

# GRIDDED CHINESE EMISSION INVENTORIES OF DIOXINS

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## Introduction

Polychlorinated Dibenzo-p-dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) (or dioxins) are persistent, semi-volatile, and toxic substances. They are designated toxic and are listed as a substance of concern in a number of international agreements such as the UNEP Stockholm Convention, UNECE LRTAP Convention, NACEC Sound Management of Chemicals, and the Great Lakes Binational Toxics Strategy. Although a significant reduction has been achieved in the last two decades and the declining trends are noticed in the environmental compartments, their major atmospheric pathways and worldwide sources still remain unclear. The purpose of this document is to present gridded dioxin atmospheric emission inventories on a national scale in China, which reveal the potential sources of these compounds in this country.

## Materials and methods

**Emission data** The annual Chinese dioxin emission data in 2004 were got from reference <sup>(1)</sup>, which was the first official report for the emission of these compounds in China. These data gave total values (gTEQ) for dioxin emissions without details, such as congener profile and the emission geographic distributions.

**Source identification** There are 10 major categories and 83 sub-categories of potential sources in the UNEP toolkit. We have used these categories as a base categories database, collected and settled the different sources related to China. **Table 1** lists the major categories of dioxin emission from UNEP toolkit and in China.

**Data gridding** With the help of GIS (geographic information system), the emission data of dioxin was allocated to a grid system with a 1/4° longitude by 1/6° latitude resolution, with a size for each grid cell of approximately 25 km by 25 km. Gridded Chinese population were used as a surrogate data to allocate the dioxin data in grid system. Before gridded, provincial contamination source were used as the surrogate to distribute dioxin emission data on a province scale <sup>(2)</sup>.

**Emission data based on congeners in gram** By using the dioxin emission profiles <sup>(3,4)</sup>, the emissions of dioxin in g TEQ calculated above can be transferred to emissions of 17 toxic PCDD/F congeners, and gridded emission inventories with the grid system on a 1/4° longitude by 1/6° latitude resolution for each PCDD/F congener can be compiled.

**Table 1** Major categories of dioxin emission from UNEP toolkit and in China

Major category (UNEP)	Major category (China)
Waste Incineration	Yes
Ferrous and Non-Ferrous Metal Production	Yes
Power Generation and Heating/Cooking	Yes
Production of Minerals	Yes
Transportation	Yes
Uncontrolled Combustion Processes	Yes
Production and Use of Chemicals and Consumer Goods	Yes
Miscellaneous	Yes
Disposal/Landfill	Yes
Hot Spots	No

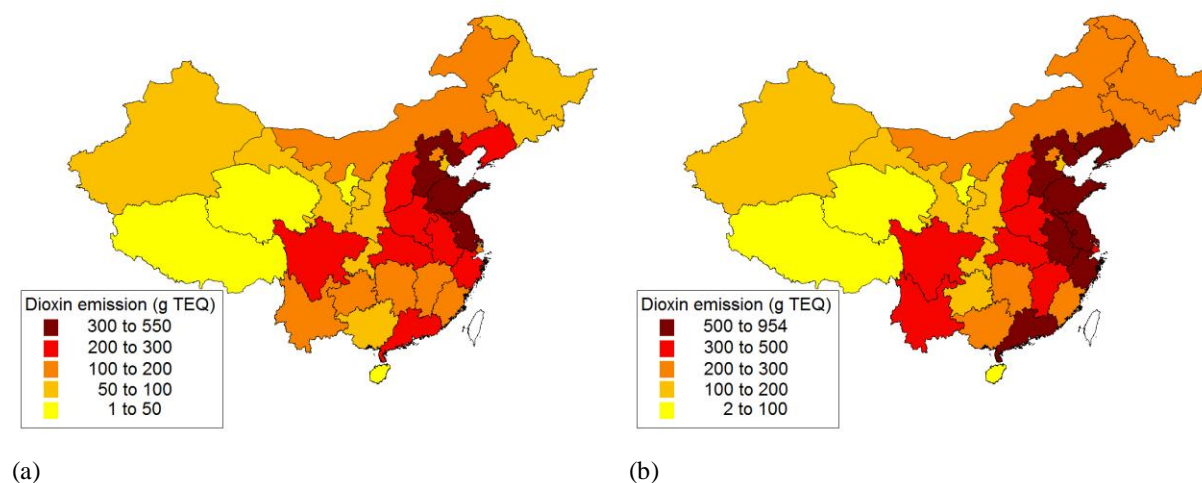
## Results and discussion:

There are 9 major categories (see **Table 1**) and 51 sub-categories dioxin sources in China. As shown in **Table 2**, a total of 10,200 g TEQ dioxin were released to the environment in 2004 in China, among which, 5,000 g TEQ were emitted to the air. The category of “Ferrous and Non-Ferrous Metal Production” is the largest dioxin emission category, with the total emission of 4,600 g TEQ, and followed by “Power Generation and Heating/Cooking” and “Waste Incineration” (Table 2). These three categories took up to 81% of the total emission in China.

**Table 2** Emissions of dioxin depended on major categories in China (g TEQ)

Major category	Air	Water	Product	Residue	Total
Waste Incineration	610.5	0	0	1147.1	1757.6
Ferrous and Non-Ferrous Metal Production	2486.2	13.5	0	2167.2	4667.0
Power Generation and Heating/Cooking	1304.4	0	0	588.1	1892.5
Production of Minerals	413.6	0	0	0	413.6
Transportation	119.7	0	0	0	119.7
Uncontrolled Combustion Processes	64.0	0	0	953.0	1017.0
Production and Use of Chemicals and Consumer Goods	0.7	23.2	174.39	68.9	267.1
Miscellaneous	44.2	0	0	11.0	55.2
Disposal/Landfill	0	4.53	0	43.2	47.7
Total	5042.4	41.2	174.4	4978.7	10236.8

Emissions to air and total release of Dioxin based on province in China for 2004 are presented in **Figure 1**. As shown in Figure 1, Hebei Province had the largest dioxin emission, with a total value of 954 g TEQ released to environment and 550 g TEQ emitted to air, followed by Jiangsu (total 761, air 344 g TEQ) and Shandong (760, 356 g TEQ) Province. As for the province of Ningxia, Hainan, Qinghai and Xizang, the total emission was less than 50 g TEQ. The emission trends of dioxin are obviously decline from east to west, which associated with the development of industry.

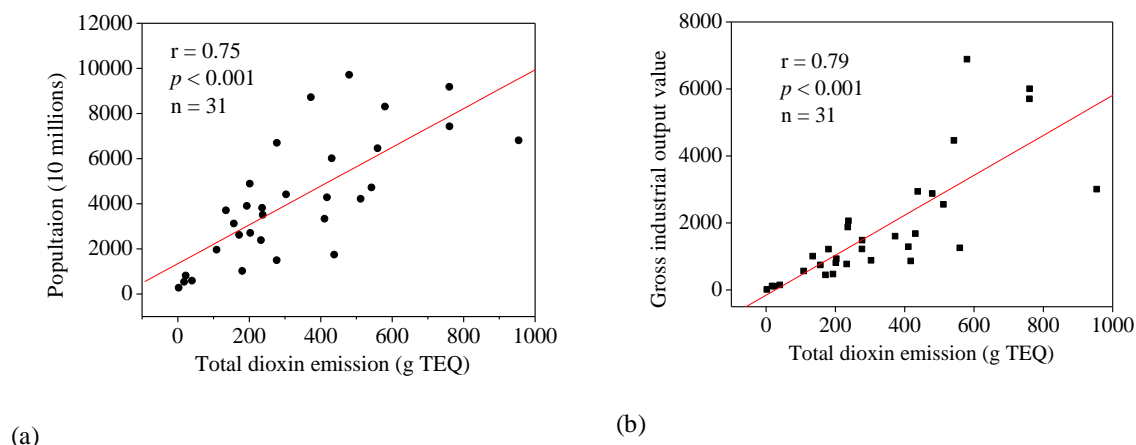


**Figure 1** Air (a) and total (b) provincial dioxin emissions in China in 2004

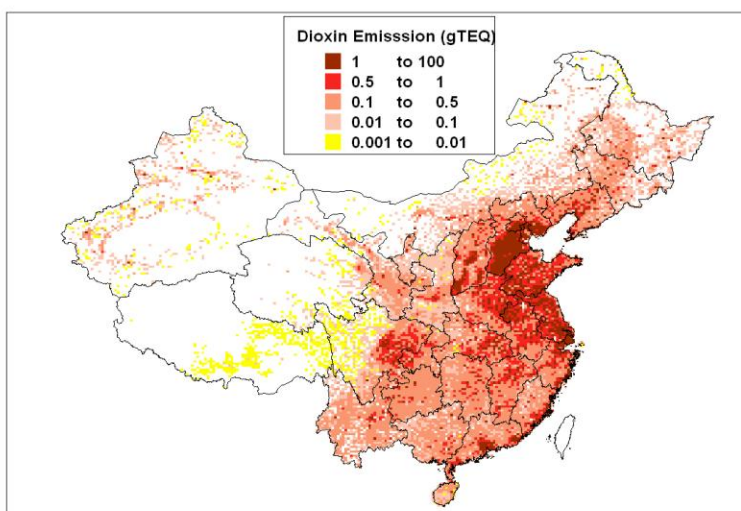
Correlation was performed between total dioxin emission and population based on provinces, a good agreement was found (**Figure 2a**). A significant correlation was also found between the total dioxin emission and gross industrial value (**Figure 2b**).

Since dioxin emissions closely linked with populations, we use the population dataset on a  $1/4^\circ$  longitude by  $1/6^\circ$  latitude resolution as a surrogate data to develop a gridded Chinese dioxin emission inventories on the same grid

system, and the result is shown in **Figure 3**. Obviously, dioxin emissions were more densely in central and east China than other area, but quite lower in north, northwest, and west China.



**Figure 2** Correlation between total dioxin emissions and (a) populations and (b) gross industrial output value based on provinces.



**Figure 3** Gridded total dioxin emission with a  $1/4^\circ$  longitude by  $1/6^\circ$  latitude resolution in China in 2004. Total emissions to air were 5 kg TEQ.

#### References:

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- (4). NCEA (2001): National Center for Environmental Assessment (2001) Database of sources of environmental releases of dioxin-like compounds in the United States. <http://www.epa.gov>. Accessed 17 March 2011