The GTAP version 11 Data Base and Environmental Emissions

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Abstract

In this paper, we present the various environmental emissions—e.g., greenhouse gas (CO2, Methane, N2O, F-gas) and air pollution emissions—obtained from the most recent GTAP version 11 Data Base (Aguiar et al. 2022) with a 2017 base year. The GTAP Data Base describes the domestic transactions, global bilateral trade patterns, international transport margins and protection matrices that link individual countries and regions. For each country/region, the Data Base provides values of production, in addition to intermediate and final consumption of goods and services measured in millions of current U.S. dollars. Many domestic policies are also captured by this database, including value-added taxes, producer subsidies and consumption taxes.

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1. Introduction

The Global Trade Analysis Project (GTAP) Data Base version 11 (Aguiar et al 2022) provides snapshots of the global economy for five reference years: 2004, 2007, 2011, 2014 and 2017, with the latter being the latest year added to GTAP 11. The Data Base describes global bilateral trade patterns, international transport margins and protection matrices that link individual countries/regions. For each country/region, the Data Base presents values of production, and intermediate and final consumption of commodities and services in millions of U.S. dollars. The GTAP Data Base serves as a benchmark data for the majority, if not all, of global general equilibrium models—e.g., the GTAP model (Corong et al., 2017)—that are used to examine economic and environmental issues at the global level.

The GTAP Data Base relies on country-based Input Output Tables (IOTs), and is supplemented by various international datasets as discussed below. The GTAP version 11 Data Base covers to 141 individual countries and 19 aggregate regions to capture global economic activity across 65-sectors—with individual countries accounting for 99.1% of world Gross Domestic Product (GDP) and 96.4% of world population.

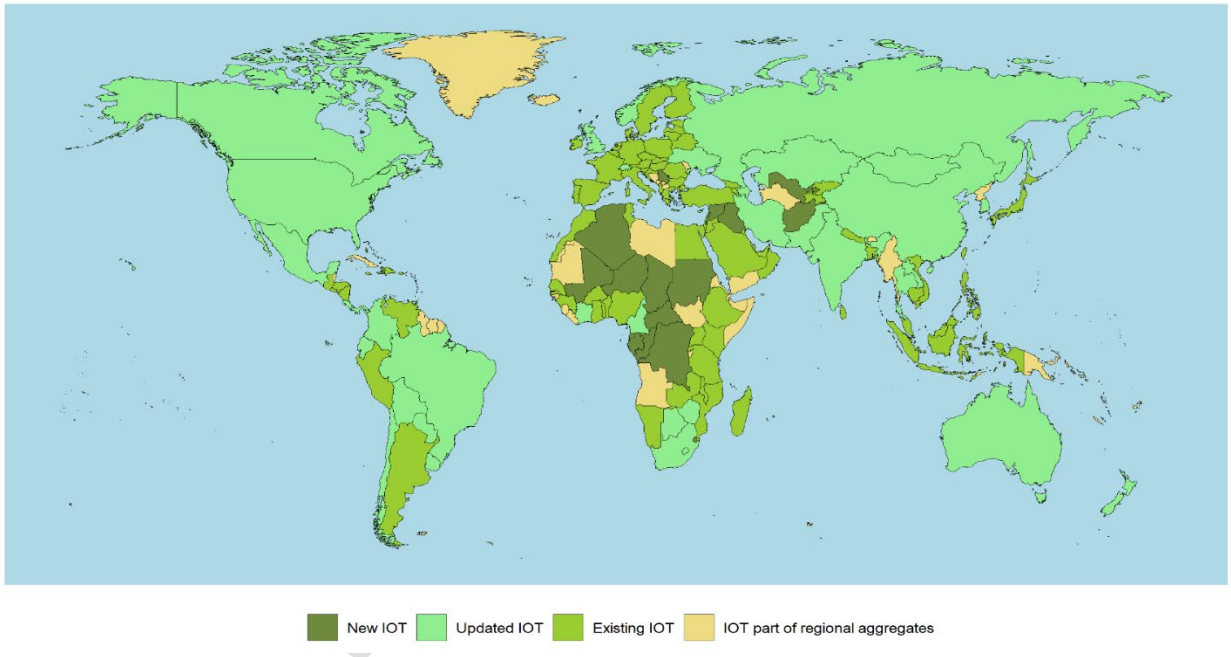

Figure 1. Regional Coverage in GTAP 11 Data Base

Notes: Countries in green are part of GTAP 11. The darkest green indicates a country which is newly extracted from a composite region, based on newly available IOTs. The lightest green represents countries that have been updated for version 11. The medium shade of green is for existing countries with no new IOT updates. Other countries (in beige) with no IOT are represented in GTAP's 'Rest of' regions. (Source: Aguiar et al. 2022).

There are several data extensions/satellites that accompany the standard GTAP Data Base, which are generally updated soon after the public release. The additional satellite data are: (1) energy volumes and CO2emissions; (2) bilat-eral time-series trade data; (3) Non-CO2 greenhouse gases (GHGs) (documented in Chepeliev (2020a)) and air pollution emissions (Chepeliev, 2021a), which also include estimates of process CO2emissions; and (4) food balance sheets (Chepeliev,2022b), which allow for analysis of nutritional impacts of policies. These files can be aggregated when placed along the main data files in each distribution. The GTAP extensions/satellites provide modified data to be used with specific models. Among others, these are the energy extension (GTAP-E documented in McDougall and Golub (2009)), land use and cover (GTAP-LULC documented in Baldos and Corong (2019)), international migration and remittances (GMIG documented in Walmsley, Winters, and Ahmed (2007); Aguiar (2020)), foreign income payment and receipts (GDYN documented in McDougall et al. (2012); Golub (2016)), electricity generation (GTAP-Power documented in Peters (2016); Chepeliev (2020c)),multi-region Input Output (MRIO described in Carrico, Corong, and van der Mensbrugghe (2020)) and domestic margins (Corong, 2018).

2. Environmental Emissions

In this paper, we present the various environmental emissions—e.g., greenhouse gas (CO2, Methane, N2O, F-gas) and air pollution emissions—obtained from the most recent GTAP version 11 Data Base (Aguiar et al. 2022) with a 2017 base year. Our calculated environmental emissions are further described below.

First, aside from CO2 emissions from fossil fuel combustion, we additionally account for CO2-equivalent (CO2e) emissions from industrial processes (e.g. chemicals, cement) and non-CO2 greenhouse gases (GHGs) such as methane (CH4), nitrous oxide (N2O) and fluorinated gases (F-gases) based on GTAP non-CO2 data by Chepeliev (2023).This allows for a more complete evaluation of emission intensities across commodities and, in particular, provides a better measure of emission intensities of agricultural and food commodities (mainly due to non-CO2 GHGs) which are often associated with high tariff and non-tariff barriers.

Second, we extend the assessment of emission intensities to include nine air pollutants based on the database developed by Chepeliev (2023). According to the Global Burden of Disease study (Cohen et al., 2017), ambient air pollutant emissions in 2015 caused 4.2 million deaths and resulted in a loss of 103.1 million disability-adjusted life-years, making it the fifth-ranked global risk factor. In terms of the welfare costs of mortality and illnesses associated with outdoor air pollutant emissions, global estimates range between $2.7-3.2 trillion, which is equivalent to 40% of global health expenditures (Coady et al., 2015; WB, 2021). Therefore, it is important to additionally consider air pollutant emissions in the overall context of environmental damages.

Third, for estimating emission intensities, we employ in this paper the emissions embodied into trade (EEBT) method, which assumes that the production technology is

based on fixed proportions or that the production of domestically supplied commodities has the same characteristics as the exported products. Once the GTAP-MRIO version 11 Data Base becomes available, we will then calculate and compare the environmental emissions obtained from the proportional approach currently employed in the paper.

3. Results and Discussions

The global environmental emissions from production, as calculated from the GTAP version 11 Data Base (Aguiar et al. 2022) with a 2017 base year, are shown in Figures 2 and 3. Total greenhouse gas emissions from production alone amounts to 45,746 metric tons of CO_2-equivalent (MTCO2-e) of which 72% is due to carbon dioxide (CO_2) emissions followed by Methane (CH_4), Nitrous Oxide (N_20) and Fluorinated gasses (F-gas) with 19%, 6% and 3% share respectively. Figure 2 also shows that three sectors account for 90% of total global CO_2 emissions. The most carbon-intensive sub-sector is utility and construction where power generation is aggregated. This sub-sector accounts for 42% of total global CO_2 emissions, followed by heavy manufacturing (28% share) which includes cement and metals production. Global transport contributes roughly 19% of global CO_2 emissions, while all other sectors in the global economy account for the remaining 10% of worldwide CO_2 emissions. On the other hand, 99% of global Methane emissions mainly originate from five sectors, namely: Meat and Livestock (33%), Utilities/Construction (25%), Extraction/Mining (24%), Heavy manufacturing (10%) and crops (8%).

Figure 3 shows the embodied air pollution emissions from production at the global level in 2017. Carbon Monoxide (CO) is the most significant global air pollutant followed by Nitrous Oxide (NOx), Sulfur Oxide (SO_2), Volatile Organic Compounds (NMVOC) and Ammonia (NH_3). These five categories account for a combined 90% of total global air pollution with 38%, 16%, 14%, 14% and 7% respectively. Roughly 62% of total Carbon Monoxide pollution in the world comes from Heavy manufacturing and Crops subsectors, while about 72% of total Nitrous Oxide emissions come from Transport and Utilities. The transport sector also accounts for at least half of total Sulfur Oxide emissions. On the other hand, the entire manufacturing sector accounts for 73% of total Volatile Organic Compounds while the combined Crops and Meat/Livestock sector accounts for 94% of total global pollution coming from Ammonia.

Figure 4 shows the distribution of global greenhouse gas emissions. It shows that much of the global greenhouse gas emissions from production come from East Asia, North America, West Europe, South Asia and Middle East and North Africa. Finally, Figure 5 shows that East Asia significantly accounts for global air pollution contribution from production followed by South Asia, North America, Latin America and Sub-Saharan Africa.

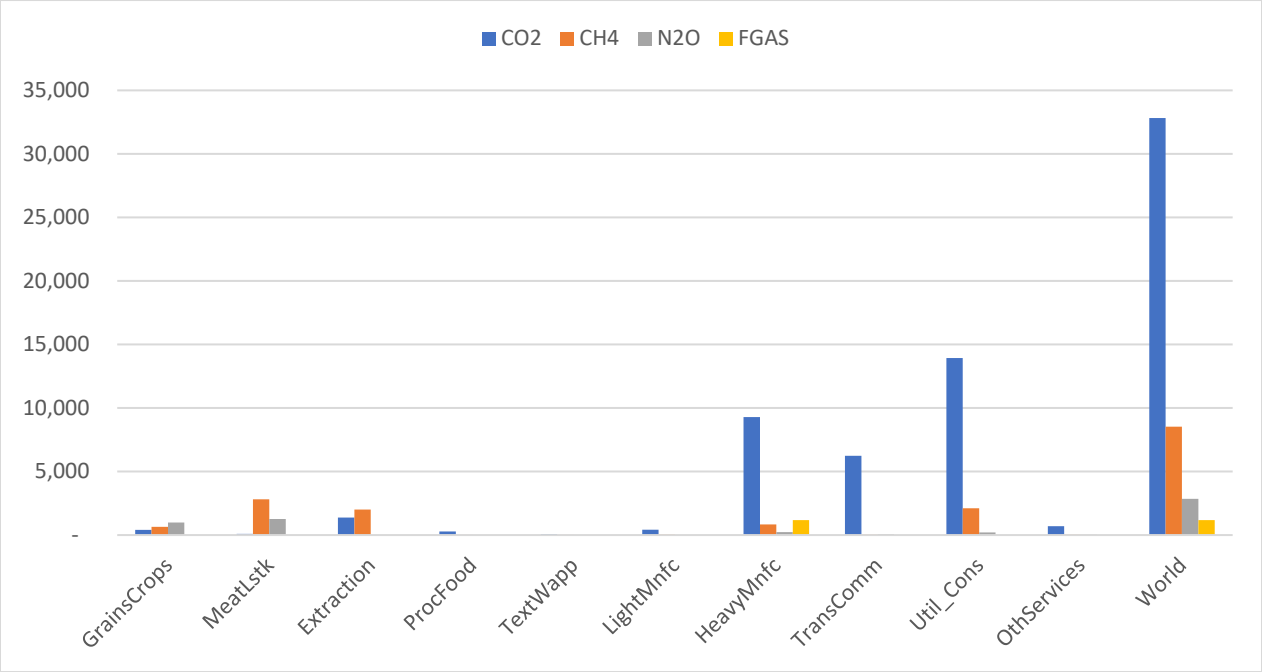

Figure 2. Global Greenhouse Gas Emissions, by type (2017)

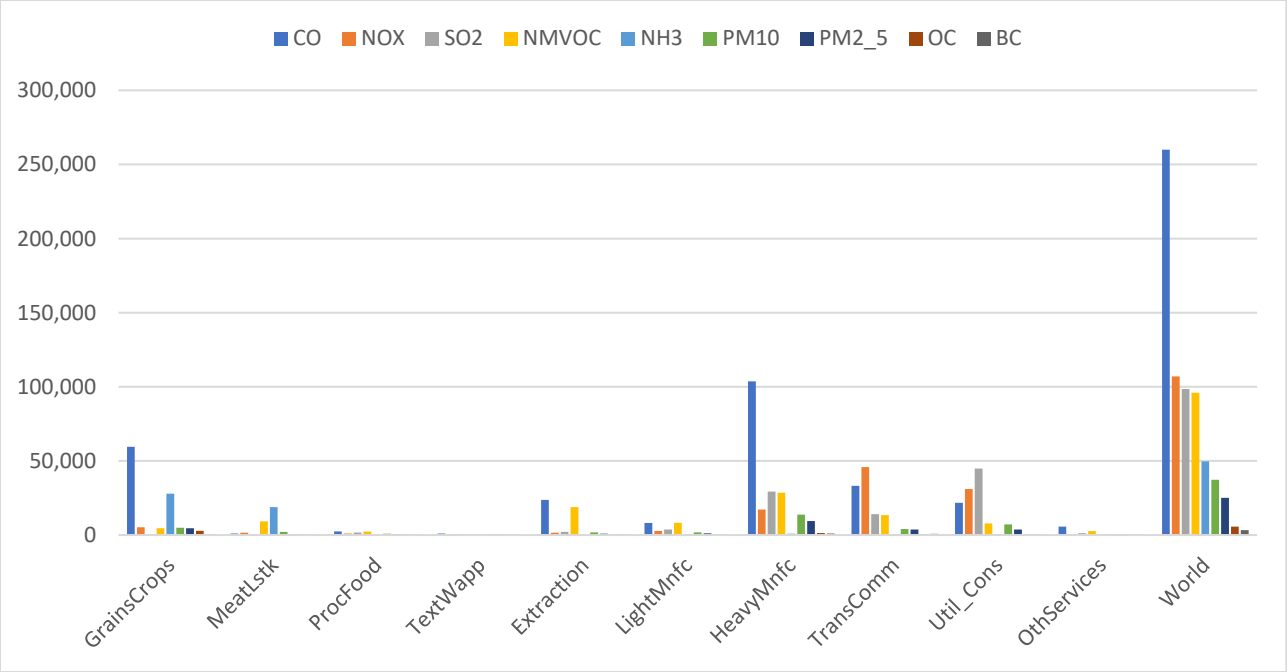

Figure 3. Global Air Pollution Emissions, by type (2017)

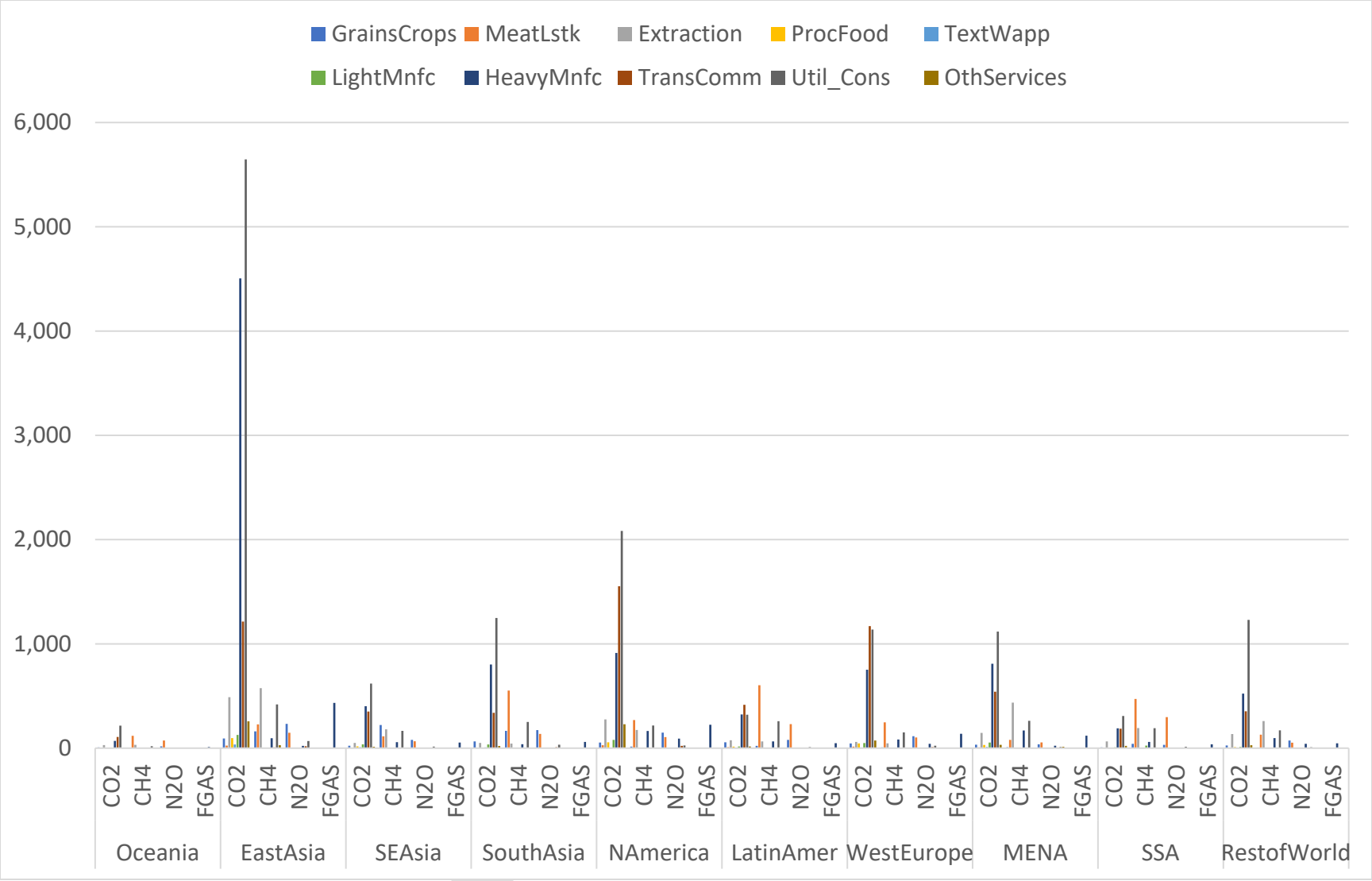

Figure 4. Global Greenhouse Gas Emissions, by country and type of emission (2017)

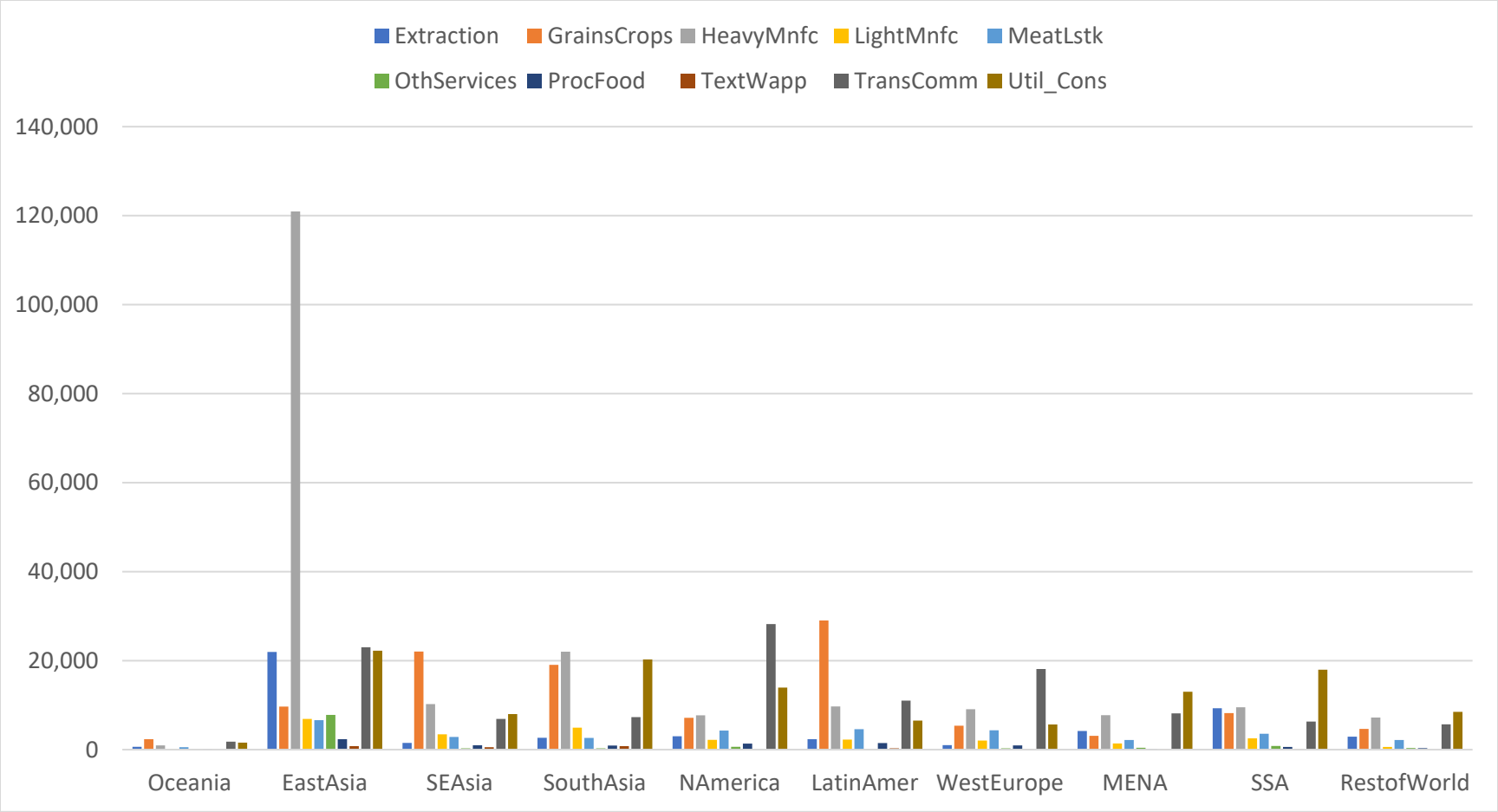

Figure 5. Global Air Pollution Emissions, by country and type of emission (2017)

4. Summary

This paper presents the various environmental emissions—e.g., greenhouse gas (CO2, Methane, N2O, F-gas) and air pollution emissions—obtained from the most recent GTAP version 11 Data Base (Aguiar et al. 2022) with a 2017 base year. The GTAP Data Base describes the domestic transactions, global bilateral trade patterns, international transport margins and protection matrices that link individual countries and regions. For each country/region, the Data Base provides values of production, in addition to intermediate and final consumption of goods and services measured in millions of current U.S. dollars. Many domestic policies are also captured by this database, including value-added taxes, producer subsidies and consumption taxes.

The paper remains a work in progress and will be updated once the GTAP-MRIO version 11 Data Base—which additionally distinguishing bilateral trade and tariff flows by agents or so-called end-users, namely: firms, private household, government and investors—becomes available for public use. To construct the GTAP-MRIO, we use the International Trade Centre's (ITC) MAcMap database and the United Nations Statistics Division (UNSD) 6-digit Harmonized System (HS) to Broad Economic Categories (BEC) concordances to System of National Accounts (SNA) end-use framework and the GTAP Center's HS to GTAP concordances. We then aggregate over GTAP commodities, the trade and tariff data by end-users in MAcMap and consequently use these to disaggregate their associated bilateral trade and tariff flows in the standard GTAP Data Base.

References

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