (FERC) (EPA, 2012e). However, CARMA is now using CAMD and EIA data in the place of eGRID.

The second dataset, GHG Data, from the EPA was scrutinized based on the same areas of interest as CARMA. The first area of interest, or an investigation of the background of the parent organization, indicated that the EPA continues to be a trusted source of environmental data. The EPA was created in 1970 with the mission of protecting human health and the environment by organizing federal research, monitoring, standard-setting and enforcement activities (EPA, 2013h).

The second area of interest concerns the source and quality of the organization’s data. The Consolidated Appropriations Act of 2008 required US facilities with greenhouse gas emissions over 25,000 metric tons to submit data directly to the EPA. The data submission program began in 2010 with the first data being made available in 2011 (EPA, 2012f). The EPA employs the Quality System for Environmental Data and Technology division to ensure the data collected is of sufficient quality to support the data’s use (EPA, 2013m). The division runs all data through a multi-step data verification process and conducts data checks during the data entry phase. Automated checks continue once the data has been entered to insure internal consistency, as well as checks which compare the data to expected ranges for similar facilities. Any errors are followed up by the EPA and eventually field audits to US facilities will be included in their follow-up measures (EPA, 2012 c).

The third area of interest is the EPA’s use and presentation of the data. The EPA makes use of the data to further explore the impacts of GHGs on the environment and human health. The EPA also wants to collect GHG data in a way that can influence future policy decisions. Currently the EPA employs its own GHG Data publication tool which allows users to visualize the data in map format. Users are provided with information such as the facility’s greenhouse gas emission totals, net power generation (if applicable) and street address, state, Zip Code and geographic coordinates.

The fourth area of interest is the organization’s data curating techniques. The Greenhouse Gas Reporting Program began in 2010 and will continue collecting data annually moving forward. Facilities with large emissions are not required to provide data from before 2010.

# Discussion

There were several strengths and weakness for both datasets. These attributes were considered by the project leaders, and comparisons were made between the datasets. Several of these comparisons are found in Table 1.

One available comparison concerns the number of chemicals found in each dataset which can be linked to information in TOXNET. Carbon dioxide (CO2) contributed to 84 % of the greenhouse gasses emissions in the United States in 2010 (EPA, 2012b), making it one of the key chemicals to follow. The majority of carbon dioxide (CO2) enters the atmosphere from the combustion of fossil fuels such coal, natural gas and oil, which are used in the generation of electricity.

While carbon dioxide (CO2) contributes the largest amount to greenhouse gas emissions, there are several other chemicals which contribute to the overall problem (EPA, 2012b). Methane (CH4) is emitted during the production of fossil fuels. Nitrous oxide (N2O) is emitted during the combustion of fossil fuels and through agricultural and industrial activities. Fluorinated gases such as hydrofluorocoarbons, perfluorocarbons and sulfur hexafluoride are emitted in smaller quantities but have high potential for trapping heat in the atmosphere. Interestingly, fluorinated gases are often used as substitutes for ozone-depleting chemicals such as chlorofluorocarbons, hydrochlorofluorocarbons and halons. (EPA, 2012b).

While CARMA reports only carbon dioxide (CO2) emissions, the Greenhouse Gas (GHG) Data reports on the emission of several chemicals: Carbon Dioxide (CO2), Methane (CH4), Nitrous Oxide (N2O), Tetrafluoromethane PFC-14, Hexafluoroethane PFC-116, and Fluoroform HFC-23. The uniqueness of TOXMAP to other GIS environmental mapping programs is the ability to provide links into the plethora of information in TOXNET. Users will find Carbon Dioxide (CO2) and Methane (CH4) in TOXMAP, as these are both chemicals involved in Superfund sites. All of the chemicals in CARMA and GHG Data can be linked to information found in TOXNET.

## Table 1. Comparison of Greenhouse Gas Data and CARMA

|  | Greenhouse Gas Data | CARMA |
| --- | --- | --- |
| Chemicals reported: | Carbon Dioxide (CO2)  Methane (CH4)  Nitrous Oxide (N2O)  Tetrafluoromethane PFC-14  Hexafluoroethane PFC-116  Fluoroform HFC-23 | Carbon Dioxide (CO2) |
| Chemicals present in TOXNET? | Yes, all chemicals are present in TOXNET | Yes, all chemicals are present in TOXNET |
| Facilities reported: | Facilities emitting 25,000 metric tons of carbon dioxide equivalent (CO2e) per year.  Also includes the suppliers of GHGs (i.e. supply certain fossil fuels or fluorinated gases into the economy which when combusted emit GHGs). | All power generating plants and companies which emit CO2.No threshold requirement. |
| Number of Facilities reported: | 6,700 US facilities | 60,000 power plants, 20,000 power companies, global |
| Industry coverage: | Power Plants  Refineries,  Chemical Manufacturing  Other Industrial  Landfills  Metals  Minerals  Pulp and Paper  Government and Commercial | Power generating plants and companies, standard and alternative energies |
| Geographical coverage: | United States and territories | United States and territories, and Canada (also global data if needed) |
| Quality of geographical coordinates: | Plants and Companies are in correct location | Plants and Companies are in correct location |
| Facility names: | Company Name is used on GHG Data publication tool. Parent Company Name available under “View Reported data.” | Parent Company Name is used on map display. |
| Data Release Frequency | New data released yearly, periodic updates when needed | New version every two years, though no officially designated timeframe for releases, periodic updates when needed |
| Time period of data: | Reports 2010, with 2011 soon to be released | Reports 2004, 2009 and future |

CARMA reports data on all power generating plants and companies, including facilities which generate energy from alternative means such as wind, solar and water. The inclusion of these sources allows users to examine net energy production and carbon dioxide (CO2)emissions for power generation by both standard and alternative means. In comparison, GHG Data reports data on direct emitters in nine industry groups which includes over 6,700 US facilities emitting 25,000 metric tons or more per year of GHGs (EPA, 2012f) . Also included are suppliers of certain fossil fuels or fluorinated gases into the economy which when combusted emit large quantities of GHGs. While CARMA provides data on facilities emitting less than 25,000 metric tons of carbon dioxide (CO2), GHG Data provides a broader range of facility types rather than focusing solely on power generation.

The datasets differed greatly in the number of years covered. CARMA provides data from 2004, 2009 and projections of future data. Future data refers to any point after 2009 and should be interpreted with caution. The future data attempts to reflect both the planned expansion of power plant capacity and plant closures (Ummel, 2012a). GHG Data provides data from 2010 with 2011 data being made public soon (EPA, 2012f). US facilities were not required by the EPA to provide data before 2010.

The project leaders have not decided which dataset, if any, will be added in the upcoming release of TOXMAP 5. The associate fellow toured both TOXMAP 4 and 5 and provided some basic ways in which the CARMA or GHG Data could be used in TOXMAP. However, once a decision is reached on which dataset, if any, will be included, then further discussion and creative thinking about representation of data will occur.

# Recommendations

Each dataset provides a unique view of greenhouse gas emissions. After a thorough review and comparison of the two datasets, the Associate Fellow recommends the Environmental Protection Agency’s (EPA) Greenhouse Gas (GHG) Data dataset for several reasons.

GHG Data incorporates several greenhouse gases which can be linked out to TOXNET, as compared to Carbon Monitoring for Action (CARMA) which only covers carbon dioxide. Providing users with access to information on more greenhouse gases, such as methane, nitrous oxide and hydrofluorocarbons greatly increases the value of the data, and contributes to the overall mission of TOXMAP.

GHG Data covers several industries in addition to electricity production, which increases the exposure of how greenhouse gases are emitted in the United States. Greater industry coverage provides a better picture of which areas contribute to greenhouse gas emissions, and may be important to users trying to understand the impact of the cap and trade program within certain industries in United States.

While the GHG Data only covers 2010 data (with 2011 data being made available soon) there is a very clear understanding of the quality of the data because of the rigorous process through which the data is submitted to and reviewed by the EPA. Confidence can be maintained that the EPA will continue to support the current dataset, and additionally there is clearly a future for GHG data, because the continued collection of this data was mandated by Congress as part of the 2008 Consolidation Appropriations Act and the subsequent Mandatory Reporting of Greenhouse Gases Rule issued by the EPA (EPA, 2012f).

In addition, SIS has a long standing relationship with the EPA in which the EPA provides other datasets for inclusion in TOXMAP. This relationship has endured personnel changes in both agencies, and will continue to yield invaluable contributions to the accessibility and dissemination of environmental data which is collected and maintained by the EPA.

The Associate Fellow has thoroughly enjoyed learning more about reviewing datasets. Her previous work with the National Children’s Study was an introduction to the large quantities of data which are collected and maintained by the US government, and the difficulties of making the data accessible to various users. This project has allowed her to gain familiarity with several datasets, both those reviewed and those she found interesting along the way. In addition, the application of GIS technology has piqued her interest in learning more on how the visualization of data can open up worlds of possibilities for researchers, students and the general public.

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1. TOXMAP <http://toxmap.nlm.nih.gov/toxmap/main/index.jsp> [↑](#footnote-ref-1)
2. TOXNET < http://toxnet.nlm.nih.gov/> [↑](#footnote-ref-2)
3. Toxics Release Inventory <http://www.epa.gov/tri/tridata/index.html> [↑](#footnote-ref-3)
4. TRI Explorer < http://iaspub.epa.gov/triexplorer/tri\_release.chemical> [↑](#footnote-ref-4)
5. EnviroMapper <http://www.epa.gov/emefdata/em4ef.home> [↑](#footnote-ref-5)
6. National Atlas <http://www.nationalatlas.gov/> [↑](#footnote-ref-6)
7. National Cancer Institute’s Cancer Mortality Maps < http://ratecalc.cancer.gov/> [↑](#footnote-ref-7)
8. Hazardous Substances Databank <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB > [↑](#footnote-ref-8)
9. CERCLIS Public Access Database <http://cumulis.epa.gov/supercpad/cursites/srchsites.cfm> [↑](#footnote-ref-9)