

Spanish national greenhouse gas emission monitoring system

Methodological document for the spatial distribution of annual emissions

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About RESPIRE-CLIMATE

The Next Generation EU funds are being implemented in Spain through the Recovery, Transformation and Resilience Plan (Plan de Recuperación, Transformación y Resiliencia, PRTyR). Within the framework of this plan, the modernisation of meteorological infrastructure and services was identified as one of the priority investment areas. As a result, funding was allocated to the Spanish State Meteorological Agency ([AEMET](#)) to modernise observation networks and develop advanced meteorological services in the context of climate change. Among the funded initiatives is the “National high-resolution emissions system for air quality forecasting and greenhouse gas monitoring”, an initiative led by the Barcelona Supercomputing Center ([BSC](#)) that gave rise to the [RESPIRE](#) (high Resolution Emission System to support modelling and monitoring Efforts in Spain) project. This initiative maintains strong synergies with two other actions led by AEMET, the organisation responsible for Spain’s national air quality forecasting system and greenhouse gas (GHG) monitoring network. These actions focus on the installation and deployment of the national [COCCON](#)-Spain network for GHG monitoring, as well as the creation of the national repository of GHG observations (García et al., 2024).

RESPIRE aims to strengthen Spain’s strategic capabilities to support better decision-making in air pollution control and climate change mitigation. The project consists of two specific components: RESPIRE-AIR, focused on modelling atmospheric pollutant emissions in Spain, and **RESPIRE-CLIMATE, a national GHG emissions monitoring system**.

The main objective of **RESPIRE-CLIMATE** is to design, build, and implement a national monitoring service for carbon dioxide (CO₂) and methane (CH₄) emissions by combining activity-based emissions data, produced by the BSC, with observation-derived data generated through AEMET’s initiatives.

The **RESPIRE-CLIMATE activity-based emissions system** is structured around three fundamental pillars (Figure 1): (i) the development of annual GHG emissions maps; (ii) the development of a low-latency GHG emissions system; and (iii) the development of a web application.

Annual GHG emission maps: the first pillar is described by the present methodological document. It uses the High-Elective Resolution Modelling Emission System, delta version ([HERMES Δ](#)), a Python-based open-source system developed ad hoc by the BSC within the framework of RESPIRE-AIR. HERMES_Δ enables the spatial disaggregation of Spain’s official GHG inventories reported by the Ministry for Ecological Transition and the Demographic Challenge (MITECO) through the Spanish Emissions Inventory System ([SEIE](#)) under the United Nations Framework Convention on Climate Change (MITECO, 2025). The result is a collection of annual CO₂ and CH₄ emissions maps with a spatial resolution of 1 km², organised by sector according to the Gridded Nomenclature for Reporting (GNFR) classification system. These maps are intended to support subnational entities by providing useful emissions information (Castesana et al., 2026).

Daily GHG emissions system: this pillar constitutes the low-latency emissions product of RESPIRE-CLIMATE. It is a system through which emissions are estimated and reported

with a delay of up to three months from the time they were emitted. Within this pillar, another Python-based open-source system has been developed: [PHENOMENA](#) (sPanish EmissionN mOnitoring systeM for grEeNhouse gAses), which consists of four main modules:

1. **Download module:** responsible for collecting low-latency, high-temporal-resolution activity data from multiple databases, including public datasets (e.g., electricity generation, natural gas flows, traffic congestion and vehicle counts, and surface temperature) as well as commercial data on air and maritime traffic.
2. **Preprocessing module:** responsible for standardising and formatting the collected activity data, including gap-filling routines, quality-control procedures, and fail-safe protocols, ensuring that the data are suitable for emissions estimation.
3. **Emissions estimation module:** responsible for estimating CO₂ and CH₄ emissions based on activity data and emission factors, as described below.
4. **Post-processing module:** designed to combine and generate the final GHG emissions products that are delivered through the web application.

Web application: this pillar focuses on the development and maintenance of the [web application](#) for the visualisation, analysis, and download of emissions data generated by HERMES_Δ and PHENOMENA within the framework of RESPIRE-CLIMATE.

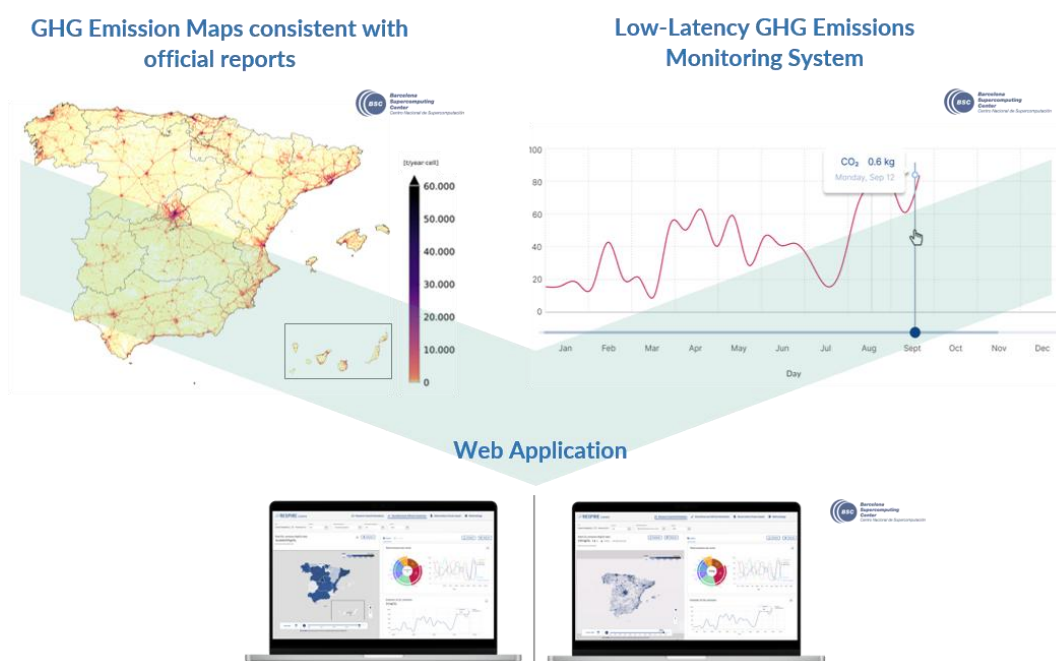


Figure 1. Overview of the main RESPIRE-CLIMATE products.

It should be noted that the datasets and products developed within RESPIRE-CLIMATE are continuously evolving and may be periodically modified as a result of the incorporation of new information, methodological improvements, technical revisions, or

validation and correction processes. Consequently, the results available on the platform may vary between different versions or update dates. Each file, visualisation, or downloadable product is associated with the methodological version in force at the time of consultation or download.

It should also be emphasised that, unlike the estimates presented in the [Annual Emissions](#) section of this web portal, the [Daily Emissions](#) estimates may differ from those reported in MITECO's official GHG inventories. These differences arise not only from methodological variations but also from the low-latency nature of the daily emissions system, which incorporates information up to recent dates, whereas the official inventories are published with a lag of at least two years relative to the reporting period.

Methodology for the spatial distribution of emissions

The HERMES_Δ emissions model combines official GHG emissions information reported by MITECO through the Spanish Emissions Inventory System (SEIE) with industrial emissions databases reported under the framework of Large Point Sources (LPS; MITECO, personal communication, April 2025) and the Spanish Pollutant Release and Transfer Register (PRTR; <https://prtr-es.miteco.gob.es/>, last accessed May 2026). These datasets are combined with spatial allocation proxies to generate annual emissions maps at a 1 km² resolution that are consistent with the inventories reported to the United Nations Framework Convention on Climate Change (UNFCCC).

HERMES_Δ uses as input the emissions reported in the SEIE according to the Selected Nomenclature for Air Pollution (SNAP) sector classification. Consequently, the methodology described in this document follows the same classification scheme. Within HERMES_Δ, a remapping procedure has been implemented to reclassify SNAP emissions into the Gridded Nomenclature for Reporting (GNFR) system, which is used for the final emissions map products generated within RESPIRE-CLIMATE. Table A 1 (Annex A) describes the correspondence between each SNAP activity included in HERMES_Δ and the GNFR sectors. It is also important to note that CO₂ emissions associated with biomass combustion and burning are not included in the SEIE, as biomass is considered a carbon-neutral fuel with respect to CO₂ emissions. Consequently, these emissions are not included in the resulting emissions maps.

The following sections describe in detail the preprocessing of the original inventories reported by MITECO to adapt them to the input requirements of HERMES_Δ, as well as the methodologies and databases applied for their spatial allocation. The resulting annual GHG emissions maps at 1 km² resolution, organised by GNFR sector and generated with HERMES_Δ, are published in the [Annual emissions](#) section of the RESPIRE-CLIMATE web application.

1. Preprocessing of original emissions data

This section describes the preprocessing applied to the original emissions files reported by MITECO, including the LPS and PRTR point-source databases, as well as the SEIE inventory. The tasks performed during this preprocessing include both the validation and correction of certain parameters (e.g., geolocation of point sources) and the aggregation

of detailed information required to integrate emissions into the HERMES_Δ model (e.g., assigning SNAP codes to PRTR sources and disaggregating SEIE emissions to a fourth SNAP level).

1.1. Point sources

The LPS and PRTR registries are two official databases that compile information on emissions from industrial activities subject to reporting requirements, in accordance with the criteria established in Royal Decree 100/2011 and Annex I of Royal Decree 815/2013.

- The LPS registry (2023) provides industrial emissions disaggregated by emission source, specifying the corresponding SNAP and NFR (Nomenclature for Reporting) codes, as well as the geographic location and stack height associated with each source. Emissions reported in the LPS are based on calculations performed by MITECO using information collected from questionnaires completed by companies. The LPS database does not include the name of the installation.
- The PRTR registry (2023) reports total emissions at the industrial installation level, regardless of the number of internal sources or processes generating those emissions. This database provides the name and geolocation of each installation but does not include information on the associated SNAP or NFR sector, nor stack height. Instead, PRTR installations are classified according to CNAE and IED codes, following the National Classification of Economic Activities and the Industrial Emissions Directive (Directive (EU) 2024/1785), respectively. Emissions reported in the PRTR are calculated and reported by the companies themselves and subsequently reviewed by the competent authorities of each Autonomous Community. Reported emissions may be based on measurements, calculations, or estimates.

To ensure the quality and consistency of the data used in HERMES_Δ, the modifications and validation procedures described below were carried out.

1.1.1. LPS

1.1.1.1. Assignment of installation names

Since the LPS database does not include installation names, the company responsible for each georeferenced point source was identified, making it possible to link each industrial facility to its corresponding Integrated Environmental Authorisation (IEA). This process facilitated the validation and correction of potential inconsistencies in the reported information, particularly regarding geolocation data and stack heights, as described in the following section.

1.1.1.2. Review and correction of geolocation and stack heights

A total of 29 LPS installations had their locations adjusted because they originally corresponded to administrative headquarters rather than the actual emission sources, or because they exhibited significant location errors. Figure 2 illustrates a specific case in

the Autonomous Community of Andalusia, where the location reported in the LPS registry is situated in the centre of an urban area (red icon), while the actual industrial facility is located approximately 1.1 km to the northwest (green square). The geolocation corrections carried out were communicated to MITECO so that they can be incorporated into the LPS registry.

In addition, installations associated with combustion processes were identified that reported a stack height of 0 m, as well as other cases with outdated information. For these facilities, the corresponding IEAs were consulted and stack-height values were updated to reflect actual operating conditions.



Figure 2. Example of the geolocation correction of an installation in Andalusia. In red, the location reported in the LPS registry. In green, the corrected location.
Source: authors' own elaboration based on Google Maps, 2025.

1.1.1.3. Filtering of the original catalogue

Several categories of installations were removed from the original LPS catalogue, as detailed below:

- Controlled municipal solid waste landfills: within the waste management sector, landfills registered in LPS (SNAP activity 090401) were excluded because approximately 150 cases with incorrect locations were identified. In many instances, landfills appeared to be located in urban centres, vacant lots, or other implausible locations. Future work will involve collaboration with MITECO to investigate how these locations can be corrected and incorporated into HERMES_Δ.
- Airports: Emissions associated with airports registered in LPS were removed because HERMES_Δ treats these as area sources and distributes emissions using the polygons defining each airport infrastructure in Spain, as described in Section 2.8.

1.1.2. PRTR

1.1.2.1. Filtering of the original catalogue

From the original PRTR catalogue, industrial installations corresponding to the following CNAE and IED codes were excluded:

- Landfills and other waste management facilities (CNAE codes 3811, 3812, 3821, 3822, 3831): these facilities were excluded to maintain methodological consistency with the LPS database. In particular, all records from the waste sector were removed because many correspond to storage, sorting, industrial landfill, or construction-waste disposal facilities, which are not included in the SEIE emissions inventory. The SEIE only considers emissions originating from municipal solid waste landfills.
- Livestock farms (IED code 7.a.): these facilities were not considered because the PRTR registry provides only limited coverage of livestock operations, including only pig and poultry farms that exceed specific capacity and emissions thresholds. Instead, HERMES_Δ estimates livestock-sector emissions by combining SEIE data with the Spanish Livestock Holdings Register (REGA; MAPA, 2023a), which includes all registered livestock farms in Spain and provides detailed information on location and animal numbers by species. The methodology is described in Section 2.10.
- Oil and gas refineries (IED code 1.a.i): these installations were excluded because they are already included in the LPS database.

Similarly, an additional 241 installations that were present in both PRTR and LPS were removed from the PRTR database to avoid double counting of emissions. When an installation appeared in both datasets, the LPS version was retained because it provides a finer disaggregation of emissions by emission source and SNAP activity, whereas PRTR reports emissions only at the installation level without distinguishing between processes or emission sources. Furthermore, LPS emissions are consistent with the SEIE inventory, unlike PRTR emissions.

1.1.2.2. Assignment of SNAP codes

To integrate PRTR emissions into the HERMES_Δ model, it was necessary to assign a SNAP code to each installation. This process followed the steps described below:

1) Use of the CNAE-SNAP correspondence:

First, a SNAP activity was assigned to each installation based on the CNAE code reported in the PRTR registry. The CNAE–SNAP correspondences used are summarised in Table B 1 (Annex B).

2) Use of the Catalogue of Potentially Air-Polluting Activities (CAPCA) Code

Next, for installations whose IEA included a CAPCA code—which corresponds to the fourth level of the SNAP nomenclature—the SNAP activity assigned in the previous step

was reviewed. In cases of discrepancy, priority was given to the CAPCA code reported in the installation's IEA.

However, some PRTR installations contain multiple emission sources associated with different CAPCA codes, making it difficult to assign all emissions to a single SNAP activity. Several situations were identified:

a) Clear assignment to a single SNAP activity

In some cases, it was possible to assign a single SNAP activity based on the reported pollutants and the main equipment used. For example:

- Installations containing boilers, furnaces, or reporting only NO_x, NO₂, CO, and CO₂ emissions were classified within the combustion sector (SNAP 03).
- When these pollutants were not reported, installations were assigned to other sectors such as industrial processes (SNAP 04), solvent and product use (SNAP 06), or waste treatment and disposal (SNAP 09).

b) Splitting emissions between two SNAP activities

In other cases, it was possible to clearly separate emissions of one or more pollutants according to the type of process or emission source. In such situations, the corresponding record was duplicated so that total emissions could be distributed among the different SNAP activities involved. This duplication and allocation procedure was applied only to a subset of facilities classified under the following SNAP activities: SNAP 040416 – Other industrial processes in the inorganic chemical industry; SNAP 040506 – Low-density polyethylene production; SNAP 060403 – Printing and graphic arts; SNAP 060404 – Extraction of fats and oils; SNAP 060305 – Rubber processing.

c) Complex industries: simplified assignment to a single SNAP activity due to the difficulty of disaggregating emissions:

Other PRTR facilities were identified for which it was not possible to distribute emissions among different SNAP codes because of the complexity of the installations (multiple emission sources with different CAPCA codes) and the lack of information regarding the contribution of each process to total emissions.

To prevent inaccurate SNAP assignments in PRTR facilities from generating sectoral inconsistencies when compared with SEIE data, HERMES_Δ incorporates a consistency mechanism that automatically adjusts PRTR emissions. This mechanism ensures that total emissions by pollutant, Autonomous Community, and SNAP activity reported by the combined LPS and PRTR datasets never exceed the corresponding values reported in the SEIE inventory.

1.1.2.3. Verification and correction of geolocations

As in the LPS database, errors were detected in the location of some PRTR installations. In total, adjustments were made to 146 installations, which presented geolocation errors involving displacements ranging from several hundred metres to several kilometres. The corrections made were communicated to MITECO so that they can be updated in the PRTR register.

1.2. Sectoral disaggregation of SEIE emissions

SEIE emissions are originally disaggregated by Autonomous Community (CCAA), pollutant and SNAP activity at level 3. Although this level of sectoral detail allows emissions to be obtained with a very high degree of process and activity disaggregation (353 emission categories), in some cases it is insufficient to apply appropriate spatial distribution methods. To overcome this limitation, the original SEIE inventory has been pre-processed to increase the level of disaggregation (level 4) for a selection of activities. This process has been carried out using emissions data by CCAA and pollutant provided by MITECO (personal communication), consistent with the SEIE information. The sectors for which this level 4 disaggregation has been applied are as follows:

- SNAP01: Combustion in energy and transformation industries
- SNAP02: Non-industrial combustion plants
- SNAP05: Extraction and distribution of fossil fuels and geothermal energy
- SNAP10: Agriculture

The following subsections describe in detail the disaggregation processes carried out for each of these sectors. As a result of this process, the number of emission categories has increased from the original 353 in the SEIE to a total of 982 categories.

1.2.1. SNAP 01. Combustion in energy and transformation industries

For SNAP01, the disaggregation process has been applied to district heating and cooling networks for public service. As the Spanish catalogue of these facilities includes information on the fuel used at each installation (see Section 2.1), the original SEIE emissions have been disaggregated by fuel type (biomass and natural gas) in order to enable a more precise spatial distribution. Information provided by MITECO (personal communication) has been used to carry out this process.

1.2.2. SNAP 02. Non-industrial combustion plants

Emissions reported in the SEIE for this SNAP sector are classified according to the sector to which the installation belongs and the combustion technology used. However, this classification does not include detailed information on fuels used, which is particularly relevant for the spatial distribution of emissions from SNAP 0201 (commercial and institutional combustion) and 0202 (residential combustion). For example, in Spain, natural gas consumption is typically associated with urban areas, whereas the use of wood is more common in rural settings. The lack of fuel disaggregation hinders a more accurate spatial distribution of emissions. Likewise, in the case of SNAP 0203 (combustion in agriculture, forestry and aquaculture), there is also no distinction between installation types (livestock farms, aquaculture facilities or irrigated farming operations). This limitation has been addressed using a more detailed database provided by MITECO (personal communication).

For emissions from SNAP 0201 and 0202, this database includes information disaggregated into a total of 19 fuels, which have been regrouped into the following five broad fuel categories for simplification purposes:

- Natural gas
- Liquefied petroleum gas (LPG)
- Coal: including sub-bituminous coal, coke oven coke (from bituminous and anthracite coal), petroleum coke, and manufactured fuels
- Biomass: including wood pellets, wood and wood waste, nutshell residues, sawdust and wood shavings, olive stones, chips, and charcoal
- Other fuels: including diesel, fuel oil, kerosene, manufactured gas and biogas

For SNAP 0203 (agriculture, forestry and aquaculture sector), the following sectoral disaggregations have been carried out:

- SNAP 020302 (boilers in combustion plants < 50 MWt): disaggregation of original emissions between those generated in livestock farms and in aquaculture facilities.
- SNAP 020304 (stationary engines): disaggregation of original emissions between those generated in irrigated farming operations and in livestock farms.

1.2.3. SNAP 05. Extraction and distribution of fossil fuels and geothermal energy

Within the emission sources of this SNAP sector, maritime terminals (SNAP 050401) are included. This activity covers emissions associated with different sub-activities, such as loading and unloading of tankers and the handling and storage of crude oil and petroleum products. These operations may take place both at refineries and at maritime terminals. Since these emissions are not generated at a single location, they were disaggregated assuming that 93% occur at maritime terminals and the remaining 7% at refineries (MITECO, personal communication).

1.2.4. SNAP 10. Agriculture

1.2.4.1. Application of fertilisers to crops

With regard to emissions associated with agricultural crops where nitrogen fertilisers are used (SNAP 1001), the SEIE reports them according to the following SNAP activities:

- Permanent crops (SNAP 100101)
- Arable crops (SNAP 100102)
- Rice fields (SNAP 100103)
- Horticulture (SNAP 100104)
- Grasslands (SNAP 100105)
- Fallow land (SNAP 100106)

This level of disaggregation does not allow for detailed treatment of emissions, since within each category there are crops whose spatial distributions differ significantly. To

address this limitation, a database provided by MITECO (personal communication) has been used, in which SNAP 1001 emissions are classified according to:

- a) Specific crop type, including a total of 109 crops. Table 1 relates the crops included in the MITECO database to the six SNAP activities mentioned above.

Table 1. Relationship between crops considered in the SNAP nomenclature and the MITECO database.

SNAP activity	Crop family	Crops included in the MITECO database
Permanent crops (SNAP 100101)	Fruit trees	Avocado, apricot, almond, hazelnut, cherry and sour cherry, custard apple, plum, fig, lemon, mandarin, apple, peach, quince, orange, loquat, walnut, table olive grove, other citrus, pear, banana
	Non-fruit crops	Oil olive grove, table vineyard, wine vineyard
	Other fruit crops	Other non-citrus crops
	Other	Other woody crops
	Cereals	Oats, barley, rye, maize, other cereals, sorghum, wheat, triticale
Arable crops (SNAP 100102)	Industrial crops	Cotton, sugar cane, rapeseed, sunflower, flax, hops, other industrial crops, sugar beet, soybean, tobacco
	Pulse grains	Lupin, chickpea, dry pea, dry broad bean, dry bean, lentil, vetch
	Other arable crops	Other pulses, natural grasslands
	Tubers	Other tuber crops, potato
Rice fields (100103)	Rice	Rice
Horticulture (100104)	Vegetables	Swiss chard, chicory and others, garlic, artichoke, celery, aubergine, cabbage, pumpkin and courgette, cardoon, onion, spring onion, cabbage and head cabbage, cauliflower, endive, asparagus, spinach, ornamental flowers and plants, strawberry, green pea, green broad bean, green bean, lettuce, melon, turnip and others, other vegetables, gherkin, cucumber, pepper, leek, radish, table beet, watermelon, tomato, carrot
Grasslands (100105)	Fodder crops	Alfalfa, winter cereals, forage maize, other forage grasses, multi-species pastures, forage sorghum
	Forage legumes	Sainfoin, other forage legumes, clover, forage vetch, bitter vetch, sulla
	Grasslands	Grasslands
	Other fodder crops	Other fodder crops, fodder cabbage, fodder pumpkin
Fallow land (100106)	Land use	Fallow land, rough grazing land, open woodland, wooded land

- b) Type of fertiliser applied: through the NFR nomenclature, the MITECO database also includes information on the type of fertiliser used in each case, allowing for differentiated spatial elements to be applied. Table 2 summarises the equivalence between NFR categories and fertiliser types.

Table 2. Equivalence between the type of fertiliser applied to agricultural crops and NFR code.

NFR code	Description (type of fertiliser)
3Da1	Inorganic nitrogen fertilisers
3Da2a	Animal manure applied to soil

3Da2b	Sewage sludge applied to soil
3Da2c	Other organic fertilisers applied to soil
3Da3	Urine and dung deposited by grazing animals
3Dc	Agricultural operations at farm level, including storage, handling and transport
3De	Crops

The implementation of this disaggregation process at crop and fertiliser level has made it possible to increase the number of categories within SNAP 1001 from 6 to a total of 632.

1.3. Filtering of SEIE emissions

From the total set of emission activities reported in the SEIE, the following have been excluded from the HERMES_Δ database:

- SNAP 080402–080403–080404 (domestic maritime traffic, national fishing, and international maritime traffic): emissions from domestic and international maritime navigation, which are determined based on the port of departure and arrival, are excluded from HERMES_Δ, since using only SEIE-reported data would provide an incomplete picture of all maritime emissions occurring in Spanish territorial waters.
- SNAP 080503–080504 (aviation traffic > 1000 m): these emissions are not considered because SEIE-reported emissions only include flights arriving at or departing from a Spanish airport, which provides an incomplete picture of the total amount of aviation emissions over Spanish territory.
- SNAP 090700 (open burning of agroforestry waste) and SNAP 100305 (open burning of agricultural residues in the field): these emissions are excluded to avoid double counting with emission data from the Copernicus Global Fire Assimilation System (GFAS) (Kaiser et al., 2012), which is widely used in the modelling community to account for biomass burning emissions (Colette et al., 2025).
- SNAP 11 (other sources and sinks – natural): this entire set of emissions is excluded because they are not of anthropogenic origin.

2. Spatial distribution of emissions

2.1. SNAP 01. Combustion in energy and transformation industries

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from combustion activities in the energy production and transformation sector. Emissions from this sector are divided into the following five subgroups, which are further disaggregated into a total of 29 SNAP activities, described in Table 3:

- SNAP 0101 – Public power stations: emissions generated by electricity-producing combustion plants whose primary activity is supplying electricity to the public grid.
- SNAP 0102 – Public district heating networks: emissions from conventional heat production plants based on combustion, whose primary activity is supplying heat through public distribution networks, also known as district heating systems.
- SNAP 0103 – Combustion in petroleum refineries: emissions arising from heat and electricity generation within refineries.
- SNAP 0104 – Solid fuel transformation plants: emissions originating from combustion processes used in the conversion of solid fuels into other processed forms, with or without a change in physical state.
- SNAP 0105 – Non-specific combustion in coal mining and oil and gas extraction, and non-specific combustion in fuel pipeline transport networks: emissions generated by combustion associated with the extraction, initial processing, transport and storage of fuels such as coal, oil and gas. This category also includes emissions from combustion processes related to the pipeline transport of petroleum products and natural gas.

In order to assign more representative spatial distribution proxies, the original emissions reported in the SEIE for this SNAP sector were disaggregated to a more detailed sectoral level, as described in Section 1.2.1.

The spatial distribution of emissions reported in this sector was conducted primarily using the LPS and PRTR databases, following the treatment and processing described in Section ;**Error! No se encuentra el origen de la referencia.**. The remaining emissions were allocated using a range of auxiliary spatial proxies, including, among others, a catalogue of biogas plants containing data on installed electrical capacity and a catalogue of biomass and natural gas district heating networks containing data on installed thermal capacity. For SNAP activities for which the corresponding facilities could not be identified, the industrial land-use layer from the CORINE Land Cover product (CLMS – Copernicus Land Monitoring Service, 2020) was used as an auxiliary spatial proxy.

Table 3 summarises the georeferenced spatial proxies assigned to each SNAP 01 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy. As noted in Section 1.2.1, the original emissions reported in the SEIE for SNAP activity 010203 were disaggregated by fuel type. Consequently, Table 3 includes two entries for this activity, depending on whether biomass or natural gas is used as fuel.

Table 3. Georeferenced spatial proxies assigned to each SNAP 01 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
010101	Public power plants: boilers ≥ 300 MW _t	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010102	Public power plants: boilers ≥ 50 and < 300 MW _t	LPS and PRTR databases (2023) Biomass plants catalogue (2024) Industrial land use (2018)	LPS, PRTR, industrial land use: Not applicable Biomass plants: installed thermal capacity [MW _t] (2024)	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Biomass plants: Proxy: PRETOR (MITECO, 2024a) Weight: integrated environmental permits for each installation (PRTR-España, 2025b) Industrial land use: CLMS (2020)
010103	Public power plants: boilers < 50 MW _t	LPS and PRTR databases (2023) Biogas and biomass plants catalogue (2024) Industrial land use (2018)	LPS, PRTR, industrial land use: Not applicable Biogas and biomass plants: installed electrical capacity [MW _e] (2024)	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Biogas and biomass plants Proxy and weight: PRETOR (MITECO, 2024a) and several reports (MAPA, 2023b; MITECO, 2024b; EPSAR, 2024; Agencia Andaluza de la Energía, 2023) Industrial land use: CLMS (2020)
010104	Public power plants: gas turbines	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
010105	Public power plants: stationary engines	LPS and PRTR databases (2023) Biogas plants (2024) Industrial land use (2018)	LPS, PRTR, industrial land use: Not applicable Biogas plants: installed electrical capacity [MW _e] (2024)	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Biogas plants: Proxy and weight: PRETOR (MITECO, 2024a) and several reports (MAPA, 2023b; MITECO, 2024b; EPSAR, 2024; Agencia Andaluza de la Energía, 2023) Industrial land use: CLMS (2020)
010201	District heating plants: boilers ≥ 300 MW _t	-	-	-
010202	District heating plants: boilers ≥ 50 and <300 MW _t	-	-	-
010203_biomass	District heating plants: biomass boilers < 50 MW _t	Biomass district heating plants catalogue (2024)	Total installed capacity [MW] (2024)	ADHAC (2024)
010203_natural_gas	District heating plants: natural gas boilers < 50 MW _t	Natural gas district heating plants catalogue (2024)		
010204	District heating plants: gas turbines	-	-	-
010205	District heating plants: stationary engines	-	-	-
010301	Petroleum and/or gas refining plants: boilers ≥ 300 MW _t	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010302	Petroleum and/or gas refining plants: boilers ≥ 50 and < 300 MW _t			
010303	Petroleum and/or gas refining plants: boilers < 50 MW _t			
010304	Petroleum and/or gas refining plants: gas turbines	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010305	Petroleum and/or gas refining plants: stationary engines	-	-	-
010306	Petroleum and/or gas refining plants: process furnaces	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010401	Solid fuel transformation plants: boilers ≥ 300 MW _t	-	-	-
010402	Solid fuel transformation plants: boilers ≥ 50 and 300 MW _t	-	-	-

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
010403	Solid fuel transformation plants: boilers < 50 MW _t	Industrial land use (2018)	Not applicable	CLMS (2020)
010404	Solid fuel transformation plants: gas turbines	-	-	-
010405	Solid fuel transformation plants: stationary engines	Industrial land use (2018)	Not applicable	CLMS (2020)
010406	Solid fuel transformation plants: coke oven furnaces	LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
010407	Solid fuel transformation plants: other (coal gasification, liquefaction...)	-	-	-
010501	Coal mining, oil/gas extraction, pipeline compressors: boilers ≥ 300 MW _t	-	-	-
010502	Coal mining, oil/gas extraction, pipeline compressors: boilers ≥ 50 and > 300 MW _t	-	-	-
010503	Coal mining, oil/gas extraction, pipeline compressors: boilers < 50 MW _t	LPS database (2023) and industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
010504	Coal mining, oil/gas extraction, pipeline compressors: gas turbines			
010505	Coal mining, oil/gas extraction, pipeline compressors: stationary engines			
010506	Coal mining, oil/gas extraction, pipeline compressors: pipeline compressors			

As an example, Figure 3 presents the spatial proxy used for the disaggregation of emissions from SNAP activity 010103. As detailed in Table 3, the proxy used in this case is a map of biogas and biomass plants, while the weighting factor corresponds to the installed electrical capacity (MWt).

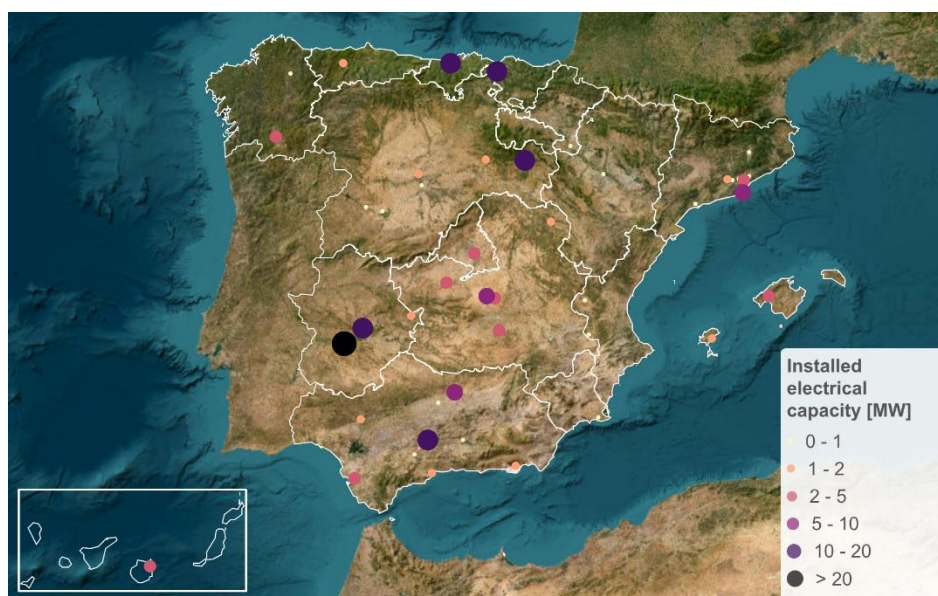


Figure 3. Spatial proxy used for the disaggregation of emissions from SNAP activity 010103 (public power plants: boilers < 50 MWt): installed electrical capacity at biogas and biomass plants.

2.2. SNAP 02. Non-industrial combustion plants

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from non-industrial combustion installations. These include emissions arising from heat generation activities and, to a lesser extent, combined heat and power generation (cogeneration), intended for individual use in residential and service-sector buildings, as well as in agricultural and livestock establishments. Emissions from this sector are divided into the following three subgroups, which are further disaggregated into a total of 27 SNAP activities, described in Table 4:

- SNAP 0201 – Commercial and institutional sector
- SNAP 0202 – Residential sector
- SNAP 0203 – Agriculture, forestry and aquaculture

In order to assign more representative spatial distribution proxies, the original emissions reported in the SEIE for this SNAP sector were disaggregated to a more detailed sectoral level, as described in Section 1.2.2.

The spatial distribution of emissions reported in SNAP sector 02 was conducted entirely using auxiliary spatial proxies. Unlike other sectors, information from the LPS and PRTR point-source databases was not used, as these databases do not report most of the emission sources associated with this sector.

For subgroups 0201 (commercial and institutional sector) and 0202 (residential sector), the locations of the associated boilers, gas turbines and stationary engines are not available.

Therefore, different municipal- or provincial-level statistics were used depending on the fuel type. For example, for natural gas, the GHS-POP population density layer from the Global Human Settlement Layer project (GHSL; Schiavina et al., 2023a) was combined with the list of municipalities connected to the natural gas network (CNMC, 2018) and province-level relative energy consumption for heating purposes (Cuchi et al., 2017), as shown in Figure 4. In contrast, for biomass, whose use in Spain is generally concentrated in rural areas, the GHS-SMOD rural population density layer from GHSL (Schiavina et al., 2023b) was combined with a range of regional indicators related to domestic biomass use, depending on the information available in each CCAA.

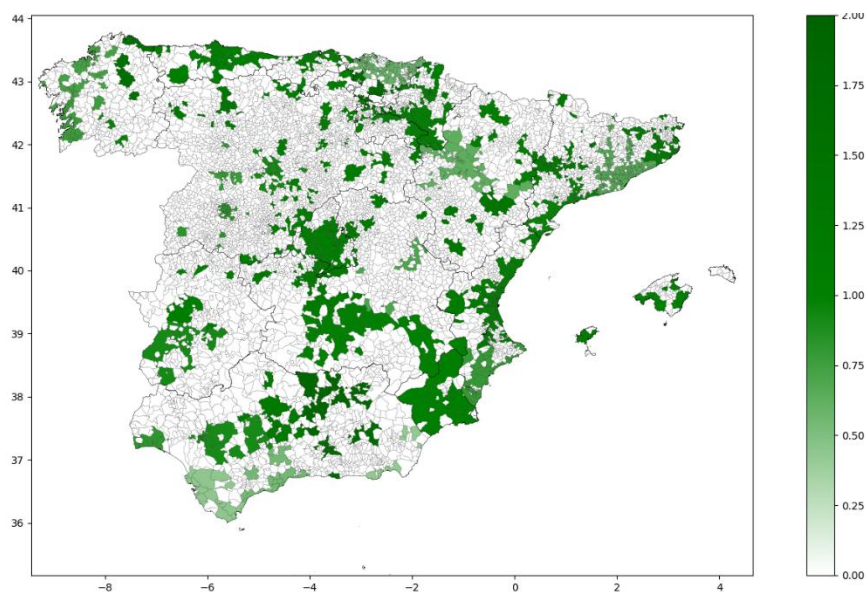


Figure 4. Spatial proxy used for the disaggregation of emissions from SNAP activities 020103_natural_gas, 020104_natural_gas, 020105_natural_gas and 020202_natural_gas. The weighting factor is based on relative energy consumption for heating purposes combined with the list of municipalities connected to the natural gas network. The combination of this spatial proxy with the GHS-POP population density layer is performed internally by HERMES_Δ.

For subgroup SNAP 0203 (agriculture, forestry and aquaculture), a map of inland aquaculture facilities (MAPA, 2024), a farm database (MAPA, 2023a), and the CORINE Land Cover land-use layer (CLMS, 2020) were used. Due to the lack of information on energy consumption at individual farms and aquaculture facilities, a relative weight of 1 was assigned to all installations. Figure 5 shows part of the farm database used as an auxiliary spatial proxy for SNAP activities 020302_farms and 020304_farms.

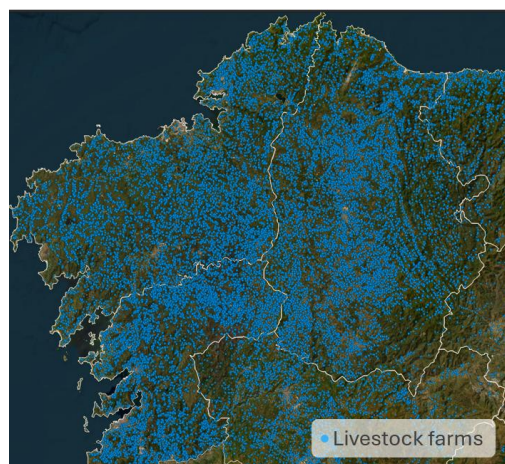


Figure 5. Spatial proxy used for the disaggregation of emissions from SNAP activities 020302_farms and 020304_farms in the Galicia region. Due to the lack of information on energy consumption at individual holdings, the same relative weight was assigned to all installations.

In summary, Table 4 describes the georeferenced spatial proxies assigned to each SNAP 02 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy.

Table 4. Georeferenced spatial proxies assigned to each SNAP 02 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
020101	Commercial and institutional plants Boilers ≥ 300 MW _t	-	-	-
020102	Commercial and institutional plants Boilers ≥ 50 and < 300 MW _t	-	-	-
020103_biomass	Commercial and institutional plants Boilers < 50 MW _t . Fuel: biomass	Population type: rural (2020) Municipal boundaries (2018)	Regional indicators of household biomass use, according to the information available in each CCAA (Comunidad Valenciana: 2008; Cataluña: 2023; País Vasco: 2021; Rest: 2021)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Household biomass use indicators: Institut Valencià d'Estadística (2024); Institut Català d'Energia (2025); Instituto Vasco de Estadística (2022); Instituto para la Diversificación y Ahorro de la Energía (2025)
020103_coal	Commercial and institutional plants Boilers < 50 MW _t . Fuel: coal	Population type: rural, suburban and urban (2020)	Not applicable	Schiavina et al. (2023b)
020103_lpg	Commercial and institutional plants Boilers < 50 MW _t . Fuel: liquid petroleum gas	Population density (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020103_natural_gas	Commercial and institutional plants Boilers < 50 MW _t . Fuel: natural gas	Population density (2020) Municipal boundaries (2018)	List of municipalities with access to natural gas (2018) Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) List of municipalities with access to natural gas: CNMC (2018) Energy consumption: Cuchi et al. (2017)
020103_others	Commercial and institutional plants Boilers < 50 MW _t . Fuel: others	Population type: rural (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020104_natural_gas	Commercial and institutional plants Stationary gas turbines Fuel: natural gas	Population density (2020) Municipal boundaries (2018)	List of municipalities with access to natural gas (2018) Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) List of municipalities with access to natural gas: CNMC (2018) Energy consumption: Cuchi et al. (2017)
020104_others	Commercial and institutional plants Stationary gas turbines Fuel: others	Population type: rural (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
020105_natural_gas	Commercial and institutional plants Stationary engines Fuel: natural gas	Population density (2020) Municipal boundaries (2018)	List of municipalities with access to natural gas (2018) Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) List of municipalities with access to natural gas: CNMC (2018) Energy consumption: Cuchi et al. (2017)
020105_others	Commercial and institutional plants Stationary engines Fuel: others	Population type: rural (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020106	Commercial and institutional plants Other stationary equipments	-	-	-
020201	Residential plants. Boilers ≥ 50 MW _t	-	-	-
020202_biomass	Residential plants. Boilers < 50 MW _t . Fuel: biomass	Population type: rural (2020) Municipal boundaries (2018)	Regional indicators of household biomass use, according to the information available in each CCAA (Comunidad Valenciana: 2008; Cataluña: 2023; País Vasco: 2021; Rest: 2021)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Household biomass use indicators: Institut Valencià d'Estadística (2024); Institut Català d'Energia (2025); Instituto Vasco de Estadística (2022); Instituto para la Diversificación y Ahorro de la Energía (2025)
020202_lpg	Residential plants. Boilers < 50 MW _t . Fuel: liquid petroleum gas	Population density (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020202_natural_gas	Residential plants. Boilers < 50 MW _t . Fuel: natural gas	Population density (2020) Municipal boundaries (2018)	List of municipalities with access to natural gas (2018) Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) List of municipalities with access to natural gas: CNMC (2018) Energy consumption: Cuchi et al. (2017)
020202_others	Residential plants. Boilers < 50 MW _t . Fuel: others	Population type: rural (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020203	Residential plants. Stationary gas turbines	-	-	-
020204	Residential plants. Stationary engines	-	-	-

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
020205_biomass	Residential plants. Other equipments Fuel: biomass	Population type: rural (2020) Municipal boundaries (2018)	Regional indicators of household biomass use, according to the information available in each CCAA (Comunidad Valenciana: 2008; Cataluña: 2023; País Vasco: 2021; Rest: 2021)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Household biomass use indicators: Institut Valencià d'Estadística (2024); Institut Català d'Energia (2025); Instituto Vasco de Estadística (2022); Instituto para la Diversificación y Ahorro de la Energía (2025)
020301	Plants in agriculture, forestry and aquaculture. Boilers ≥ 50 MW _t	-	-	-
020302_aquaculture	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: aquaculture	Inland aquaculture facilities (2024) Industrial land use (2018)	Not applicable*	Inland aquaculture facilities: MAPA (2024) Land use: CLMS (2020)
020302_farms	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: farms	Livestock farms (2018) Land use: grasslands (2018)	Not applicable*	Farms: MAPA (2023a) Land use: CLMS (2020)
020303	Plants in agriculture, forestry and aquaculture. Stationary gas turbines	-	-	-
020304_farms	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: farms	Livestock farms (2018) Land use: grasslands (2018)	Not applicable*	Farms: MAPA (2023a) Land use: CLMS (2020)
020304_irrigation_system	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: irrigation systems	Land use: permanent crops and fruit plantations (2018)	Not applicable	CLMS (2020)
020305	Plants in agriculture, forestry and aquaculture. Other stationary equipments	-	-	-

*Due to the lack of information on energy consumption at individual farms and aquaculture facilities, a weight of 1 was assigned to all installations within these SNAP activities. In these cases, emissions are distributed equally among all installations belonging to the same SNAP activity and CCAA.

**For this SNAP activity, it was not possible to identify the installations corresponding to specific CCAA. In these cases, selected land-use classes from the CORINE Land Cover dataset (CLMS, 2020) were used to distribute emissions.

2.3. SNAP 03. Combustion in manufacturing industry

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from combustion in manufacturing industry. Emissions from this sector are divided into the following three subgroups, which are further disaggregated into a total of 35 SNAP activities, described in Table 5:

- SNAP 0301 – Non-specific stationary industrial combustion: emissions associated with combustion conducted in industrial installations that do not belong to a specific industrial branch. Their purpose is the production of electricity and/or heat, and combustion may take place in equipment such as boilers, gas turbines or stationary engines.
- SNAP 0302 – Industrial combustion in non-contact furnaces: emissions arising from combustion processes in furnaces where neither the flame nor the combustion gases come into direct contact with the materials being processed. Examples include gypsum kilns and blast furnaces used for pig iron production.
- SNAP 0303 – Industrial combustion processes with contact: emissions resulting from combustion in furnaces where flames or combustion gases are in direct contact with the processed materials. Examples include sintering and pelletising plants, as well as iron and steel reheating furnaces.

The spatial distribution of emissions reported in this sector was conducted primarily using the LPS and PRTR databases, following the treatment and processing described in Section **¡Error! No se encuentra el origen de la referencia.**. The remaining emissions, i.e. the difference between the emissions reported by the SEIE and the sum of those reported in the LPS and PRTR databases, were allocated using a range of auxiliary spatial proxies, including approximately 220 industrial facilities. For SNAP activities for which the associated facilities could not be identified, the industrial land-use layer from the CORINE Land Cover product (CLMS, 2020) was used as an auxiliary spatial proxy.

Table 5 summarises the georeferenced spatial proxies assigned to each SNAP 03 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy. As detailed in the table, the auxiliary spatial proxies used in this sector were derived primarily from the HERMESv3 bottom-up database (Guevara et al., 2020) and the ARDÁN business information system (2023).

Table 5. Georeferenced spatial proxies assigned to each SNAP 03 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
030101	Boilers ≥ 300 MW _t	-	-	-
030102	Boilers < 300 and ≥ 50 MW _t	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
030103	Boilers < 50 MW _t	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030104	Gas turbines	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030105	Stationary engines	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030106	Other stationary equipments	-	-	-
030203	Blast furnaces coppers	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
030204	Plaster furnaces	PRTR database (2023) Industrial land use (2018) Plaster furnaces (2022)	Not applicable*	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020) Plaster furnaces: HERMESv3 bottom-up (Guevara et al., 2020)
030205	Other furnaces	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
030301	Sinter and pelletizing plants	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030302	Reheating furnaces steel and iron	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
030303	Grey iron foundries	PRTR database (2023) Industrial land use (2018) Grey iron foundries CNAE 24.51 (2021)	Not applicable*	PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020) Grey iron foundries: ARDÁN (2023)
030304	Primary lead production	-	-	-

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
030305	Primary zinc production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030306	Primary copper production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030307	Secondary lead production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030308	Secondary zinc production	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
030309	Secondary copper production	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
030310	Secondary aluminium production	Emissions entirely derived from the PRTR database (2023)	Not applicable	PRTR: PRTR-España (2025b)
030311	Cement	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
030312	Lime	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030313	Asphalt concrete plants	Asphalt concrete plants (2022) Industrial land use (2018)	Not applicable*	Asphalt concrete plants: HERMESv3 bottom-up (Guevara et al., 2020) Industrial land use: CLMS (2020)
030314	Flat glass	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030315	Container glass	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030316	Glass wool (except binding)	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
030317	Other glass (including special glass)	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030318	Mineral wool	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030319	Bricks and tiles	Emissions entirely derived from the PRTR database (2023)	Not applicable	PRTR: PRTR-España (2025b)
030320	Fine ceramics material	Emissions entirely derived from the PRTR database (2023)	Not applicable	PRTR: PRTR-España (2025b)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
030321	Paper-mill industry (drying processes)	LPS database (2023) Paper-mill industries CNAE 17.11 y 17.12 (2022) Industrial land use (2018)	Not applicable*	LPS: MITECO (2025) Industrial land use: CLMS (2020) Paper-mill industries: ARDÁN (2023)
030322	Alumina production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030323	Magnesium production (dolomite treatment)	-	-	-
030324	Nickel production (thermal process)	-	-	-
030325	Enamel production	-	-	-
030326	Other processes with contact	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)

*Due to the lack of information, a weight of 1 was assigned to all installations included in the corresponding auxiliary spatial proxy. In these cases, emissions are distributed equally among all installations belonging to the same SNAP activity and CCAA.

As an example, Figure 6 presents the spatial proxy used for the disaggregation of emissions from SNAP activity 030313. As detailed in Table 5, the proxy used in this case is a map of asphalt mixing plants. Due to the lack of information, the same relative weight was assigned to all installations.



Figure 6. Spatial proxy used for the disaggregation of emissions from SNAP activity 030313 (asphalt mixing plants). Due to the lack of information, the same relative weight was assigned to all installations.

2.4. SNAP 04. Production processes

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from industrial processes not related to combustion. Emissions from this sector are divided into the following eight subgroups, which are further disaggregated into a total of 93 SNAP activities, described in Table 6:

- SNAP 0401 – Processes in the petroleum refining industry: emissions arising from crude oil refining operations, including the production of liquid fuels, non-fuel intermediate feedstocks and basic petrochemical products. Processes such as catalytic cracking and sulphur recovery are included.
- SNAP 0402 – Processes in the iron and steel industry and coke ovens: emissions originating from non-combustion production processes in the iron and steel industry, including those taking place in coke oven plants. Activities include blast furnace charging and pig iron casting, among others.
- SNAP 0403 – Processes in the non-ferrous metal industry: emissions associated with non-combustion processes in the non-ferrous metals industry, such as aluminium and silicon production.
- SNAP 0404 – Processes in the inorganic chemical industry: emissions arising from processes in the inorganic chemical industry, including the production of sulphuric acid, nitric acid, ammonia and fertilisers, among others.
- SNAP 0405 – Processes in the organic chemical industry: emissions resulting from processes in the organic chemical industry, such as the production of ethylene, propylene and styrene.

- SNAP 0406 – Processes in the pulp and paper, wood, food and miscellaneous sectors: emissions arising from pulp production, fermentation processes in the food and beverage industry, the application of asphaltic materials, decarbonisation processes in the cement, lime and glass industries, and quarrying activities.
- SNAP 0408 – Production of halogenated hydrocarbons and sulphur hexafluoride: emissions released to the atmosphere during the production of certain halogenated hydrocarbons and sulphur hexafluoride.
- SNAP 0409 – Storage, handling and transport of mineral products: emissions generated during the storage, handling and transport of mineral products. These emissions may occur before, during or after mining activities.

The spatial distribution of emissions reported in this sector was conducted primarily using the LPS and PRTR databases, following the treatment and processing described in Section **¡Error! No se encuentra el origen de la referencia..** The remaining emissions, i.e. the difference between the emissions reported by the SEIE and the sum of those reported in the LPS and PRTR databases, were allocated using a range of auxiliary spatial proxies, including approximately 2635 facilities.

For some SNAP activities for which the associated facilities could not be identified, several land-use classes from the CORINE Land Cover product (CLMS, 2020) were used as auxiliary spatial proxies. In other cases, such as SNAP activity 040624 (construction and demolition), where it is difficult to determine precisely where works are taking place, the associated emissions were distributed using the GHS-POP population density layer from the Global Human Settlement Layer project (GHSL; Schiavina et al., 2023a).

Table 6 summarises the georeferenced spatial proxies assigned to each SNAP 04 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy.

Table 6. Georeferenced spatial proxies assigned to each SNAP 04 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040101	Petroleum products processing	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040102	Fluid catalytic cracking CO boilers	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040103	Sulphur recovery plants	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040104	Storage & handling of products in refinery	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040201	Coke oven (door leakage and extinction)	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040202	Blast furnace charging	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040203	Pig iron tapping	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040204	Solid smokeless fuel	-	-	-
040205	Open hearth furnace steel plant	-	-	-
040206	Basic oxygen furnace steel plant	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040207	Electric furnace steel plant	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
040208	Rolling mills	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
040209	Sinter and pelletizing plants (except combustion 030301)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040301	Aluminium production (electrolysis)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040302	Ferro alloys	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040303	Silicium production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040304	Magnesium production (except 030323)	-	-	-
040305	Nickel production (except 030324)	-	-	-
040306	Allied metal manufacturing	-	-	-
040307	Galvanizing	-	-	-
040308	Electroplating	-	-	-
040309	Other processes in non-ferrous metal industries	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
040401	Sulphuric acid	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
040402	Nitric acid	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040403	Ammonia	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040404	Ammonium sulphate	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040405	Ammonium nitrate	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040406	Ammonium phosphate	-	-	-
040407	NPK fertilisers	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
040408	Urea	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040409	Carbon black	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040410	Titanium dioxide	Titanium dioxide pigment manufacturing plants (2023)	Annual revenue per facility (2021)	ARDÁN (2023)
040411	Graphite	-	-	-

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040412	Calcium carbide production	Calcium carbide manufacturing plants CNAE 20.13 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040413	Chlorine production	-	-	-
040414	Phosphate fertilizers	-	-	-
040415	Storage and handling of inorganic chemical products	-	-	-
040416	Other processes in inorganic chemical industries	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
040501	Ethylene	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040502	Propylene	PRTR database (2023) Manufacture of organic chemical products CNAE 20.14 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) Manufacture of organic chemical products: ARDÁN (2023) Industrial land use: CLMS (2020)
040503	1,2 dichloroethane (except 040505)	-	-	-
040504	Vinylchloride (except 040505)	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040505	1,2 dichloroethane + vinylchloride (balanced process)	-	-	-
040506	Polyethylene low density	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
040507	Polyethelene high density	Plastics manufacturing plants in primary forms CNAE 20.16 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040508	Polyvinylchloride	PRTR database (2023) Manufacturing plants of other chemical products n.e.c. CNAE 20.59 (2021)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023)
040509	Polypropylene	Plastics manufacturing plants in primary forms CNAE 20.16 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	ARDÁN (2023) Industrial land use: CLMS (2020)
040510	Styrene	Plastics manufacturing plants in primary forms CNAE 20.16 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040511	Polystyrene	-	-	-
040512	Styrene butadiene	Manufacturing plants of other chemical products n.e.c. CNAE 20.59 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	ARDÁN (2023) Industrial land use: CLMS (2020)
040513	Styrene-butadiene latex	Synthetic rubber manufacturing plants in primary forms CNAE 20.17 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040514	Styrene-butadiene rubber (SBR)	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040515	Acrylonitrile butadiene styrene (ABS) resins	PRTR database (2023) Plastics manufacturing plants in primary forms CNAE 20.16 (2021)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023)
040516	Ethylene oxyde	Manufacturing plants of other basic organic chemical products CNAE 20.14 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040517	Formaldehyde	Manufacturing plants of other chemical products n.e.c. CNAE 20.59 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040518	Ethylbenzene	Organic chemical manufacturing plants CNAE 20.14 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040519	Phtalic anhydride	Organic chemical manufacturing plants CNAE 20.14 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040520	Acrylonitrile	-	-	-
040521	Adipic acid	-	-	-
040522	Storage & handling of organic chemical products	-	-	-
040523	Glyoxylic acid	-	-	-
040525	Pesticide production	-	-	-
040526	Production of persistent organic compounds	-	-	-

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040527	Other processes in organic chemical industries (phytosanitary...)	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040601	Chipboard	Corrugated paper and cardboard manufacturing plants, paper and cardboard packaging and container manufacturing plants CNAE 17.21 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040602	Paper pulp (kraft process)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040603	Paper pulp (acid sulphite process)	-	-	-
040604	Paper pulp (neutral sulphite semi-chemical process.)	-	-	-
040605	Bread	PRTR database (2023) Bread and fresh pastry manufacturing plants CNAE 10.71 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023) Industrial land use: CLMS (2020)
040606	Wine	Wine production plants CNAE 11.02 (2021) Industrial land use and vineyards (2018)	Annual revenue per facility (2021)	ARDÁN (2023) Industrial land use and vineyards: CLMS (2020)
040607	Beer	PRTR database (2023) Beer manufacturing plants CNAE 11.05 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023) Industrial land use: CLMS (2020)
040608	Spirits	Plants for distillation, rectification and blending of alcoholic beverages CNAE 11.01 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	ARDÁN (2023) Industrial land use: CLMS (2020)
040610	Asphalt roofing materials	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040611	Road paving with asphalt	Land use of continuous and discontinuous urban fabric, and road and railway networks and associated land (2018)	Not applicable	Land uses: CLMS (2020)
040612	Cement (decarbonizing)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040613	Glass (decarbonizing)	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040614	Lime (decarbonizing)	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040615	Batteries manufacturing	-	-	-
040616	Extraction of mineral ores	-	-	-
040617	Other (including asbestos products manufacturing)	LPS database (2023) Plants of other extractive industries n.e.c. CNAE 08.99 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	LPS: MITECO (2025) Plants of other extractive industries: ARDÁN (2023) Industrial land use: CLMS (2020)
040618	Limestone and dolomite use	LPS database (2023) Manufacturing and processing plants for other glass, including technical glass CNAE 23.19 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	LPS: MITECO (2025) Manufacturing and processing plants for other glass: ARDÁN (2023) Industrial land use: CLMS (2020)
040619	Soda ash production and use	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040620	Woodworking	-	-	-
040623	Quarrying	PRTR database (2023) Extraction of gravel and sand, extraction of clay and kaolin CNAE 08.12 Mineral extraction sites land use (2018)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023) Mineral extraction sites land use: CLMS (2020)
040624	Construction and demolition	Population density (2020)	Not applicable	Schiavina et al., 2023a
040625	Sugar production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040801	Production of halocarbons - subproducts	-	-	-
040802	Production of halocarbons - fugitive emissions	-	-	-
040803	Production of halocarbons - others	-	-	-

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040804	Production of sulphur hexafluoride - subproducts	-	-	-
040805	Production of sulphur hexafluoride - fugitive emissions	-	-	-
040806	Production of sulphur hexafluoride - others	-	-	-
040900	Storage, handling and transport of mineral products	Mineral extraction sites land use (2018)	Not applicable	CLMS (2020)

As an example, Figure 7 presents the spatial proxy used for the disaggregation of emissions from SNAP activity 040623. As detailed in Table 6, the proxy used in this case is a map of active quarries, with the annual revenue of each facility used as the weighting factor.

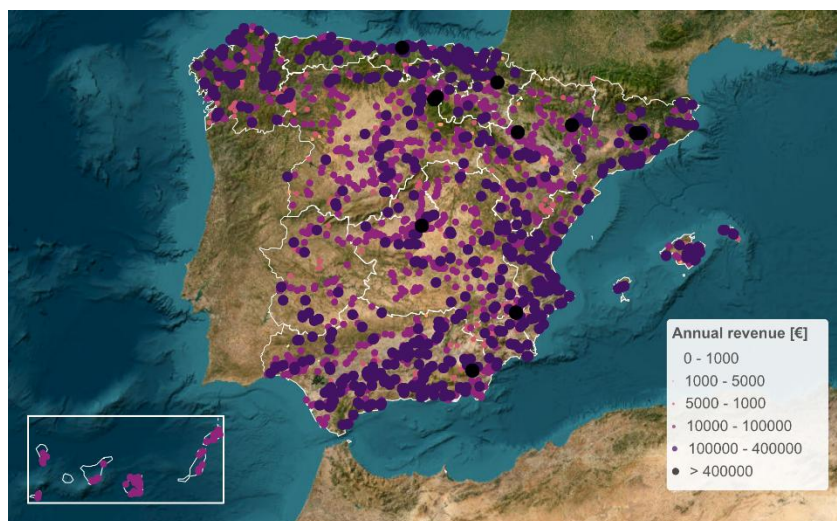


Figure 7. Spatial proxy used for the disaggregation of emissions from SNAP activity 040623 (quarrying), using the annual revenue of each facility as the weighting factor.

2.5. SNAP 05. Extraction and distribution of fossil fuels and geothermal energy

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from fossil fuel extraction and distribution activities. Emissions from this sector are divided into the following six subgroups, which are further disaggregated into a total of 14 SNAP activities, described in Table 7:

- **SNAP 0501 – Extraction and initial processing of solid fossil fuels:** fugitive emissions arising from the production, processing, handling and use of coal.
- **SNAP 0502 – Extraction, initial processing and loading of liquid fossil fuels:** fugitive emissions originating from crude oil exploration and extraction activities, its initial on-site processing, and loading operations for subsequent transport and processing. These activities may be located either onshore or offshore.
- **SNAP 0503 – Extraction, initial processing and loading of gaseous fossil fuels:** fugitive emissions resulting from the exploration, extraction, processing and loading of natural gas onshore or offshore.
- **SNAP 0504 – Distribution of liquid fuels (excluding petrol distribution):** fugitive emissions generated during the unloading of oil tankers, the handling and storage of crude oil and petroleum products at refineries, as well as during pipeline transport and the distribution of liquid fuels.
- **SNAP 0505 – Petrol distribution:** fugitive emissions arising from petrol distribution activities. This fuel is treated separately from SNAP 0504 because of its particularly high volatility.
- **SNAP 0506 – Gas distribution networks:** fugitive emissions of natural gas, propane-air mixtures, manufactured gas and liquefied petroleum gases distributed through pipeline networks, occurring at different points along the transport and distribution system.

In order to assign more representative spatial distribution proxies, the original emissions reported in the SEIE for this SNAP sector were disaggregated to a more detailed sectoral level, as described in Section 1.2.3.

The spatial distribution of emissions reported in this sector was conducted using the LPS and PRTR databases, following the treatment and processing described in Section **¡Error! No se encuentra el origen de la referencia..** The remaining emissions, i.e. the difference between the emissions reported by the SEIE and the sum of those reported in the LPS and PRTR databases, were allocated using a range of auxiliary spatial proxies, including nearly 12,000 sites. For some SNAP activities for which the associated facilities could not be identified, the industrial land-use layer from the CORINE Land Cover product (CLMS, 2020) was used as an auxiliary spatial proxy. In other cases, such as SNAP activity 050603 (fugitive emissions and venting from gas distribution infrastructure), where it is difficult to determine precisely where these emissions occur, emissions were distributed using the GHS-POP population density layer from the Global Human Settlement Layer project (GHSL; Schiavina et al., 2023a).

Table 7 summarises the georeferenced spatial proxies assigned to each SNAP 05 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy. As described in Section 1.2.3, the original emissions reported in the SEIE for SNAP activity 050401 were disaggregated between operations conducted at refineries and those taking place at maritime terminals. Consequently, Table 7 includes two entries for this activity.

Table 7. Georeferenced spatial proxies assigned to each SNAP 05 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
050101	Open cast mining	-	-	-
050102	Underground mining	Underground mining (2020)	Not applicable*	Lagos (2020)
050103	Storage of solid fuel	-	-	-
050201	Land-based activities	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
050202	Off-shore activities	-	-	-
050301	Land-based desulfuration	-	-	-
050302	Land-based activities (other than desulfuration)	LPS database (2023) Exploitation concessions and underground storage (2020)	Not applicable*	LPS: MITECO (2025) Exploitation concessions and underground storage: CNMC (2024a)
050303	Off-shore activities	-	-	-
050401_mar	Liquid fuel distribution (except gasoline distribution): maritime	Maritime terminals (2024)	Total crude oil throughput [tonnes]	HERMESv3 bottom-up (Guevara et al., 2020) y Google Maps (2024)

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
	terminals		(2009)	
050401_ref	Liquid fuel distribution (except gasoline distribution): refineries	Refineries (2024)	Refinery capacity [ktonnes] (2024)	Spatial proxy: HERMESv3 bottom-up (Guevara et al., 2020) Weight: (CORES, 2024a)
050402	Other handling and storage (including pipeline)	Industrial land use (2018)	Not applicable	CLMS (2020)
050501	Refinery dispatch station	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
050502	Transport and depots (except 050503)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
050503	Service stations (including refuelling of cars)	Service stations (2024)	Not applicable*	MINETAD (2024)
050601	Gas distribution networks: pipelines	LPS database (2023) Pipelines (2020)	Not applicable*	LPS: MITECO (2025) Pipelines: HERMESv3 bottom-up (Guevara et al., 2020) y IDEIB (2020)
050603	Gas distribution networks: distribution networks	Population density (2020)	Not applicable	Schiavina et al. (2023a)

*Due to the lack of information, a weight of 1 was assigned to all installations included in the corresponding auxiliary spatial proxy. In these cases, emissions are distributed equally among all installations belonging to the same SNAP activity and CCAA.

As an example, Figure 8 presents several auxiliary spatial proxies used for the disaggregation of emissions from SNAP activities 050401, 050503 and 050603 in the Tarragona area. As detailed in Table 7, the proxies used in this case are maps of refineries and maritime terminals (represented as polygons), service stations (represented as points), and gas pipelines (represented as lines), respectively. This figure illustrates the flexibility of HERMES_Δ in handling spatial proxies based on different geometry types. In addition, the figure includes the SNAP 05 point-sources located within the study area.

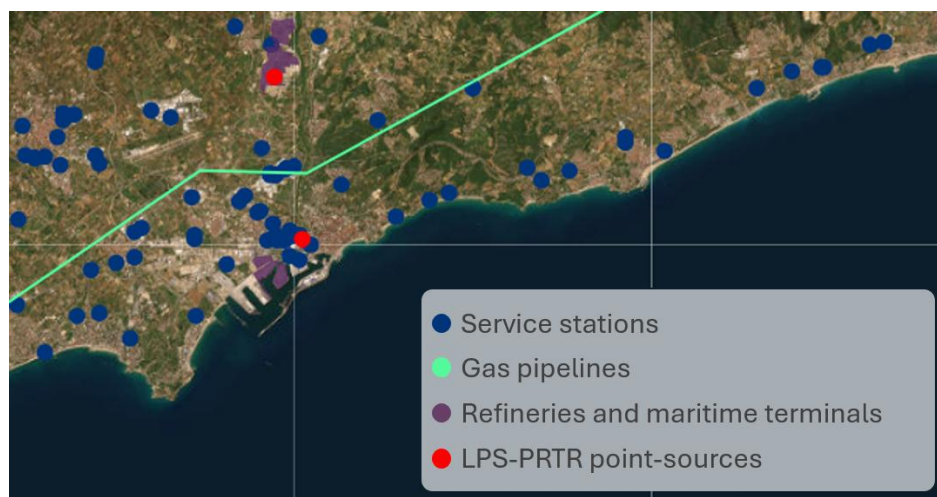


Figure 8. Spatial proxies used for the disaggregation of emissions from SNAP activities 050401 (refineries and maritime terminals), 050503 (service stations) and 050601 (gas pipelines) in the Tarragona area. SNAP 05 point-sources located within the same area are also shown.

2.6. SNAP 06. Solvent use and other product use

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from solvent and other product use activities. Emissions from this sector are divided into the following six subgroups, which are further disaggregated into a total of 49 SNAP activities, described in Table 8:

- SNAP 0601 – Paint application: emissions arising from the use of paints in domestic and industrial sectors, such as vehicle manufacturing and shipbuilding.
- SNAP 0602 – Dry cleaning, degreasing and electronics: emissions originating from cleaning and degreasing activities involving organic solvents, such as the manufacture of electronic components and metal degreasing.
- SNAP 0603 – Chemical manufacturing and processing: emissions generated during the manufacture or application of chemical products containing organic solvents, for example in polyester treatment or pharmaceutical production.
- SNAP 0604 – Other solvent use activities: a miscellaneous subgroup comprising other activities involving the use of organic solvents, such as glass wool coating, printing and graphic arts, and the extraction of fats and oils.
- SNAP 0605 – Use of HFCs, PFCs, SF₆, N₂O and NH₃: emissions of these gases released into the atmosphere through specific products and applications, including anaesthesia and fire extinguishers.
- SNAP 0606 – Other products: emissions associated with products other than solvents, such as tobacco and fireworks.

The spatial distribution of emissions reported in this sector was carried out using the LPS and PRTR databases, following the treatment and processing described in Section ;Error! No se encuentra el origen de la referencia.. The remaining emissions, i.e. the difference between the emissions reported by the SEIE and the sum of those reported in the LPS and PRTR databases, were allocated using a range of auxiliary spatial proxies, including nearly 5,800 sites.

For some SNAP activities for which the associated facilities could not be identified, several CORINE Land Cover land-use layers (CLMS, 2020) were used as auxiliary spatial proxies. In other cases, such as SNAP 060104 (paint application: domestic use), where it is difficult to determine precisely where emissions occur, emissions were distributed using the GHS-POP population density layer from the Global Human Settlement Layer project (GHSL; Schiavina et al., 2023a).

Table 8 summarises the georeferenced spatial proxies assigned to each SNAP 06 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy.

Table 8. Georeferenced spatial proxies assigned to each SNAP 06 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060101	Manufacture of automobiles	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
060102	Car repairing	Vehicle repair shops (2023)	Not applicable*	HERMESv3 bottom-up (Guevara et al., 2020) y ARDÁN (2023)
060103	Construction and buildings (except 060107)	Land use: continuous urban fabric, discontinuous urban fabric and construction sites (2018)	Not applicable	CLMS (2020)
060104	Domestic use (except 060107)	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060105	Coil coating	Industrial land use (2018)	Not applicable	CLMS (2020)
060106	Boat building	Boat building facilities (2023)	Annual revenue per facility (2023)	HERMESv3 bottom-up (Guevara et al., 2020) y ARDÁN (2023)
060107	Wood	Industrial land use (2018)	Not applicable	CLMS (2020)
060108	Other industrial paint application	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) Land use: CLMS (2020)
060109	Other nonindustrial paint application	Land use: continuous urban fabric, discontinuous urban fabric and construction sites (2018)	Not applicable	CLMS (2020)
060201	Metal degreasing	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Land use: CLMS (2020)
060202	Dry cleaning	Washing and cleaning of textiles and leather garments CNAE 96.01 (2023)	Annual revenue per facility (2023)	ARDÁN (2023)

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060203	Electronic components manufacturing	-	-	-
060204	Other industrial cleaning	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
060301	Polyester processing	Industrial land use (2018)	Not applicable	CLMS (2020)
060302	Polyvinylchloride processing	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) CLMS (2020)
060303	Polyurethane foam processing	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) CLMS (2020)
060304	Polystyrene foam processing	Industrial land use (2018)	Not applicable	CLMS (2020)
060305	Rubber processing	PRTR database (2023) Facilities under CNAE codes 20.17 – Manufacture of synthetic rubber in primary forms, 22.19 – Manufacture of other rubber products, 22.11 – Manufacture of tyres and tubes, rubber, retreading and rebuilding (2023) Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Rubber processing facilities: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Rubber processing facilities: ARDÁN (2023) Land use: CLMS (2020)
060306	Pharmaceutical products manufacturing	PRTR database (2023) Facilities under CNAE codes 21.10 – Manufacture of basic pharmaceutical products, 21.20 – Manufacture of pharmaceutical preparations (2023) Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Pharmaceutical products manufacturing: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Pharmaceutical products manufacturing: ARDÁN (2023) Land use: CLMS (2020)

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060307	Paints manufacturing	PRTR database (2023) Facilities under CNAE code 20.30 – Manufacture of paints, varnishes and similar coatings, inks and mastics (2023)	Paint manufacturing facilities: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Paints manufacturing facilities: ARDÁN (2023)
060308	Inks manufacturing	Facilities under CNAE code 20.30 – Manufacture of paints, varnishes and similar coatings, inks and mastics (2023)	Inks manufacturing facilities: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Inks manufacturing facilities: ARDÁN (2023)
060309	Glues manufacturing	Facilities under CNAE code 20.52 – Manufacture of glues, 20.59 – Manufacture of other chemical products n.e.c. (2023) Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Annual revenue per facility (2023)	Glues manufacturing facilities: ARDÁN (2023) Land use: CLMS (2020)
060310	Asphalt blowing	-	-	-
060311	Adhesive, magnetic tapes, films & photographs manufacturing	-	-	-
060312	Textile finishing	-	-	-
060313	Leather tanning	Facilities under CNAE code 15.11 – Preparation, tanning and dressing of leather; dressing and dyeing of fur (2023)	Annual revenue per facility (2023)	ARDÁN (2023)
060314	Other chemicals products manufacturing or processing	-	-	-
060401	Glass wool enduction	Facilities for the manufacture of glass wool insulation (2019)	Not applicable*	HERMESv3 bottom-up (Guevara et al., 2020)
060402	Mineral wool enduction	Facilities for the manufacture of rock wool insulation (2019)	Not applicable*	HERMESv3 bottom-up (Guevara et al., 2020)
060403	Printing industry	PRTR database (2023) Facilities under CNAE codes 18.11 – Printing of newspapers; 18.12 – Other printing and related service activities (2023)	Printing facilities: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Printing facilities: ARDÁN (2023)

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060404	Fat, edible and not edible oil extraction	PRTR database (2023) Facilities under CNAE codes 10.43 – Manufacture of olive oil; 10.44 – Manufacture of oils and fats (2023) Land use: discontinuous urban fabric and industrial (2018)	Facilities for the extraction of fats and oils: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Facilities for the extraction of fats and oils: ARDÁN (2023) Land use: CLMS (2020)
060405	Application of glues and adhesives	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060406	Preservation of wood	Industrial land use (2018)	Not applicable	CLMS (2020)
060407	Underseal treatment and conservation of vehicles	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
060408	Domestic solvent use (other than paint application)	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060409	Vehicles dewaxing	-	-	-
060411	Domestic use of pharmaceutical products	-	-	-
060412	Other (preservation of seeds...)	-	-	-
060501	Anaesthesia	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060502	Refrigeration and air condition equipment using halocarbons	-	-	-
060503	Refrigeration and air condition equipment using other products than halocarbons	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060504	Foam blowing (except 060304)	-	-	-
060505	Fire extinguishers	-	-	-
060506	Aerosol cans	-	-	-
060507	Electrical equipment (except 060203)	-	-	-
060508	Other use of HFC, N ₂ O, NH ₃ , PFC and SF ₆	Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Not applicable	CLMS (2020)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060601	Fireworks	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060602	Tobacco consumption	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060603	Footwear wear	-	-	-

*Due to the lack of information, a weight of 1 was assigned to all installations included in the corresponding auxiliary spatial proxy. In these cases, emissions are distributed equally among all installations belonging to the same SNAP activity and CCAA.

**For some Autonomous Communities within these SNAP activities, it was not possible to identify facilities directly associated with the corresponding activity in the ARDÁN (2023) database. In these cases, specific land-use classes from CORINE Land Cover (CLMS, 2020) were used to distribute emissions.

As an example, **¡Error! No se encuentra el origen de la referencia.** presents, by way of example, the auxiliary spatial proxy used for the disaggregation of emissions from SNAP activity 060306. As detailed in Table 8, this proxy consists of a map of pharmaceutical manufacturing plants, with the annual revenue of each facility used as the weighting factor.

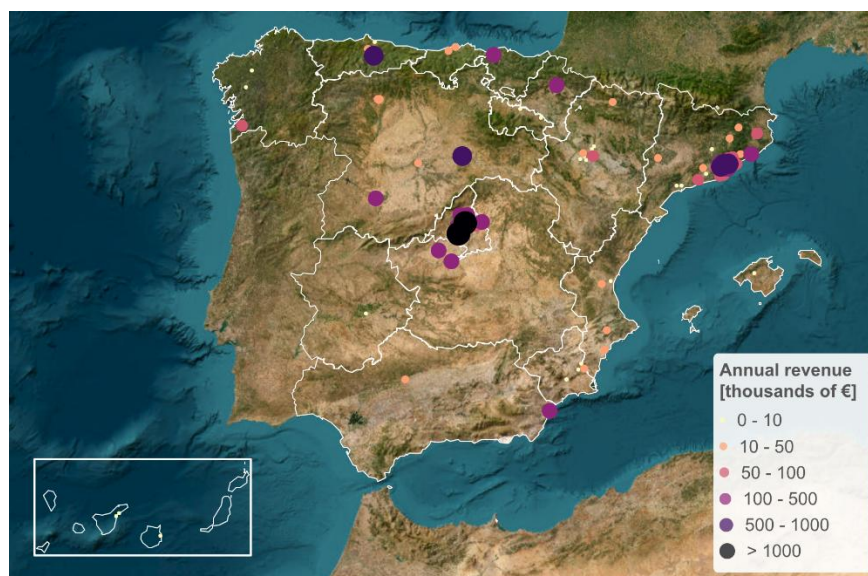


Figure 9. Spatial proxy used for the disaggregation of emissions from SNAP activity 060306 (manufacture of pharmaceutical products), using the annual revenue of each facility as the weighting factor.

2.7. SNAP 07. Road transport

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from road transport activities. Emissions from this sector are divided into the following four subgroups, which are further disaggregated into a total of 22 SNAP activities, described in Table 9:

- SNAP 0701, 0702, 0703, 0704 and 0705 – Combustion: emissions resulting from combustion in internal combustion engines and released through vehicle exhaust systems. These emissions are classified according to driving pattern (motorway/interurban, rural and urban) and vehicle type (passenger cars, light-duty vehicles, heavy-duty vehicles and buses, mopeds and motorcycles with an engine capacity of 50 cm³ or less, and motorcycles with an engine capacity greater than 50 cm³).
- SNAP 0706 – Gasoline evaporation from vehicles: emissions arising from the evaporation of volatile organic compounds contained in fuel.
- SNAP 0707 – Tyre and brake wear: emissions generated by tyre wear resulting from friction with the road surface, as well as by brake wear during vehicle deceleration.
- SNAP 0708 – Road surface abrasion: emissions produced by the progressive wear of road surface materials caused by repeated vehicle traffic.

For the road transport sector, the spatial distribution of emissions was carried out entirely using the following three auxiliary spatial proxies: (i) a mosaic of interurban and rural road maps containing annual average daily traffic (AADT) data by vehicle type; (ii) an urban road network map with different weights assigned according to street type, combined with a map of Spanish municipalities with more than 10,000 inhabitants; and (iii) the GHS-POP population density layer from the Global Human Settlement Layer project (GHSL; Schiavina et al., 2023a).

The first proxy was used for motorway/interurban and rural driving patterns, while the second was used for urban driving. The third proxy was used exclusively for SNAP 0706 (gasoline evaporation), as emissions associated with this activity were assumed to occur mainly in urban areas while vehicles are parked. Table 9 links these three spatial proxies to the different SNAP activities and provides further details on the weighting factors applied in each case.

Table 9. Georeferenced spatial proxies assigned to each SNAP 07 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
070101	Combustion emissions: Passenger cars: highway driving	Interurban and rural roads (see Table 10. for details)	Light-duty vehicles AADT [vehicles/day] (see Table 10 for details)	See Table 10. for details
070102	Combustion emissions: passenger cars, rural driving			
070201	Combustion emissions: light-duty vehicles < 3,5 t, highway driving			
070202	Combustion emissions: light-duty vehicles < 3,5 t, rural driving			
070301	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, highway driving		Heavy-duty vehicles AADT [vehicles/day] (see Table 10. for details)	
070302	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, rural driving			
070501	Combustion emissions: motorcycles > 50 cm³, highway driving		Motorcycles AADT [vehicles/day] (see Table 10. for details)	
070502	Combustion emissions: motorcycles > 50 cm³, rural driving			
070103	Combustion emissions: passenger cars, urban driving	Urban roads (2024) in municipalities > 10.000 inhabitants (2023)	Weighting factors by road type (2022)	Spatial proxy: OpenStreetMap collaborators (2024) Weighting factors by road type: Mu et al. (2022) Municipality layer: MITECO (2024c)
070203	Combustion emissions: light-duty vehicles < 3,5 t, urban driving			
070303	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, urban driving			
070400	Combustion emissions: mopeds and motorcycles < 50 cm³			
070503	Combustion emissions: motorcycles > 50 cm³, urban driving			
070600	Gasoline evaporation from vehicles	Population layer GHS-POP (2020)	Population density [number of inhabitants per cell] (2020)	Schiavina et al. (2023a)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
070700_IR_light	Automobile tyre and brake wear: light-duty vehicles, highway and rural driving	Rural and interurban roads (see Table 10. for details)	Light-duty vehicles AADT [vehicles/day] (see Table 10. for details)	See Table 10. for details
070700_IR_heavy	Automobile tyre and brake wear: heavy-duty vehicles, highway and rural driving		Heavy-duty vehicles AADT [vehicles/day] (see Table 10. for details)	
070800_IR_light	Road surface wear: light-duty vehicles, highway and rural driving	Rural and interurban roads (see Table 10. for details)	Light-duty vehicles AADT [vehicles/day] (see Table 10. for details)	See Table 10. for details
070800_IR_heavy	Road surface wear: heavy-duty vehicles, highway and rural driving		Heavy-duty vehicles AADT [vehicles/day] (see Table 10. for details)	
070700_U_light	Automobile tyre and brake wear: light-duty vehicles, urban driving	Urban roads (2024) in municipalities > 10.000 inhabitants (2023)	Weighting factors by road type (2022)	Spatial proxy: OpenStreetMap collaborators (2024) Weighting factors by road type: Mu et al. (2022) Municipality layer: MITECO (2024c)
070700_U_heavy	Automobile tyre and brake wear: heavy-duty vehicles, urban driving			
070800_U_light	Road surface wear: light-duty vehicles, urban driving			
070800_U_heavy	Road surface wear: heavy-duty vehicles, urban driving			

*To ensure consistency with the assumptions used in the SEIE, mopeds and motorcycles with an engine capacity below 50 cm³ were assumed to operate only under urban driving conditions.

According to the methodology published by the Emissions Inventory Unit (2025) of MITECO, interurban roads include those belonging to the State Road Network (RCE) and half of those managed by the Autonomous Communities. Rural roads include those managed by Provincial Councils together with the remaining half of the regional road network. Urban roads correspond to all remaining roads, primarily those managed by local authorities. Due to the difficulty of classifying regional roads as either interurban or rural, a single spatial proxy was developed for both interurban and rural driving patterns. Sections **¡Error! No se encuentra el origen de la referencia.** and **¡Error! No se encuentra el origen de la referencia.** provide further details on the development of this horizontal distribution proxy and the corresponding proxy for urban driving, respectively.

2.7.1. Interurban and rural driving patterns

As noted above, a single spatial proxy was developed to represent motorway/interurban and rural roads, namely those belonging to the State Road Network, the Autonomous Communities and the Provincial Councils. This proxy consists of a set of road maps containing AADT data [vehicles/day] disaggregated by vehicle type: light-duty vehicles, heavy-duty vehicles and motorcycles. Figure 10 shows an illustrative example of the auxiliary spatial proxy used for SNAP activities corresponding to light-duty vehicles under motorway/interurban and rural driving conditions in the Community of Madrid. AADT values are higher on access routes to the capital and on major roads; consequently, higher emission values are allocated to these roads.

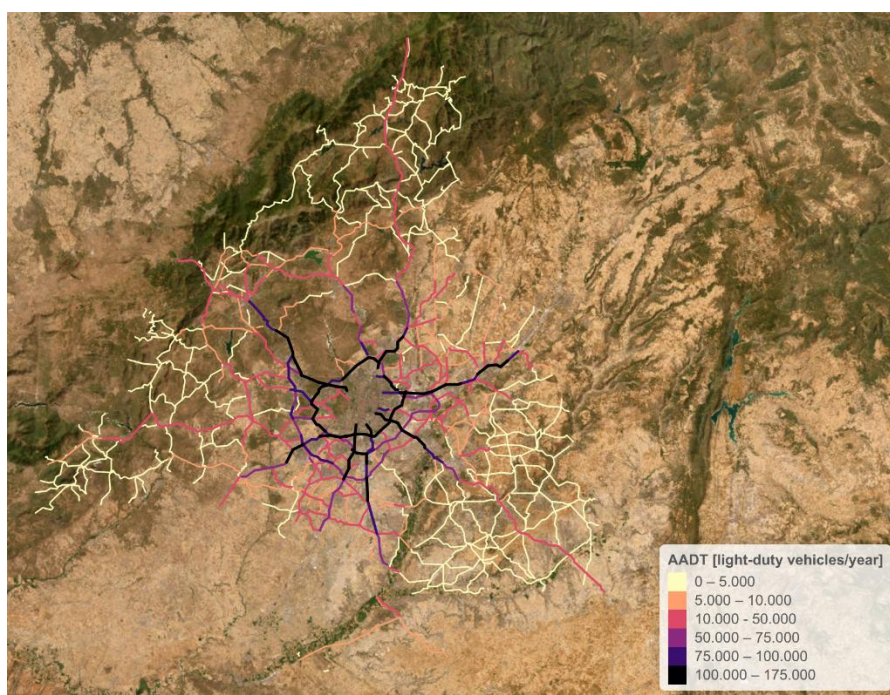


Figure 10. Spatial proxy used for the disaggregation of emissions from SNAP activities corresponding to light-duty vehicles under motorway/interurban and rural driving patterns (070101, 070102, 070201, 070202, 070700_IR_light and 070800_IR_light) in the Community of Madrid. The weighting factor corresponds to the AADT of light-duty vehicles.

To develop this mosaic of maps, data were compiled from 37 different sources, summarised in Table 10 together with their corresponding reference year. Many of these sources provide georeferenced AADT data by road segment. However, in some regions this information is not available; therefore, a base road network map was used and average AADT values reported by the relevant authority were manually assigned, in most cases according to road type. Furthermore, in most regions, motorcycle AADT data by road segment are not available. Consequently, motorcycle traffic volumes were estimated by multiplying total AADT on each road segment by the average provincial share of motorcycles, based on data from MITMA (2022).

Table 10. Information sources by competent authority and territorial entity used to develop the spatial proxies for highway and rural driving patterns. “–” indicates that the corresponding territorial entity has no roads managed by the respective competent authority.

Competent authority	Territorial entity	Spatial proxy: data sources and reference year		Relative weight: data sources and reference year	
State (MITMA – Ministry of Transport and Sustainable Mobility)	Ceuta	IGN (2023b)	2023	Ciudad Autónoma de Ceuta (2011)	2010
	Melilla			Ciudad Autónoma de Melilla (2013)	2003
	Balearic Islands, Canary Islands and Basque Country	-			
	Rest of CCAA	MITMA (2023)			2021
Autonomous Communities	Andalusia	Junta de Andalucía (2022)			2021
	Aragon	Gobierno de Aragón (2023)			2021
	Cantabria	Gobierno de Cantabria (2024)			2021
	Catalonia	Generalitat de Catalunya (2024)			2021
	Valencian Community	Generalitat Valenciana (2023)			2021
	Extremadura	Junta de Extremadura (2023)			2021
	Galicia	Xunta de Galicia (2023)			2021
	Community of Madrid	Comunidad de Madrid (2024)			2021
	Region of Murcia	Región de Murcia (2023)			2021
	Castile-La Mancha	IGN (2023b)	2023	Gobierno de Castilla-La Mancha (2022)	2021
	Castile and León			Junta de Castilla y León (2022)	2021
	Ceuta			Ciudad Autónoma de Ceuta (2011)	2010
	Melilla			Ciudad Autónoma de Melilla (2013)	2003
	Navarre			Gobierno de Navarra (2022)	2021
	Asturias			MITMA (2024b y 2024c)	2021
	La Rioja				
	Balearic Islands, Canary Islands and Basque Country	-			

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Competent authority	Territorial entity	Spatial proxy: data sources and reference year		Relative weight: data sources and reference year		
Provincial Councils	Andalusia	IGN (2023b)	2023	MITMA (2024b y 2024c)	2021	
	Aragon					
	Castile-La Mancha					
	Castile and León					
	Valencian Community					
	Extremadura					
	Galicia					
	Catalonia (Girona, Lleida, Tarragona)					
	Catalonia (Barcelona)	Diputació de Barcelona (2024)				2021
	Balearic Islands: Mallorca	IGN (2023b)	2023	Consell de Mallorca (2023)	2021	
	Balearic Islands: Menorca			Consell Insular de Menorca (2022)	2021	
	Balearic Islands: Eivissa			Consell Insular d'Eivissa (2021), Cantisano Mulero (2022) y Consell Insular d'Eivissa (2016)	2019 y 2012 (en ausencia de datos de 2019)	
	Balearic Islands: Formentera	IGN (2023b)	2023	MITMA (2024b y 2024c)	2021	
	Canary Islands: El Hierro	IGN (2023b)	2023	Cabildo El Hierro (2011)	2009	
	Canary Islands: Fuerteventura			Cabildo de Fuerteventura (2022)	2022	
	Canary Islands: Gran Canaria			Cabildo de Gran Canaria (2022)	2021	
	Canary Islands: La Palma			Cabildo Insular de La Palma (2022)	2011-2013	
	Canary Islands: Lanzarote			Cabildo de Lanzarote (2023)	2021	
	Canary Islands: La Gomera			MITMA (2024b y 2024c)	2021	
	Canary Islands: Tenerife	Cabildo Insular de Tenerife (2023a)	2023	Cabildo Insular de Tenerife (2022)	2021	
	Basque Country: Araba	IGN (2023b)	2023	Diputación Foral de Álava (2022)	2021	
	Basque Country: Gipuzkoa			Diputación Foral de Gipuzkoa (2024)	2021	
	Basque Country: Biscay	Diputación Foral de Bizkaia (2023a)				2022
	Asturias, Cantabria, Ceuta, Community of Madrid, Melilla, Region of Murcia, Navarre, La Rioja	-				

2.7.2. Urban driving pattern

For the horizontal distribution of emissions associated with urban driving, a combined spatial proxy was used, consisting of: (i) a road network map with different weights assigned according to street type and (ii) a map of Spanish municipalities. In this case, AADT data were not used due to the lack of information available for most cities.

For the first proxy, maps from OpenStreetMap (OpenStreetMap Contributors, 2024) were used as the basis, as they classify roads into different categories. These maps were pre-processed to retain only urban roads, i.e. those under the jurisdiction of local authorities. To represent the relative importance of different road types in terms of vehicle traffic, the weighting factors reported by Mu et al. (2022) were adopted, as summarised in Table 11. As this study does not provide a value for residential streets, a weight of 0.05 was assumed for this category. To avoid overestimating emissions, these relative weights were adjusted in some cases according to the available metadata. For example, the weight assigned to service roads was reduced by half. In addition, due to the lack of more detailed information, the same auxiliary spatial proxy was used for all vehicle types under urban driving conditions.

Table 11. Relative weights applied in the urban driving road network map, based on Mu et al. (2022).

Open Street Maps category	Relative weight
<i>Motorway, motorway link</i>	1.00
<i>Trunk, trunk link</i>	1.00
<i>Primary, primary link</i>	0.50
<i>Secondary, secondary link</i>	0.30
<i>Tertiary, tertiary link</i>	0.10
<i>Residential</i>	0.05
<i>Unclassified</i>	0.05
<i>Living street</i>	0.01

For the second auxiliary spatial proxy, namely the map of Spanish municipalities, the 2023 population map published by MITECO (2024c) was used, selecting only municipalities with more than 10,000 inhabitants. This criterion is based on the methodology published by the Emissions Inventory Unit (2025), in which urban emissions are only considered for municipalities exceeding this population threshold.

Figure 11 shows an illustrative example of the auxiliary spatial proxy used for SNAP activities corresponding to urban driving conditions in the Community of Madrid. The relative weight is highest on the M-30 ring road and the city's main streets; consequently, higher emission values are allocated to these roads.

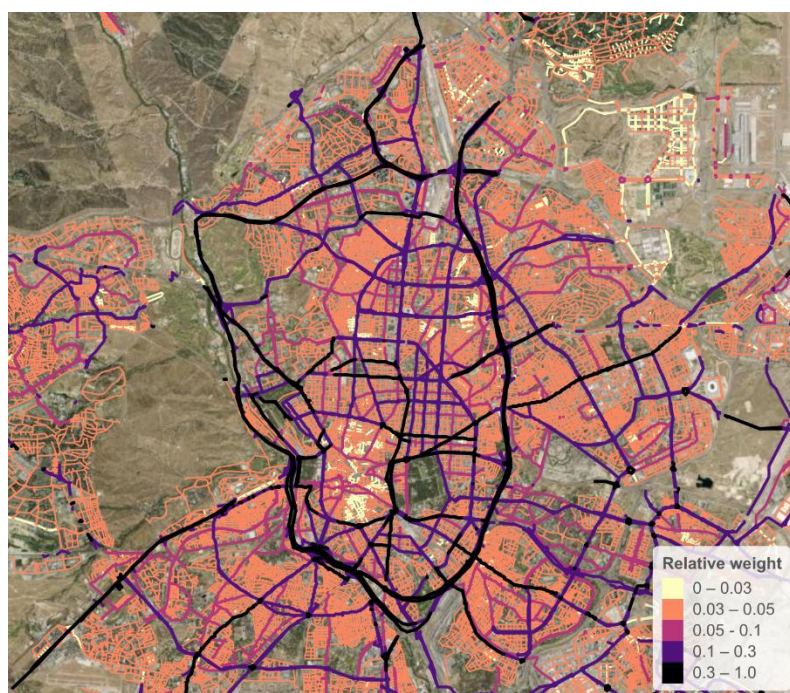


Figure 11. Spatial proxy used for the disaggregation of emissions from SNAP activities corresponding to urban driving conditions (070103, 070203, 070303, 070400, 070503, 070700_U_light, 070700_U_heavy, 070800_U_light and 070800_U_heavy) in the Community of Madrid.

2.8. SNAP 08. Other mobile sources and machinery

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from vehicle fleets and mobile machinery not included within SNAP 07. Emissions from this sector are divided into the following nine subgroups, which are further disaggregated into a total of 19 SNAP activities, described in Table 12:

- **SNAP 0801 – Military mobile machinery:** emissions generated by the use of vehicles and mobile equipment in military activities, including armoured vehicles and logistical support equipment, among others.
- **SNAP 0802 – Rail transport:** emissions arising from diesel consumption by self-propelled locomotives, shunting locomotives and steam generators.
- **SNAP 0803 – Inland waterway transport:** emissions produced by vessels operating on inland waters (canals, reservoirs, navigable rivers, etc.). In Spain, these emissions are considered negligible.
- **SNAP 0804 – Maritime transport and fishing activities:** emissions associated with civil maritime transport carried out by vessels and with marine fishing activities.
- **SNAP 0805 – Air transport:** emissions arising from civil aviation activities.

- SNAP 0806 – Agricultural mobile machinery: emissions associated with machinery used in the agricultural sector, including tractors, motor cultivators and combine harvesters, among others.
- SNAP 0807 – Forestry mobile machinery: emissions produced by forestry machinery during reforestation operations, the maintenance and improvement of forest roads, the creation and maintenance of firebreaks, logging activities and other forestry operations.
- SNAP 0808 – Industrial mobile machinery: emissions associated with mobile machinery operating in open areas, particularly in the mining, construction, public works and industrial sectors, such as excavators and milling machines.
- SNAP 0810 – Other machinery: emissions produced by other types of mobile machinery, although this is considered a residual category.

As noted in Section **Error! No se encuentra el origen de la referencia.**, emissions from SNAP activities 080402, 080403, 080404, 080503 and 080504 are not included in HERMES_Δ.

As SNAP 08 does not contain installations registered in the LPS and PRTR databases, the spatial distribution of emissions reported for this sector was carried out entirely using auxiliary spatial proxies derived from official national datasets. These proxies include military bases, airports, non-electrified railway lines and railway shunting yards. Figure 12 presents an example of the spatial proxies used for this SNAP sector in the Madrid metropolitan area. The figure highlights Adolfo Suárez Madrid–Barajas Airport (shown in orange), two military bases (purple), several non-electrified railway lines (green), and railway shunting areas (blue). In addition, for SNAP activities for which specific associated locations could not be identified, several land-use layers from the CORINE Land Cover product (CLMS, 2020) were used as auxiliary spatial proxies.

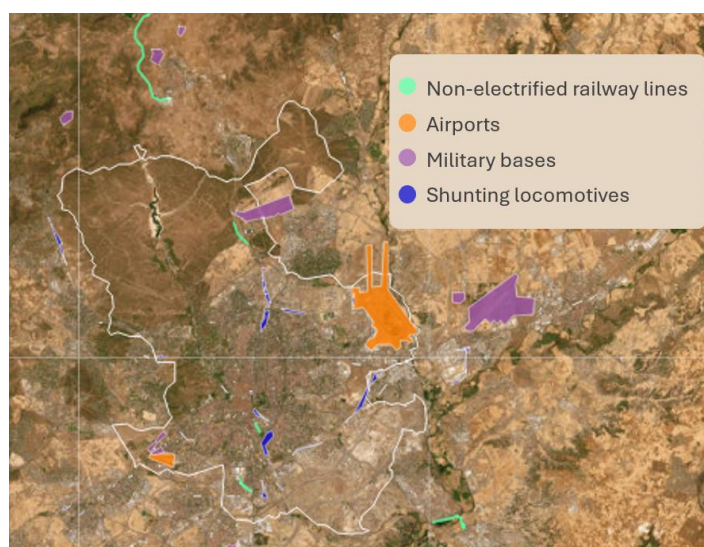


Figure 12. Spatial proxies used for the disaggregation of emissions from SNAP activities 080203 (mainline locomotives), 080501 and 080502 (domestic and international air traffic during landing and take-off cycles), 080100 (military mobile machinery), and 080201 (shunting locomotives), respectively, in the Madrid metropolitan area.

For reference, Table 12 summarises the georeferenced spatial proxies assigned to each SNAP 08 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy.

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Table 12. Georeferenced spatial proxies assigned to each SNAP 08 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
080100	Military	Spanish Army units (2023)	Depending on the availability of land for manoeuvres and mobile military equipment at each installation	MINISDEF (2024)
080201	Shunting locs	Rail infrastructure sidings and stations (2023)	Not applicable*	IGN (2023b)
080202	Rail-cars	-	-	-
080203	Locomotives	Non-electrified railway lines (2023)	Not applicable*	IGN (2023b)
080301	Sailing boats with auxiliary engines	-	-	-
080302	Motorboats / workboats	-	-	-
080303	Personal watercraft	-	-	-
080304	Inland goods carrying vessels	-	-	-
080402	National sea traffic within emep area	SNAP activity not included in HERMES_Δ		
080403	National fishing	SNAP activity not included in HERMES_Δ		
080404	International sea traffic (international bunkers)	SNAP activity not included in HERMES_Δ		
080501	Domestic airport traffic (LTO cycles - < 1000 m)	Spanish airports (2023)	Number of international operations per airport (2023)	AENA (2024)
080502	International airport traffic (LTO cycles - < 1000 m)	Spanish airports (2023)	Number of national operations per airport (2023)	AENA (2024)
080503	Domestic cruise traffic (> 1000 m)	SNAP activity not included in HERMES_Δ		
080504	International cruise traffic (> 1000 m)	SNAP activity not included in HERMES_Δ		
080600	Agriculture	Land use: rainfed cropland, permanently irrigated land, fruit and	Not applicable	CLMS (2020)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
		berry plantations, annual crops associated with permanent crops, and complex cultivation patterns		
080700	Forestry	Land use: broadleaf forests, coniferous forests and mixed forests	Not applicable	CLMS (2020)
080800	Industry	Land use: industrial	Not applicable	CLMS (2020)
081000	Other off-road	Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Not applicable	CLMS (2020)

*Due to the lack of information, a weight of 1 was assigned to all installations included in the corresponding auxiliary spatial proxy. In these cases, emissions are distributed equally among all installations belonging to the same SNAP activity and CCAA.

As noted in Section **¡Error! No se encuentra el origen de la referencia., emissions from SNAP activities 080402, 080403, 080404, 080503 and 080504 are not considered in HERMES_Δ because they are already included in HERMES_GR.

2.9. SNAP 09. Waste treatment and disposal

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from waste treatment and disposal activities. Emissions from this sector are divided into the following five subgroups, which are further disaggregated into a total of 22 SNAP activities, described in Table 13 summarises the georeferenced spatial proxies assigned to each SNAP 09 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy.

Table 13:

- **SNAP 0902 – Waste incineration**: emissions arising from the incineration of different types of waste, including municipal and industrial waste.
- **SNAP 0904 – Landfills**: emissions originating from managed and unmanaged landfill sites, arising directly or indirectly from the waste deposited therein.
- **SNAP 0907 – Open burning of agricultural and forestry residues**: emissions generated by the open burning of pruning residues from woody crops, such as olive groves, vineyards, citrus orchards and other fruit trees. As noted in Section **¡Error! No se encuentra el origen de la referencia.**, emissions from SNAP activity 090700 are not considered in HERMES_Δ because they are already included in HERMES_GR through the GFAS model.

- SNAP 0909 – Cremation: emissions resulting from the incineration of human corpses or animal carcasses in crematoria.
- SNAP 0910 – Other waste treatment activities: a miscellaneous subgroup covering other waste treatment processes, such as compost production and biogas generation.

The spatial distribution of emissions reported in this sector was carried out using the LPS and PRTR databases, following the treatment and processing described in Section **¡Error! No se encuentra el origen de la referencia..** The remaining emissions, i.e. the difference between the emissions reported by the SEIE and the sum of those reported in the LPS and PRTR databases, were allocated using a range of auxiliary spatial proxies, including nearly 31455 sites. For SNAP activities for which the associated facilities could not be identified, several land-use layers from the CORINE Land Cover product (CLMS, 2020) were used as auxiliary spatial proxies.

Table 13 summarises the georeferenced spatial proxies assigned to each SNAP 09 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy.

Table 13. Georeferenced spatial proxies assigned to each SNAP 09 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “–” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
090201	Incineration of domestic or municipal wastes	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
090202	Incineration of industrial wastes (except flaring)	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
090203	Flaring in oil refinery	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
090204	Flaring in chemical industries	LPS database (2023) Chemical industry flaring map (2023)	Not applicable*	LPS: MITECO (2025) Chemical industry flaring map: MITECO (2019b)
090205	Incineration of sludges from waste water treatment	LPS database (2023) Population density (2020)	Not applicable	LPS: MITECO (2025) Population density: Schiavina et al. (2023a)
090206	Flaring in gas and oil extraction	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
090207	Incineration of hospital wastes	-	-	-

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SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
090208	Incineration of waste oil	-	-	-
090209	Accidental fires	Land use: industrial, construction sites and urban green areas (2018)	Not applicable	CLMS (2020)
090401	Managed waste disposal on land	Map of controlled landfills (2021)	Total waste input per landfill [tonnes] (2020)	MITECO (2024b) y PRTR-España (2025b)
090402	Unmanaged waste disposal on land	Land use: landfills (2018) Population density (2020)	Not applicable	Land use: CLMS (2020) Population density: Schiavina et al. (2023a)
090403	Other solid waste disposal sites	-	-	-
090700	Open burning of agricultural wastes (except 100300)	SNAP activity not included in HERMES_Δ		
090901	Incineration of corpses	Map of funeral service providers (2021) Population density (2020)	Not applicable*	Map of funeral service providers: Panasef – Asociación Nacional de Servicios Funerarios (2021) Population density: Schiavina et al. (2023a)
090902	Incineration of carcasses	-	-	-
091001	Waste water treatment in industry	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Land use: CLMS (2020)
091002	Waste water treatment in residential/commercial sectors	Map of wastewater treatment plants (2020)	Capacity per wastewater treatment plant [population equivalent]	EEA (2023)
091003	Sludge spreading	Agricultural plots for the application of WWTP sludge (2018) Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Amount of sludge applied to each agricultural plot [tonnes of dry matter] (2018)	Agricultural plots: MITECO (2020) Land use: CLMS (2020)
091005	Compost production	PRTR database (2023) Map of composting plants (2020)	Total amount of waste for composting (2020)	PRTR: PRTR-España (2025b) MITECO (2021)

Recovery, Transformation and Resilience Plan (PRTyR) – Next Generation EU: Development of a high-resolution national emissions system for air quality forecasting and GHG emissions monitoring.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
091006	Biogas production	Biogas plants catalogue (2024)	Installed electrical capacity [MW _e] (2024)	PRETOR (MITECO, 2024a) and several reports (MAPA, 2023b; MITECO, 2024b; EPSAR, 2024; Agencia Andaluza de la Energía, 2023)
091007	Latrines	-	-	-
091008	Other production of fuel (refuse derived fuel)	-	-	-

*Due to the lack of information, a weight of 1 was assigned to all installations included in the corresponding auxiliary spatial proxy. In these cases, emissions are distributed equally among all installations belonging to the same SNAP activity and CCAA.

**For some Autonomous Communities within these SNAP activities, the CORINE Land Cover product (CLMS, 2020) does not include the landfill land-use class. In these cases, population density was used instead.

***As noted in Section **Error! No se encuentra el origen de la referencia.**, emissions from SNAP activity 090700 are not considered in HERMES_Δ because they are already included in HERMES_GR through the GFAS model.

****For some Autonomous Communities within this SNAP activity, the locations of funeral service providers were not available. In these cases, population density was used instead.

As an example, Figure 13 presents the auxiliary spatial proxy used for the disaggregation of emissions from SNAP activity 091002. As detailed in Table 13, this proxy consists of a map of domestic wastewater treatment plants, with the treatment capacity of each facility, expressed in population equivalent (p.e.), used as the weighting factor. As expected, facilities with the highest capacities correspond to the most populated cities, such as Madrid and Barcelona, and therefore receive the largest share of emissions allocated by HERMES_Δ.

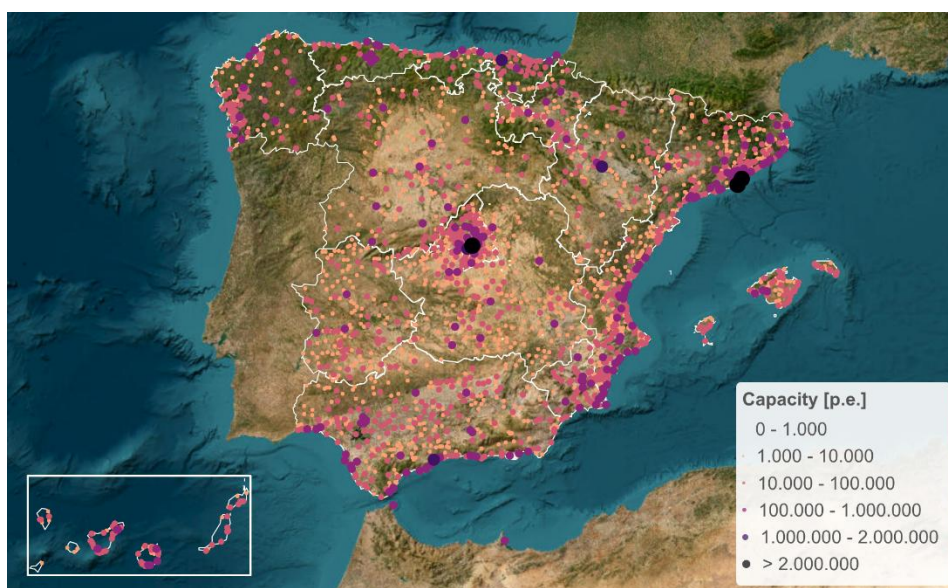


Figure 13. Spatial proxy used for the disaggregation of emissions from SNAP activity 091002 (wastewater treatment in the residential and commercial sectors), using the treatment capacity of each wastewater treatment plant, expressed in population equivalent (p.e.), as the weighting factor.

2.10. SNAP 10. Agriculture

This chapter presents the methodologies and data sources used for the spatial distribution of emissions from agricultural activities. Emissions from this sector are divided into the following seven subgroups, which are further disaggregated into a total of 49 SNAP activities, described in Table 14:

- **SNAP 1001 – Crops with fertilisers**: emissions associated with agricultural crops where nitrogen fertilisers are applied, including mineral fertilisers, organic fertilisers derived from livestock manure, compost from municipal solid waste, and sewage sludge from wastewater treatment plants.
- **SNAP 1002 – Crops without fertilisers**: emissions arising from agricultural crops where nitrogen fertilisers are not applied. The SEIE does not report emissions for this SNAP activity.
- **SNAP 1003 – Open-field burning of crop residues**: emissions generated by the in situ burning of crop residues and other straw residues. As described in Section 1.3, this activity is excluded from HERMES_Δ.
- **SNAP 1004 – Livestock (enteric fermentation)**: methane emissions originating from enteric fermentation in livestock.
- **SNAP 1005 – Manure management related to organic compounds**: methane emissions derived from livestock manure management systems.
- **SNAP 1006 – Pesticide and limestone use**: emissions associated with the application of pesticides and limestone.
- **SNAP 1009 – Manure management related to nitrogen compounds**: emissions of nitrogen compounds, nitrous oxide and ammonia resulting from livestock manure management.

In order to assign more representative spatial distribution proxies, the original emissions reported in the SEIE for subgroup 1001 were disaggregated to a more detailed sectoral level, as described in Section 1.2.4.

The spatial distribution of emissions reported in the SNAP 10 sector was carried out entirely using auxiliary spatial proxies. Unlike other sectors, information reported in the LPS and PRTR point-source databases was not used because these databases only include certain intensive poultry and pig farming facilities exceeding specific capacity thresholds, as established by Royal Decree 100/2011.

Table 14 summarises the georeferenced spatial proxies assigned to each SNAP 10 activity, together with the relative weights attributed to the different individual elements comprising each spatial proxy.

Table 14. Georeferenced spatial proxies assigned to each SNAP 10 activity and the relative weights assigned to the individual elements comprising each spatial proxy. SNAP categories marked with a “—” symbol indicate that no emissions are reported by the SEIE.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
100101	Cultures with fertilisers: permanent crops	Land use: codes 13, 15, 16, 17, 18, 19, 20 (2018) Crop map: code 290 (2018)	Not applicable	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021)
100102	Cultures with fertilisers: arable land crops	Land use: codes 12, 13, 18, 19, 26 (2018) Crop map: codes 100, 211, 212, 213, 214, 215, 216, 217, 218, 219, 221, 222, 223, 230, 231, 232, 233, 240, 250, 500 (2018)	Not applicable	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021)
100103	Cultures with fertilisers: rice field	Crop map: codes 100 y 217 (2018)	Not applicable	Crop map: d'Andrimont et al. (2021)
100104	Cultures with fertilisers: market gardening	Land use: codes 13, 16, 19, 20 (2018) Crop map: codes 222, 240 (2018)	Not applicable	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021)
100105	Cultures with fertilisers: grasslands	Land use: code 18 (2018) Crop map: codes 216, 219, 240, 250, 500 (2018) REGA livestock facilities (2018)	REGA livestock facilities: number of animals by animal type per farm (2018)	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021) REGA livestock facilities: MAPA (2023a)
100106	Cultures with fertilisers: fallows	Land use: code 12 (2018) Crop map: codes 290 (2018)	Not applicable	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021)
100201 - 100206	Cultures without fertilisers	-	-	-
100301 - 100305	Stubble burning	SNAP activity not included in HERMES_Δ		
100401 - 100412	Enteric fermentation	REGA livestock facilities (2018)	Number of animals by animal type per farm (2018)	MAPA (2023a)
100501 - 100512	Manure management regarding organic compounds	REGA livestock facilities (2018)	Number of animals by animal type per farm (2018)	MAPA (2023a)
100601	Use of pesticides and limestone: agriculture	Land use: codes 12, 18, 19, 20 (2018)	Not applicable	Land use: CLMS (2020)

Recovery, Transformation and Resilience Plan (PRTyR) – Next Generation EU: Development of a high-resolution national emissions system for air quality forecasting and GHG emissions monitoring.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
100602	Use of pesticides and limestone: forestry	-	-	-
100603	Use of pesticides and limestone: horticulture	-	-	-
100604	Use of pesticides and limestone: lakes	-	-	-
100901	Manure management regarding nitrogen compounds: anaerobic lagooning	-	-	-
100902	Manure management regarding nitrogen compounds: liquid manure systems	-	-	-
100903	Manure management regarding nitrogen compounds: solid storage and dry stacking	-	-	-
100904	Manure management regarding nitrogen compounds: others	REGA livestock facilities (2018)	Number of animals by animal type per farm (2018)	MAPA (2023a)

*As noted in Section **¡Error! No se encuentra el origen de la referencia.**, emissions from SNAP subgroup 1003 are not considered in HERMES_Δ because they are already included in HERMES_GR through the GFAS model.

The following sections describe in greater detail the auxiliary spatial proxies listed in Table 14 together with the methodology used to incorporate them into HERMES_Δ. Specifically, Section 2.10.1 focuses on livestock-related activities (SNAP 1004, 1005 and 1009), while Section 2.10.2 addresses crop-related activities (SNAP 1001 and 1006). As mentioned above, the SEIE does not report emissions for subgroup 1002, while subgroup 1003 is not included in HERMES_Δ.

2.10.1. Livestock activities: SNAP 1004, SNAP 1005 and SNAP 1009

The spatial distribution of emissions associated with livestock activities (SNAP 1004, 1005 and 1009) was carried out using the Spanish Livestock Holdings Register (REGA; MAPA, 2023a). This register provides information on more than 300,000 farms, including their geolocation and the number of animals present at each holding.

The integration of REGA into HERMES_Δ required a quality-control and filtering process applied to the original registry data, including:

- Removal of farms located at sea (a total of 509 holdings).
- Removal of all farms reporting exactly the same geographical coordinates. Table 15 provides a summary of the cases with the highest number of repeated coordinate records.

Table 15. Repeated geographical coordinates in the REGA database and the corresponding number of occurrences.

Longitude	Latitude	CCAA	Occurrences
-6.0000000	43.43434	Asturias	2168
3.8487125	40.01487	Balearic Islands	253
-2.9444444	43.27111	Basque Country	217
-6.9864487	38.30798	Extremadura	63
-5.8663383	40.01251	Extremadura	26
-6.9487812	38.29366	Extremadura	24
-2.9608601	43.14094	Basque Country	24
-6.9513275	38.4338	Extremadura	20
-6.0282409	40.14405	Extremadura	20
0.0095812	40.76554	Aragón	20
-1.073081	38.17922	Murcia	18
-1.253274	41.9192	Aragón	17
-8.5944182	42.54161	Galicia	16
-6.9672204	38.27658	Extremadura	16
3.865456	39.98548	Balearic Islands	16
-6.5931093	39.5178	Extremadura	15
0.5097241	41.25032	Catalonia	15
2.8736905	39.57042	Balearic Islands	15

- Removal of all holdings reporting poultry animals in hatcheries (a total of 94 holdings).

- Correction of livestock numbers for certain holdings where reported figures were considered unrealistically high. Table 16 summarises, for each case, the corrected livestock numbers and the source used to perform the correction.

Table 16. Summary of livestock number corrections applied to holdings in the REGA database.

REGA code	CCAA	Animal type	Original number of animals (REGA)	Corrected number of animals	Source of information
ES441920000807	Aragón	Broiler chickens	2.117.056	500.000	Value obtained from the IEA
ES300390340196	Murcia	Broiler chickens	1.206.564	39.001	Average value by animal type for the CCAA
ES161180000036	Castilla-La Mancha	Broiler chickens	1.022.323	567.000	Local report
ES060930001700	Extremadura	Broiler chickens	982.519	322.300	Value obtained from the IEA
ES222390000852	Aragón	Broiler chickens	860.000	41.920	Average value by animal type for the CCAA
ES240391101271	Castile and León	Fur-bearing animals	215.500	16.500	Local report
ES410870001262	Andalusia	Equine livestock	459	20	Value obtained from the IEA
ES161910000019	Castilla-La Mancha	Laying hens	1.053.253	327.000	Value obtained from the IEA
ES450120000022	Castilla-La Mancha	Laying hens	200.511	1.946.000	Value obtained from the IEA
ES221630000851	Aragón	Laying hens	1.003.336	1.088.000	Value obtained from the IEA
ES340630500011	Castile and León	Other poultry	2.112.383	320.000	Value obtained from the IEA
ES500190000802	Aragón	Other poultry	1.139.974	109.206	Average value by animal type for the CCAA
ES252310036903	Catalonia	Other poultry	540.000	43.786	Average value by animal type for the CCAA
ES310380000117	Navarre	Sheep	20.273	9.500	Local report

Following the quality-control process, the animal categories reported in REGA were aggregated according to the corresponding SEIE livestock categories using the mapping shown in Table 17. In addition, each SEIE livestock category was assigned a shorter label, which is used within HERMES_Δ and is presented in the following table.

Table 17. Correspondence between REGA, SEIE and HERMES_Δ animal categories.

SNAP activity	REGA animal category	SEIE animal category	HERMES_Δ animal category
100401	Cattle categories: breeding cattle for milk production, breeding cattle for mixed production	Dairy cattle	dairy_cattle
100402	Cattle categories: breeding cattle for meat production, fattening cattle, open-cycle fattening units, pre-fattening cattle, educational farms	Other cattle	other_dairy
100403	All sheep categories	Sheep	sheep
100404	Pig categories: fattening pigs, piglets, rearing pigs, replacement stock, boars	Pigs	fattening_pigs

SNAP activity	REGA animal category	SEIE animal category	HERMES_A animal category
100405 100406*	All equine categories	Horses, other equines (mules, donkeys)	horses
100407	All goat categories	Goats	goat
100411	All rabbit categories	Fur animals	fur_animals
100412	Pig category: sows	Sows	sows
100501	Cattle categories: breeding cattle for milk production, breeding cattle for mixed production	Dairy cattle	dairy_cattle
100502	Cattle categories: breeding cattle for meat production, fattening cattle, open-cycle fattening units, pre-fattening cattle, educational farms	Other cattle	other_dairy
100503	Pig categories: fattening pigs, piglets, rearing pigs, replacement stock, boars	Fattening pigs	fattening_pigs
100504	Pig category: sows	Sows	sows
100505	All sheep categories	Sheep	sheep
100506	All equine categories	Horses	horses
100507	Hen categories: pullet-rearing farms for egg production (commercial poultry), egg-production farms, pullet-rearing farms for egg production (breeding poultry), multiplication farms for egg production, selection farms for egg production	Laying hens	laying_hens
100508	Hen categories: meat-production farms, pullet-rearing farms for meat production (commercial poultry), pullet-rearing farms for meat production (breeding poultry), multiplication farms for meat production, selection farms for meat production	Broilers	broilers
100509	All turkey, duck, quail, pheasant and partridge categories, excluding hatcheries	Other poultry (ducks, geese, etc.)	other_poultry_turkeys
100510	Todas las categorías de conejos	Fur animals	fur_animals
100511	All goat categories	Goats	goat
100512*	All equine categories	Other equines (mules, donkeys)	horses
100904	Cattle categories: breeding cattle for milk production, breeding cattle for mixed production	Dairy cattle	dairy_cattle
100904	Cattle categories: breeding cattle for meat production, fattening cattle, open-cycle fattening units, pre-fattening cattle, educational farms	Other cattle	other_dairy
100904	All sheep categories	Sheep	sheep
100904	Pig categories: fattening pigs, piglets, rearing pigs, replacement stock, boars and sows	Sows and fattening pigs	pigs_sows
100904	All goat categories	Goats	goat
100904	All equine categories	Horses	horses
100904	Hen categories: pullet-rearing farms for egg production (commercial poultry), egg-production farms, pullet-rearing farms for egg production (breeding poultry), multiplication farms for egg production, selection farms for egg production	Laying hens	laying_hens
100904	Hen categories: meat-production farms, pullet-rearing farms for meat production (commercial poultry), pullet-rearing farms for meat production (breeding poultry), multiplication farms for meat production, selection farms for meat production	Broiler chickens	broilers
100904	All turkey categories, excluding hatcheries	Turkeys	turkeys
100904	All duck, quail, pheasant and partridge categories, excluding hatcheries	Other poultry	other_poultry

SNAP activity	REGA animal category	SEIE animal category	HERMES_Δ animal category
100904	All rabbit categories	Rabbits	fur_animals

*The REGA database does not report data for donkeys and mules. Therefore, the REGA category “equines” has been used to distribute the emissions reported under the SEIE category “other equines (mules, donkeys)” for SNAP codes 100406 and 100512.

As an example, Figure 14 shows the auxiliary spatial dataset based on REGA used for the distribution of emissions from the SEIE category “pigs” (HERMES_Δ category: fattening_pigs) in the Region of Murcia. As noted above, the number of animals per farm was used as the weighting factor.

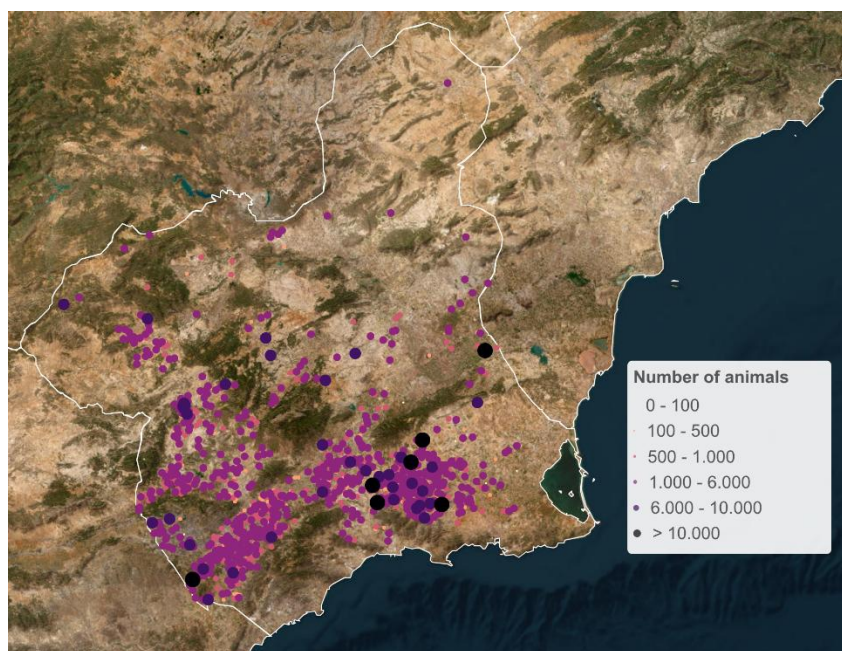


Figure 14. Spatial proxy used for the distribution of emissions from the SEIE category “pigs” (HERMES_Δ category: fattening_pigs) in the Region of Murcia. The number of animals per farm was used as the weighting factor.

2.10.2. Agricultural activities: SNAP 1001 and SNAP 1006

Agricultural activities include the SNAP subgroups 1001 (crops with fertilisers) and 1006 (use of pesticides and limestone). As detailed in Table 14, emissions from subgroup 1006, which are reported only in Andalusia and Castile and León, have been spatially distributed using a combination of several land-use layers from the CORINE Land Cover product (CLMS, 2020): arable land, pastures, annual crops associated with permanent crops, and complex cultivation patterns.

The original emissions from subgroup SNAP 1001 were preprocessed to achieve a more detailed sectoral disaggregation, as described in Section 1.2.4. This disaggregation process enabled emissions to be obtained by crop category (109 in total) and fertilisation type (7 in total) for each Autonomous Community, thereby increasing the number of categories within SNAP 1001 from 6 to 632. Based on this classification, the spatial distribution of emissions was carried out using a combination of the following auxiliary datasets:

1. EU crop map (d'Andrimont et al., 2021): This is a European Union crop map with a spatial resolution of 10 m. It was developed using Copernicus Sentinel-1 satellite observations and LUCAS 2018 Copernicus in situ data, with 2018 as the reference year. To incorporate this dataset into HERMES_Δ, it was necessary to establish correspondences between the crop categories used in the SEIE and those represented in the EU Crop Map, as detailed in Table 18:

Table 18. Mapping between the SEI crop categories considered as input in HERMES_Δ and the EUCROPMAP categories

EUCROPMAP categories		SEI crop categories
211	Common wheat	Wheat
212	Durum wheat	
213	Barley	Barley
214	Rye	Rye
215	Oats	Oats
216	Maize	Maize
217	Rice	Rice
218	Triticale	Triticale
219	Other cereals	Sorghum, winter cereals, other cereals
221	Potatoes	Potatoes
222	Sugar beet	Table beet, sugar beet
223	Other roots crops	Carrot, flowers and ornamental plants, other tubers, cabbage and head cabbage, kale, asparagus, onion, garlic
230	Other non-permanent industrial crops	Other industrial crops, hops, sugar cane, flax, cotton, leek, tobacco
231	Sunflower	Sunflower
232	Rape and turnip rape	Rape, turnip and others
233	Soya	Soya
240	Dry pulses, vegetables and flowers	Green pea, green broad bean, vetch, chickpea, dry pea, bitter vetch, dry broad bean, green bean, dry bean, lentil, lupin, other legumes, cabbage and head cabbage, kale, asparagus, celery, lettuce, spring onion, leek, radish, endive, spinach, chard, chicory and others, pumpkin and courgette, cucumber, aubergine, tomato, pepper, artichoke, cauliflower, garlic, onion, other vegetables, flowers and ornamental plants, cardoon, carrot, turnip and others, gherkin, tomato
250	Other fodder crops (excluding temporary grasslands)	Sainfoin, alfalfa, forage maize, forage vetch, clover, sulla, other cereals, sorghum, winter cereals
290	Bare arable land	Open woodland, woody woodland, pasture wasteland, fallow land, other woody crops
500	Grassland (permanent and temporary)	Mixed grasslands, pastures, forage sorghum, other forage grasses, forage pumpkin, other forage crops, forage cabbage, other forage legumes

2. CORINE Land Cover land-use map (CLMS, 2020): For SEIE crop types not represented in the EU Crop Map, as well as for the Canary Islands (which are not covered by the EU Crop Map), the CORINE Land Cover land-use dataset was used. Table 19 presents the correspondence adopted between CORINE Land Cover land-use categories and SEIE crop types. For the Basque Country, Cantabria, and Galicia, certain land-use categories were unavailable; therefore, alternative categories were selected.

Table 19. Mapping between SEI crop categories considered as input in HERMES_Δ and the CORINE Land Cover land-use categories

CORINE Land Cover land-use categories		SEI crop categories
211	Non-irrigated arable land	Fallow land
212	Permanently irrigated land	Avocado, almond, hazelnut, sweet and sour cherry, plum, fig, lemon, apple, peach, quince, walnut, other non-citrus fruits, pear, strawberry, other woody crops, table vineyard, wine vineyard
		Chard, garlic, artichoke, lupin, celery, oats, aubergine, pumpkin and courgette, sugar cane, barley, onion, spring onion, rye, winter cereals, cabbage and head cabbage, cauliflower, endive, spinach, flowers and ornamental plants, chickpea, dry pea, dry bean, green bean, lettuce, lentil, maize, turnip and others, other vegetables, other cereals, other industrial crops, other tubers, potato, cucumber, pepper, leek, radish, table beet, tobacco, tomato, wheat, triticale, vetch, carrot, strawberry, melon, watermelon, olive grove for table olives, olive grove for olive oil production, table vineyard, wine vineyard
221	Vineyards	Table vineyard, wine vineyard
222	Fruit trees and berry plantations	Avocado, almond, hazelnut, sweet and sour cherry, plum, fig, lemon, apple, peach, quince, walnut, other non-citrus fruits, pear, apricot, cherimoya, mandarin, orange, loquat, other citrus fruits, strawberry, melon, watermelon, banana
223	Olive groves	Olive grove for olive oil production, olive grove for table olives, table vineyard, wine vineyard
231	Pastures	Alfalfa, forage cabbage, forage maize, other forage grasses, other legumes, other forage legumes, other forage crops, pastures, forage sorghum, forage vetch, other woody crops
241	Annual crops associated with permanent crops	Olive grove for olive oil production
		Chard, garlic, artichoke, lupin, celery, oats, aubergine, pumpkin and courgette, sugar cane, barley, onion, spring onion, rye, winter cereals, cabbage and head cabbage, cauliflower, endive, spinach, flowers and ornamental plants, chickpea, dry pea, dry bean, green bean, lettuce, lentil, maize, turnip and others, other vegetables, other cereals, other industrial crops, other tubers, potato, cucumber, pepper, leek, radish, table beet, tobacco, tomato, wheat, triticale, vetch, carrot, strawberry, melon, watermelon
242	Complex cultivation patterns	Avocado, almond, hazelnut, sweet and sour cherry, plum, fig, lemon, apple, peach, quince, walnut, other non-citrus fruits, pear, strawberry, other woody crops
		Olive grove for table olives, olive grove for olive oil production
321	Natural grassland	Natural meadows

3. Spanish Livestock Holdings Register - REGA (MAPA, 2023a): as discussed in Section 2.10.1, REGA is a geospatial database containing the location of all livestock farms in Spain, including information on the number of animals by species at each holding. This auxiliary spatial dataset was used for the spatial disaggregation of emissions associated with manure deposited by grazing animals (SNAP 100105, NFR 3Da3). The methodology for integrating REGA into HERMES_Δ is described in detail in Section 2.10.1, which addresses livestock activities.

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Anexo A: Correspondence between GNFR sectors and SNAP activities

Table A 1. Correspondence between GNFR sectors and SNAP activities included in HERMES_Δ. SNAP activities for which the SEIE does not report emissions are excluded.

GNFR sector	GNFR sector description	SNAP activity	SNAP activity description
A	Public Power	010101	Public power stations: combustion plants ≥ 300 MWth (boilers)
		010102	Public power stations: combustion plants ≥ 50 and < 300 MWth (boilers)
		010103	Public power stations: combustion plants < 50 MWth (boilers)
		010104	Public power stations: gas turbines
		010105	Public power stations: stationary engines
		010203	Public district heating networks: combustion plants < 50 MWth (boilers)
		090201	Municipal solid waste incineration
		090202	Industrial waste incineration (excluding flares)
B	Industry	010301	Combustion in petroleum refineries: combustion plants ≥ 300 MWth (boilers)
		010302	Combustion in petroleum refineries: combustion plants ≥ 50 and < 300 MWth (boilers)
		010303	Combustion in petroleum refineries: combustion plants < 50 MWth (boilers)
		010304	Combustion in petroleum refineries: gas turbines
		010306	Combustion in petroleum refineries: process furnaces without contact in refineries
		010403	Solid fuel transformation plants: combustion plants < 50 MWth (boilers)
		010405	Solid fuel transformation plants: stationary engines
		010406	Solid fuel transformation plants: coke ovens
		010503	Unspecified combustion in coal mining and oil and gas extraction: combustion plants < 50 MWth (boilers)
		010504	Unspecified combustion in coal mining and oil and gas extraction: gas turbines
		010505	Unspecified combustion in coal mining and oil and gas extraction: stationary engines
		030102	Industrial combustion plants: combustion plants ≥ 50 and < 300 MWth (boilers)
		030103	Industrial combustion plants: combustion plants < 50 MWth (boilers)
		030104	Industrial combustion plants: gas turbines
		030105	Industrial combustion plants: stationary engines
		030203	Blast furnace stoves
		030204	Gypsum kilns
		030205	Other non-contact process furnaces
		030301	Sintering and pelletising plants
		030302	Iron and steel reheating furnaces
		030303	Iron foundries
		030305	Primary zinc production
		030306	Primary copper production
		030307	Secondary lead production

GNFR sector	GNFR sector description	SNAP activity	SNAP activity description
		030308	Secondary zinc production
		030309	Secondary copper production
		030310	Secondary aluminium production
		030311	Cement production
		030312	Lime production (including iron and steel and pulp industries)
		030313	Asphalt mixing plants
		030314	Flat glass production
		030315	Hollow glass production
		030316	Glass wool production (excluding binding processes)
		030317	Other glass production
		030318	Rock wool production (excluding binding processes)
		030319	Bricks and tiles
		030320	Fine ceramics
		030321	Paper industry (drying processes)
		030322	Alumina production
		030326	Other contact process furnaces
		040202	Blast furnace charging
		040203	Pig iron casting
		040206	Basic oxygen furnaces in steelworks
		040207	Electric arc furnaces in steelworks
		040208	Rolling mills – scarfing
		040209	Sintering and pelletising plants (excluding 03.03.01)
		040302	Ferro-alloys
		040303	Silicon production
		040309	Other processes in non-ferrous metal industries
		040401	Sulphuric acid production
		040402	Nitric acid production
		040403	Ammonia production
		040404	Ammonium sulphate production
		040405	Ammonium nitrate production
		040407	NPK fertiliser production
		040408	Urea production
		040409	Carbon black production
		040410	Titanium dioxide production
		040412	Calcium carbide production
		040414	Phosphate fertiliser production
		040416	Other inorganic chemical industry processes
		040501	Ethylene production
		040502	Propylene production
		040504	Vinyl chloride production (excluding 04.05.05)
		040506	Low-density polyethylene production
		040507	High-density polyethylene production
		040508	Polyvinyl chloride (PVC) and copolymer production
		040509	Polypropylene production
		040510	Styrene production

GNFR sector	GNFR sector description	SNAP activity	SNAP activity description
		040512	Styrene-butadiene production
		040513	Styrene-butadiene latex production
		040514	Styrene-butadiene rubber (SBR and PB) production
		040515	Acrylonitrile-butadiene-styrene (ABS and SAN) resin production
		040516	Ethylene oxide production
		040517	Formaldehyde production
		040518	Ethylbenzene production
		040519	Phthalic anhydride production
		040527	Other organic chemical industry processes (plant protection products, etc.)
		040601	Cardboard production
		040602	Kraft pulp production
		040605	Bread production
		040606	Wine production
		040607	Beer production
		040608	Spirits production
		040610	Roofing waterproofing with bituminous materials
		040611	Road paving with asphalt mixtures
		040612	Cement production (decarbonation)
		040613	Glass production (decarbonation)
		040614	Lime production (decarbonation)
		040617	Other activities (including manufacture of asbestos products)
		040618	Use of limestone and dolomite
		040619	Production and use of sodium carbonate
		040623	Quarrying
		040624	Construction and demolition
		040625	Sugar production
		060503	Refrigeration and air-conditioning equipment using substances other than halocarbons
		090204	Flares in chemical industries
C	Other Stationary Combustion	020103	Commercial and institutional sector: combustion plants < 50 MWth (boilers)
		020104	Commercial and institutional sector: stationary gas turbines
		020105	Commercial and institutional sector: stationary engines
		020202	Residential sector: combustion plants < 50 MWth (boilers)
		020205	Residential sector: other equipment (stoves, fireplaces, cookers, etc.)
		020302	Agriculture, forestry and aquaculture: combustion plants < 50 MWth (boilers)
		020304	Agriculture, forestry and aquaculture: stationary engines
D	Fugitives	040101	Processing of petroleum products
		040102	Fluid catalytic cracking – coke furnace
		040103	Sulphur recovery plants
		040104	Storage and handling of petroleum products in refineries
		040201	Opening and extinguishing of coke ovens
		050102	Underground mining
		050201	Onshore installations

GNFR sector	GNFR sector description	SNAP activity	SNAP activity description
		050302	Activities at onshore installations (excluding desulphurisation)
		050401	Marine terminals (tankers, handling and storage)
		050402	Other handling and storage activities (including pipeline transport)
		050501	Refinery supply stations
		050502	Transport and logistical storage depots (excluding 05.05.03)
		050503	Service stations (including vehicle refuelling)
		050601	Gas transmission pipelines
		050603	Distribution networks
		090203	Flares in petroleum refineries
		090206	Flares in oil and gas extraction facilities
E	Solvents	060101	Manufacture of automobiles
		060102	Car repairing
		060103	Construction and buildings (except 060107)
		060104	Domestic use (except 060107)
		060105	Coil coating
		060106	Boat building
		060107	Wood
		060108	Other industrial paint application
		060109	Other nonindustrial paint application
		060201	Metal degreasing
		060202	Dry cleaning
		060204	Other industrial cleaning
		060301	Polyester processing
		060302	Polyvinylchloride processing
		060303	Polyurethane foam processing
		060304	Polystyrene foam processing
		060305	Rubber processing
		060306	Pharmaceutical products manufacturing
		060307	Paints manufacturing
		060308	Inks manufacturing
		060309	Glues manufacturing
		060313	Leather tanning
		060401	Glass wool enduction
		060402	Mineral wool enduction
		060403	Printing industry
		060404	Fat, edible and not edible oil extraction
		060405	Application of glues and adhesives
		060406	Preservation of wood
		060407	Underseal treatment and conservation of vehicles
		060408	Domestic solvent use (other than paint application)
		060501	Anaesthesia
		060508	Refrigeration and air condition equipment using other products than halocarbons
		060601	Other use of HFC, N ₂₀ , NH ₃ , PFC and SF ₆

GNFR sector	GNFR sector description	SNAP activity	SNAP activity description
		060602	Fireworks
F	Road Transport	070101	Combustion emissions: Passenger cars: highway driving
		070102	Combustion emissions: passenger cars, rural driving
		070103	Combustion emissions: passenger cars, urban driving
		070201	Combustion emissions: light-duty vehicles < 3,5 t, highway driving
		070202	Combustion emissions: light-duty vehicles < 3,5 t, rural driving
		070203	Combustion emissions: light-duty vehicles < 3,5 t, urban driving
		070301	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, highway driving
		070302	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, rural driving
		070303	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, urban driving
		070400	Combustion emissions: mopeds and motorcycles < 50 cm ³
		070501	Combustion emissions: motorcycles > 50 cm ³ , highway driving
		070502	Combustion emissions: motorcycles > 50 cm ³ , rural driving
		070503	Combustion emissions: motorcycles > 50 cm ³ , urban driving
		070600	Gasoline evaporation from vehicles
		070700	Automobile tyre and brake wear
		070800	Road surface wear
H	Aviation	080501	Domestic airport traffic (LTO cycles - < 1000 m)
		080502	International airport traffic (LTO cycles - < 1000 m)
I	Off-Road Transport	010506	Unspecified combustion in fuel transport pipeline networks: compressors
		080100	Military mobile machinery
		080201	Shunting locs
		080203	Locomotives
		080600	Agricultural mobile machinery
		080700	Forestry mobile machinery
		080800	Industrial mobile machinery
		081000	Other off-road machinery
J	Waste	090205	Incineration of sludges from waste water treatment
		090209	Accidental fires
		090401	Managed waste disposal on land
		090402	Unmanaged waste disposal on land
		090901	Incineration of corpses
		091001	Waste water treatment in industry
		091002	Waste water treatment in residential/commercial sectors
		091003	Sludge spreading
		091005	Compost production
		091006	Biogas production
K	Agricultural Livestock	100401	Livestock (enteric fermentation): dairy cattle
		100402	Livestock (enteric fermentation): other cattle
		100403	Livestock (enteric fermentation): sheep
		100404	Livestock (enteric fermentation): pigs

GNFR sector	GNFR sector description	SNAP activity	SNAP activity description
		100405	Livestock (enteric fermentation): horses
		100406	Livestock (enteric fermentation): other equines (mules, donkeys)
		100407	Livestock (enteric fermentation): goats
		100411	Livestock (enteric fermentation): fur animals
		100412	Livestock (enteric fermentation): breeding sows
		100501	Manure management with respect to organic compounds: dairy cattle
		100502	Manure management with respect to organic compounds: other cattle
		100503	Manure management with respect to organic compounds: fattening pigs
		100504	Manure management with respect to organic compounds: breeding sows
		100505	Manure management with respect to organic compounds: sheep
		100506	Manure management with respect to organic compounds: horses
		100507	Manure management with respect to organic compounds: laying hens
		100508	Manure management with respect to organic compounds: broiler chickens
		100509	Manure management with respect to organic compounds: other poultry (ducks, geese, etc.)
		100510	Manure management with respect to organic compounds: fur animals
		100511	Manure management with respect to organic compounds: goats
		100512	Manure management with respect to organic compounds: other equines (mules, donkeys)
		100904	Manure management with respect to nitrogen compounds: other
L	Other Agriculture	100101	Cultures with fertilisers: permanent crops
		100102	Cultures with fertilisers: arable land crops
		100103	Cultures with fertilisers: rice field
		100104	Cultures with fertilisers: market gardening
		100105	Cultures with fertilisers: grasslands
		100601	Use of pesticides and limestone: agriculture

Anexo B: Correspondence between SNAP activities and CNAE codes

Table B 1. Mapping between SNAP and CNAE categories proposed for the PRTR industrial facilities

SNAP code	CNAE category	
010104	35.19	Electricity production from other sources
030103	8.12	Extraction of gravel and sand; extraction of clay and kaolin
	10.11	Processing and preserving of meat
	10.12	Processing and preserving of poultry meat
	10.13	Production of meat and poultry meat products
	10.32	Manufacture of fruit and vegetable juice
	10.39	Other processing and preserving of fruit and vegetables
	10.54	Operation of dairies and cheese making
	10.91	Manufacture of prepared feeds for farm animals
	15.11	Tanning and dressing of leather; dressing and dyeing of fur
	18.12	Other printing and printing services
	20.12	Manufacture of dyes and pigments
	20.13	Manufacture of other basic inorganic chemicals
	20.14	Manufacture of other basic organic chemicals
	20.15	Manufacture of fertilisers and nitrogen compounds
	20.51	Manufacture of explosives
	20.59	Manufacture of other chemical products n.e.c.
	21.10	Manufacture of basic pharmaceutical products
	21.20	Manufacture of pharmaceutical preparations
	24.10	Manufacture of basic iron and steel and of ferro-alloys
	24.20	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
	24.32	Cold rolling of narrow strip
	24.34	Cold drawing of wire
	24.42	Aluminium production
	24.53	Casting of light metals
	24.54	Casting of other non-ferrous metals
	25.72	Manufacture of locks and hinges
	25.73	Manufacture of tools
	29.10	Manufacture of motor vehicles
	29.32	Manufacture of other parts and accessories for motor vehicles
	30.11	Building of ships and floating structures
	30.30	Manufacture of air and spacecraft and related machinery
	37.00	Collection and treatment of wastewater
	38.21	Treatment and disposal of non-hazardous waste
	38.22	Recovery of sorted materials
	38.31	Sorting and classification of materials
	63.11	Data processing, hosting and related activities
030204	23.62	Manufacture of plaster products for construction purposes
	23.52	Manufacture of lime and plaster

SNAP code	CNAE category	
030303	24.51	Casting of iron
030311	23.51	Manufacture of cement
030314	23.13	Manufacture of hollow glass
	23.11	Manufacture of flat glass
030320	22.31	Manufacture of ceramic tiles and flags
	23.32	Manufacture of bricks, tiles and construction products, in baked clay
040207	24.52	Casting of steel
040508	20.16	Manufacture of plastics in primary forms
040602	17.11	Manufacture of pulp
040625	10.81	Manufacture of sugar
040623	7.29	Extraction of other non-ferrous metal ores
060404	10.44	Manufacture of other oils and fats
091005	38.32	Recovery of sorted materials