



Data Article

Developing a dataset for the expected anthropogenic mercury release in China in response to the Minamata convention on mercury

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ABSTRACT

This paper contains supplementary data in support of a research paper published [1] regarding the expected anthropogenic mercury release in China in response to the Minamata Convention on Mercury (MCM). The dataset provided within this article contains a set of excel spreadsheets. Each spreadsheet contains filtered (collected) and analysed data, i.e., parameters, collected data, calculated and summarized results for mercury distribution by the category of mineral production, intentional uses, secondary metal production, extraction and combustion, and waste treatment in a specific year. The collected (filtered) data in this article consist of the input factor (IF), activity rate data (ARD), output scenario (OS), initial distribution factor (iDF), and redistribution factor (rDF). IF was from the default IF in the United Nations Environment Programme (UNEP) Toolkit Level 2 and published scientific papers. ARD was obtained from the U.S. Geological Survey database, China Statistical Yearbooks, and published scientific papers. The OS content was from the default OS in the UNEP Toolkit Level 2 and published scientific papers. iDF was from the default distribution factor (DF) in the UNEP Toolkit Level 2 and published scientific papers.

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rDF was from published scientific paper. The mercury input was calculated using IF and ARD. The mercury release to different media in the initial distribution step was calculated using the mercury input and iDF. The release of mercury to the final sinks in the redistribution step was calculated using the amount of sector-specific treatment/disposal, product or by-product, and rDF. The dataset with combination of the collected (filtered) and analyzed data can contribute to an understanding of differences in anthropogenic mercury release before and after implementation of the MCM, especially considering technology transformation in China. Government policymakers involved in hazardous waste management, especially those working on MCM, and engineers and scientists interested in hazardous waste management may benefit from these data. The data can be used for identifying the environmental impact of anthropogenic mercury release before and after the MCM in China. The data can facilitate the creation of strategic management policies for mercury as the MCM is implemented in China.

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Specifications Table

| | |
|--------------------------------|---|
| Subject | Environmental Engineering |
| Specific subject area | Waste Management and Disposal |
| Type of data | Table |
| How the data were acquired | Chinese statistical data published by the National Bureau of Statistics of the People's Republic of China, and electronic yearbooks in both Chinese and English can be accessed freely on the Bureau of Statistics website. Mineral Yearbooks by the National Minerals Information Center in the United States can be accessed freely on the U.S. Geological Survey (USGS) website. Toolkits for identifying and quantifying mercury release, reference reports and revised inventory level 2 reports are provided by the United Nations Environment Programme (UNEP) Chemicals, and can be downloaded freely. Other secondary data can be acquired from published scientific papers. |
| Data format | Collected Filtered Analyzed |
| Description of data collection | The collected and filtered data in this article consist of input factors (IF), activity rate data (ARD), output scenarios (OS), initial distribution factors (iDF), and redistribution factors (rDF). IF was obtained from the default IF in the UNEP Toolkit Level 2 and published scientific papers. ARD was from the USGS database, China Statistical Yearbooks, and published scientific papers. The types of OS were from the default OS in UNEP Toolkit Level 2 and published scientific papers. iDF was from the default DF in UNEP Toolkit Level 2, and published scientific papers. The rDF was from published scientific paper. |
| Data source location | USGS database: USGS, 2016–2020. Minerals Yearbooks, National Minerals Information Center. https://www.usgs.gov/centers/nmic/minerals-yearbook-metals-and-minerals . Minerals Yearbooks of the National Minerals Information Center (U.S. Geological Survey), U.S. China Statistical Yearbook: NBSC, 2016–2020. China Statistical Yearbook 2016–2020 (in both Chinese and English). http://www.stats.gov.cn/tjsj/ndsj/ . National Bureau of Statistics of the People's Republic of China, Beijing, China. |

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|--------------------------|---|
| | Toolkit Level 2: United Nations Environment Programme (UNEP) Chemicals, 2017. Toolkit for Identification and Quantification of Mercury Releases, Reference Report and Revised Inventory Level 2. https://wedocs.unep.org/handle/20.500.11822/30684 . Report by Chemicals, UNEP, Switzerland. |
| Data accessibility | Published scientific papers: [4–8,11] Habuer; Fujiwara, Takeshi; Takaoka, Masaki (2022), "Dataset for the expected anthropogenic mercury release in China between 2016 to 2019", Mendeley Data, V2 doi: 10.17632/tjzm2gdntf.2 |
| Related research article | Habuer, T. Fujiwara, M. Takaoka, The response of anthropogenic mercury release in China to the Minamata Convention on Mercury: a hypothetical expectation, J. Clean. Prod. 323 (2021) 129089. doi: 10.1016/j.jclepro.2021.129089 |

Value of the Data

- Standardized data collection (filtering) and accounting method are important for precise identifying a time-series anthropogenic mercury release. The dataset with combination of the collected (filtered) and analyzed data can contribute to an understanding of differences in anthropogenic mercury release before and after implementation of the Minamata Convention on Mercury (MCM), especially considering technology transformation in China.
- The data provided can contribute to reduce duplication of effort for relevant data collection.
- Government policymakers involved in hazardous waste management, especially those working on the MCM, and engineers and scientists interested in hazardous waste management may benefit from these data.
- The data can be used for comparing the environmental impact of anthropogenic mercury release before and after implementation of the MCM in China.
- The data can facilitate the creation of strategic management policies for mercury as the MCM is implemented in China.

1. Data Description

The data described in this section could be found in Ref. [2]. The data comprises six spreadsheets: "Data for 2016", "Data for 2017", "Data for 2018_BAU", "Data for 2018_ACR", "Data for 2019_BAU", and "Data for 2019_ACR". Each spreadsheet contains the following worksheets:

- Worksheet 1 (title "Intro"): a title page with references.
- Worksheet 2 (title "Dataset caption"): the dataset numbers and captions.
- Worksheet 3 (title "Dataset S1"): a summary of mercury releases in the initial distribution (iD) step. Category C1 has two subcategories, of which subcategory C1.1 contains eight subcategories. Category C2 has two subcategories, of which subcategories C2.1 and C2.2 have two and five subcategories, respectively. Category C4 has four subcategories: C4.1 four subcategories; C4.2 five subcategories; and C4.4 two subcategories. Category C5 has two subcategories each of which (C5.1 and C5.2) has two subcategories. The name of each source category is provided. The calculation results are given as the release of mercury (R_{Hg}) from each category and R_{Hg} to different media, such as "air", "water", "land", "stock", "general waste", and "sector-specific treatment/ disposal".
- Worksheet 4 (title "Dataset S2"): a summary of all mercury releases from the five categories in the initial and redistribution (rD) steps. According to Habuer et al. [1], the final sinks include (1) air, (2) water, (3) land, (4) stock, and (5) stabilization, and intermediate reservoirs include "general waste" and "sector-specific treatment/ disposal". The recovered amount and total mercury released to the natural environment by category in the iD and rD stages are also provided.

- Worksheet 5 (title “Dataset C1 (Mineral production)”): this contains parameters, collected and filtered data, and the results of the mercury distribution by mineral production category. This category includes two subcategories: virgin metal and mineral production (C1.1) and cement production (C1.2). Subcategory C1.1 has eight subcategories: “mercury (primary) extraction and initial processing”, “gold (and silver) extraction with mercury amalgamation processes (GEMA)/from whole ore”, “zinc extraction and initial processing/production of zinc from concentrates”, “copper extraction and initial processing/production of copper from concentrates”, “lead extraction and initial processing/production of lead from concentrates”, “industrial gold smelting”, “aluminum extraction and initial processing/alumina production from bauxite”, and “primary ferrous metal production”. The default input factors in the United Nations Environment Programme (UNEP) Toolkit Level 2 [3] have been provided, and the input factors (IF), distribution factors (DF), and output scenarios (OS) applied for the calculation; if there were no remarks, the default values from the UNEP Toolkit Level 2 were used. The activity rate data (ARD) data and calculation results for amounts input and released to different media have also been provided.
- Worksheet 6 (title “Dataset C2 (Intentional uses)”): this contains the parameters, collected and filtered data, and results of mercury distribution by intentional use category, which has two subcategories: uses in industrial processes (C2.1) and in consumer products (C2.2). Category C2.1 contains two subcategories: “chlor-alkali production with mercury-technology” and “vinyl chloride monomer (VCM) production with mercury catalyst”. Category C2.2 contains five subcategories: “thermometers /production”, “electrical switches and relays/production”, “light sources/production”, “batteries/ production”, and “dental mercury-amalgam fillings /preparation of fillings at dental clinics”. When applying IF, DF, and OS to the calculation, if there were no remarks, the default values from the UNEP Toolkit Level 2 were used. The ARD data and the calculation results for amounts input and released to different media have also been provided.
- Worksheet 7 (title “Dataset C3 (Secondary metal.)”): a database of parameters, collected and filtered data, and results of mercury distribution by secondary metal production category. The input amount was from a published scientific paper [4], and DF was from the default value in UNEP Toolkit Level 2.
- Worksheet 8 (title “Dataset C4 (Extraction.)”): a database of parameters, collected and filtered data and results of mercury distribution by the extraction and combustion category. This category includes four subcategories: coal combustion and use (C4.1), mineral oil extraction, refining and use (C4.2), natural gas extraction, refining, and use (C4.3), and biomass combustion (C4.4). Category C4.1 has four subcategories: “coal combustion in power plants”, “coal combustion in coal fired industrial boilers”, “coke production”, and “residential coal use”. Category C4.2 has five subcategories: “extraction and uses”, “oil combustion facilities”, “transportation and other uses than residential heating and other oil combustion facilities”, “residential heating”, and “other oil combustion facilities”. Category C4.4 has two subcategories: “use of biomass” and “charcoal combustion”. When applying IF, DF, and OS to the calculation, if there were no remarks, the default values from the UNEP Toolkit Level 2 were used. The ARD data and the calculation results for amounts input and released to different media have also been provided.
- Worksheet 9 (title “Dataset C5 (Waste treatment)”): a dataset of parameters, collected and filtered data, and results of mercury distribution for the waste treatment category. This has two subcategories: waste incineration (C5.1) and municipal sewage and informal landfilling (C5.2). Category C5.1 has two subcategories: “incineration of municipal/general waste” and “incineration of hazardous waste”. Category C5.2 has two subcategories: “informal dumping of general waste” and “municipal sewage system/treatment”. When applying IF, DF, and OS to the calculation, if there were no remarks, the default values from the UNEP Toolkit Level 2 were used. The ARD data and calculation results for amounts input and released to different media have also been provided.

- Worksheet 10 (title “Dataset R1”): a dataset for mercury redistribution to different media. The wastes, products, and by-products from five categories are provided. The redistribution factors (rDF) were from a published scientific paper [5].
- Worksheet 11 (title “Dataset U1” in spreadsheet named “Data for 2016”): a dataset for an output of tornado analysis. The most sensitive input variables are listed. The downside and upside values of the input and total input are also provided.

2. Experimental Design, Materials and Methods

2.1. Definition of source categories and final sinks

The five source categories and 33 leading subcategories in the initial distribution step and 33 subcategories in the redistribution step were defined according to the UNEP Toolkit Level 2 [3] and published scientific papers [4,5]. The final sinks were (1) air, (2) water, (3) land, (4) stock, and (5) stabilization and intermediate reservoirs “general waste” and “sector-specific treatment/disposal” were defined according to UNEP Toolkit Level 2 [3] and published scientific papers [5,6].

2.2. Data collection

The collected and filtered data in this article consist of IF, ARD, type of OS, iDF, and rDF. IF was the default input factor in the UNEP Toolkit Level 2 and published scientific papers [5,7,8]. ARD was from the U.S. Geological Survey database [9], China Statistical Yearbooks [10], and published scientific papers [4,5,11]. The types of OS were from the default OS in UNEP Toolkit Level 2 and published scientific papers [5,7,8]. The DF was from the default DF in UNEP Toolkit Level 2 and a published scientific paper [5]. rDF was from a published scientific paper [5]. More details are provided in the spreadsheets [2].

2.3. Quantification of mercury releases

The input of mercury (I_{Hg}) was calculated using IF and ARD. The releases of mercury to different media in the initial step were calculated using the I_{Hg} and DF. The calculation algorithm is detailed in Habuer et al. [1]. The R_{Hg} to the final sinks in the rD step were calculated using the sector-specific treatment/disposal, products or by-products, and rDF. Then, a substance flow analysis of mercury was performed based on quantified input and output data, and distribution data. STAN (Substance flow ANALysis) 2.6 freeware was used to identify the principal release sources and visually present the distribution routes in the related research article [1].

2.4. Uncertainty and sensitivity analysis

Since the default IFs in UNEP Toolkit Level 2 have wide ranges, the total inputs contain uncertainty. This uncertainty was analyzed using a Monte Carlo method in Oracle Crystal Ball (OCB) software. To determine the contribution to the total uncertainty, tornado analysis was conducted using OCB. A tornado chart is useful for deterministic sensitivity analysis, i.e., comparing the relative importance of variables. In a tornado chart of the input variables, the upper bars represent the greatest contributors to the variability of the outcome, and therefore what the decision maker should focus on.

Ethics Statements

The authors declare that creation of these data did not involve the use of human or animal subjects, nor data collection from social media platforms.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

[Dataset for the expected anthropogenic mercury release in China between 2016 to 2019 \(Original data\)](#) (Mendeley Data).

CRedit Author Statement

Habuer: Conceptualization, Methodology, Software, Investigation, Formal analysis, Data curation, Writing – original draft; **Takeshi Fujiwara:** Supervision, Writing – review & editing; **Masaki Takaoka:** Visualization, Validation, Writing – review & editing.

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