REPAiR

REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism

D3.3 Process model for the two pilot cases: Amsterdam, the Netherlands & Naples, Italy.

Final Version

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Acronyms and Abbreviations

AG	Activity Group
AMA	Amsterdam Metropolitan Area
AS-MFA	Activity-based Spatial Material Flow Analysis
CE	Circular Economy
CDW	Construction and Demolition Waste
D3.1	Deliverable 3.1 of Work Package 3 in REPAiR
EC	Enabling Context
EoW	End-of-Waste
ESS	European Social Survey
EW-MFA	Economy-wide MFA
FA	Focus Area
FW	Food Waste
GDSE	Geodesign Decision Support Environment
GG	General Geography
HG	Human Geography
LCA	Life Cycle Assessment
LMA	Landelijk Meldpunt Afvalstoffen
MFA	Material Flow Analysis
MSW	Municipal Solid Waste
NACE	Nomenclature des Activités Économiques dans la Communauté Européene
OW	Organic Waste
PCPW	Post-consumer Plastic Waste
PG	Physical Geography
PSCA	Primer Sociocultural Analysis
PULL	Peri-urban Living Lab
SC	Supply Chain
SEA	Socioeconomic Analysis
SSCA	Secondary Sociocultural Analysis
UM	Urban Metabolism
WM	Waste Management
WP	Work Package
WVS	World Value Survey

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Publishable Summary

Deliverable 3.3 of Work Package 3 concerns an integrated analysis of the two pilot case studies within the REPAiR project, Amsterdam and Naples, from the vantage point of waste production and processing, and the transition to circular societies. It comprises spatial, social and material flow analyses of the two pilot cases, whilst testing an innovative methodology that was introduced and explained in Deliverable 3.1 [D3.1, AKA the Handbook, Geldermans et al., 2017]. The report addresses additions and clarifications to the methodology presented in Deliverable 3.1. After an update on the basis of technical insights and the work developed in practice within the peri-urban living labs (PULL) workshops carried out so far, an improved classification of Wastescapes is presented. Furthermore, a complete process model to map Wastescapes is provided. A smaller scale of the 'sample' area has been introduced to allow a better interaction with the local stakeholders, deepening the context and cutting into the intermediate scale of the 'focus-area'. Moreover, the notion of Enabling Contexts is applied to rationalise the links between spatial analysis and eco-innovation solutions (WP5). With regard to the Material Flow Analysis, new insights on data collection and processing are addressed, providing more grip on how to successfully conduct such an MFA. The lion's share of the report is allocated to presenting the results. For both cases, a rudimentary spatial and socio-economic analysis on a national level precedes a detailed regional analysis: for the Netherlands, this concerns the Amsterdam Metropolitan Area, and for Italy the Campania Region and the Metropolitan region of Naples. Embedded in this spatial-social context, the material flow analysis follows six Activity-based Spatial MFA (as introduced in D3.1) steps to pinpoint and analyse waste related challenges and activities. The report finishes with a reflection on the methodology and results. This reflection focuses on four topics in particular: physico-geographical aspects and waste-sensitivity, Waste(scape) dynamics in space & time, modelling of material flows & data intensity, and the relevance of Enabling Contexts, whilst anticipating the follow up cases as well as a wider field of application.

1. Introduction

This report – Deliverable 3.3 of Work Package 3 – concerns an integrated analysis of the two pilot case studies within the REPAiR project, Amsterdam and Naples, from the vantage point of waste production and processing, and the transition to circular societies. It comprises spatial, social and material flow analyses of these two pilot cases, whilst testing an innovative methodology that was introduced and explained in Deliverable 3.1 [D3.1, AKA the Handbook, Geldermans et al., 2017]. The report addresses additions and clarifications to the methodology presented in Deliverable 3.1.

In Chapter 2, the methodological approach from D3.1 is briefly revisited in relation to new insights and adjustments. First, an improved classification of Wastescapes is presented after an update on the basis of technical insights and the work developed in practice within the PULL workshops carried out so far. Furthermore, a complete process model to map Wastescapes will be provided, this includes data sources useful to map each of the 17 categories in which they have been articulated. Next, scale matters and issues relating to information layers are considered. Second, a smaller scale of the 'sample' has been introduced to allow a better interaction with the local stakeholders; this deepens the context and cuts into the intermediate scale of the 'focus-area'. In regard to the standardisation of the mapping process all the data has been ordered into informative layers, according to different scales and topics. Also, graphics and colours used for the pilots have been operationalized. Finally, the notion of Enabling Context is provided to rationalise the links between spatial analysis and eco-innovation solutions, addressing the interest of PULLs towards some priority areas.

Furthermore, new insights on data collection and processing regarding the Material Flow Analysis are addressed. Particularly relating to case specific supply chains (step 4 of the Activity-based Spatial Material Flow Analysis methodology, see D3.1, Chapter 2.2.4) and mass flow modelling (step 5 in the AS-MFA methodology). Obstacles for data gathering and methods to successfully conduct a material flow analysis are clarified.

Moreover, there are additions regarding the functional changes of an area, including the flows of materials and the allocation and patterns of Wastescapes, as well as the differences between countries and regions/focus areas, which cannot be understood without a social, socio-economic and demographic analysis. The basic assumption is that the different agents' understandings and behaviours related to ecological sustainability are deeply embedded into certain collectively accepted, respected and followed social values, norms, rules, attitudes and economic, demographic conditions. Social patterns, and socio-economic and demographic conditions influence the agents' way of thinking (perceptions and interpretations, i.e. concepts), their possibilities, and their way of addressing (i.e. praxes) environmental challenges.

In Chapter 3, the research results from the two pilot cases are presented. The results start with a spatial and socio-economic analysis, followed by a material flow analysis. The structure of the chapters allows the readers to gain understanding in regard to the socio-geographical context (including some historical insights) so to better understand the context of the case-specific flows and challenges. The generic methodological steps are thus applied to – and gradually developed through – two different case studies. For both cases, a rudimentary spatial and socio-economic analysis on a national level precedes a detailed regional analysis: for the Netherlands, this concerns the Amsterdam Metropolitan Area, and for Italy the Campania Region and the Metropolitan region of Naples. Embedded in this spatial-social context, the material flow analysis follows six Activity-based Spatial MFA steps to pinpoint and analyse waste related challenges and activities. This structure enables the identification of key activities and actors, which reveals where responsibilities lie and therefore surfaces distinct points for policy or business (case) interventions. Knowledge of the actors at stake and their spatial location, allows for a spatial understanding of the regional actor network and its geographical position related to material flows. Analysing the links and patterns between spatial characteristics and material flows allows designers, policy makers, investors and urban planners to seek for optimum solutions (Moffatt and Kohler, 2008) and reveal possibilities for eco-innovation and circularity.

Chapter 4 is dedicated to a reflection on the pilot cases, both in terms of methodology and results. Particular attention is given to the way in which waste dynamics ultimately take place in space, and what the spatial consequences entail from a circular perspective. Furthermore, the meaning – and visualisation – of Wastescapes is addressed, against the backdrop of ever-changing urban areas and circular scenarios that may help improve the quality in cities. Moreover, challenges are addressed regarding data collection and modelling of material flows, whilst reflecting on the pilot-related groundwork done in anticipation of, both, the four follow-up cases and wider application. Last but not least, the concept of Enabling contexts, and its relevance for the REPAiR scope, is further discussed in this chapter.

2. Spatial, Material Flow and Social Analyses

In this chapter, we are revisiting the methodology outlined in D3.1, the Handbook, regarding the Spatial-, Material Flow-, and Social analyses.

2.1 Task 3.1 | Spatial analysis

2.1.1 Introduction

In D3.1, *Introduction to methodology for integrated spatial, material flow and social analyses*, a recursive methodology - consistent with the Geodesign principles (Steinitz, 2012) and with the overall REPAiR methodology - was defined. This methodology postulates the alternation of data-based technical procedures and the continuous integrations of the draft elaborations developed within the PULLs; it has been applied to two case studies with results on the approach to mapping for both pilots, as illustrated below.

The recursive mapping process has, as expected, provided feedback on the methodology defined in D3.1. Therefore, we hereby provide further indications, related to both methodology and content, for the development of the spatial analysis in order to integrate, correct or clarify what was presented D3.1. The methodology for the spatial analysis of the pilots will not be repeated in the following text; therefor, for any reference its necessary to refer to the aforementioned D3.1. Indeed, this report only provides clarifications and additions. First, an improved classification of Wastescapes is provided, after being verified and updated on the basis of technical insights, the work developed in practice within the local laboratories, and the PULL workshops carried out so far. Then, matters related to scale and information layers are considered. Finally, the notion of Enabling Context is introduced to rationalise the links between spatial analysis and eco-innovation solutions, addressing the interest of PULLs towards some priority areas.

It is important to stress that, on the one hand the working method with the additions presented in this document can be considered completely defined and therefore transferable in the follow-up cases; on the other hand, the resulting maps, even if very advanced, are not completely ultimate and will be further updated in the following months. Indeed, some maps are still in development, and this is for two reasons. Firstly, there is a considerable difficulty - in both pilots, possibly to an even greater extent in Italy – regarding the availability and the quality of datasets that can be considered complete and appropriate to the analysis of environmental matters. Secondly, this difficulty certainly has organizational reasons, but a certain reluctance to make public sensitive data relevant to hot topics such as pollution, risk, vulnerability, etc. cannot be completely excluded.

Moreover, the developing nature of the maps means that the work of WP3 for the pilot cases of Amsterdam and Naples, will continue in parallel with the work carried on for the follow-up PULLs; this will happen in relation to the work developed within the framework of WP5. Indeed, REPAiR aims to have a spatial mapping process that relates to the perspectives on eco-innovation; this process is accompanied by a further definition of the maps, for 'sample' areas through an in-depth analysis, in parallel with the debates within the PULL workshops.

Finally, when it comes to decision support, the work developed in REPAiR it is not just referred to a "dry" decision-making process where the choices are to be made among pre-established options. The knowledge and interpretation of the starting conditions of the places, as well as the setting of the problems and challenges are intersected inextricably with the search for eco-innovative solutions. Using context leads to a more sustainable territorial structure and to the development of its potentials by focusing on the synergies and coherence between the different interventions. For this theoretical reason, the mapping process can only continue to be specified and to be detailed in thematic nodes, in parallel with the development of solutions, that are possibly combined within wider territorial strategies. The aim here is to define a method that allows a constantly updated knowledge and assessment process that could also be the result of the contribution of all the competences involved in the PULLs; that are both technical and non-technical, moreover involving the people of the place.

2.1.2 Wastescapes: Improved definitions

Going beyond the material dimension of waste flows, REPAiR includes in its experimentations the category of Wastescapes that embrace the spatial effects of waste flows on the landscape as well as all the residual spaces scattered in the peri-urban areas object of the study. As defined in D3.1, Wastescapes are related to the spatial effect of material waste flows on the territories and to the configurations of the infrastructures for their management. From a spatial, environmental, and social point of view, Wastescapes can represent challenging areas. Therefore, to be spatially connected with the surrounding settlements and become accessible areas as public spaces, they need to be transformed and regenerated. In the following paragraphs, we will further develop the definition of Wastescapes.

As stated in the Spatial Analysis Glossary of the Deliverable 5.1 PULLS Handbook (Russo et al. 2017), Wastescapes are: "patches of landscape related to waste-cycles both by functional relations and because they are 'wasted-lands': anomalous areas inconsistent with the peri-urban metabolism that become neglected spaces". According to Berger (Berger, 2006) we define drosscape as accumulation "in the wake of the socio – and spatio – economic processes of deindustrialization, post-Fordism and technological innovation. [They] are located in the declining, neglected and deindustrializing areas of cities". The notion of drosscape emphasizes the opportunity to reuse the material scraps of the city as in-between areas and abandoned spaces go beyond the mere spatial reference of soils and fields and embrace the wider and multidisciplinary field of landscape. In the REPAiR research focus, the Wastescapes involve also the spaces that enable the urban system to be efficient. According to Brenner (Brenner 2014) the operational landscapes, like mines and infrastructures, are not perceived as part of the city because of the lack of relations with the urban settlements and the gap with the human dimension. Nevertheless, these new geographies of the urbanization phenomena are the working engines of the system and should be considered as urban spaces involved in the urban policies and strategies. What we call "operational infrastructure of waste" are areas related to waste management functions such as incinerators, landfills, big waste treatment and waste disposal plants, waste-recycling plants, waste-water processing plants and even former industrial areas waiting for reclamation by the State. Territories in-between that belong to our case study host these infrastructures for waste-disposal, which has shaped peri-urban areas and are managed by national and local policies.

REPAiR defines 5+1 categories of Wastescapes, as described below, follow the criteria of decreasing natural values. The 6 categories of Wastescapes that are considered as innovative resources to be reintegrated in the metabolic dynamics for an improved quality of the peri-urban areas are hereby investigated. Some of these categories could be found at the scale of the entire focus area; other categories could be mapped instead only at a local scale, thanks to the interactions within the PULL workshops. Some categories are likely to overlap each other in the mapping process.

These 5+1 categories are grouped in DROSSCAPES and OPERATIONAL INFRASTRUCTURE OF WASTE.

DROSSCAPES

1. Degraded land (W1)

2. Degraded water and connected areas (W2)

3. Declining fields (W3)

4. Settlements and buildings in crisis (W4)

5. "Dross" of facilities and infrastructures (W5)

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6. OPERATIONAL INFRASTRUCTURE OF WASTE (W6)

For a better understanding about how to identify Wastescapes in the REPAiR focus areas (and samples), a description of the 5+1 categories is provided below.

Within the category of DROSSCAPES there are:

1 Degraded lands (W1)

Lands that have lost some degree of their natural productivity due to human-caused processes, this category includes: polluted (W1.1), and artificial soils (W1.2).

- W1.1: **Polluted soils**, characterized by the alteration of the chemical-physical and biological equilibrium with the presence of contaminants that are potentially harmful to humans, also through the food chain, if they are cultivated soils. This category also includes "potentially polluted" soils, for which in-depth investigations are planned. Polluted soils are marked by the presence of significant quantity – as defined by the reference indicators - of xenobiotic chemicals or other humanmade drosses (Panagos et al., 2013). This kind of land can be found in proximity of industrial/port areas, main infrastructures (mostly pipelines) and facilities (e.g. wastewater treatment plants), as well as in areas close to landfills and other waste treatment plants. Contamination can also be the product of industrial agriculture, due to the massive use of pesticides, herbicides and other chemicals. It is necessary to investigate the availability of data that indicates the presence of pollutants in the ground in order to identify polluted soils. Generally, the most common chemicals involved in pollution are: petroleum hydrocarbons, polynuclear aromatic hydrocarbons, solvents, pesticides, and heavy metals (lead and others). For instance, in the case of Amsterdam, polluted lands contamination depends mainly on the presence of lead in the soil. (Omgevingsdienst Noordzeekanaal: https://gisviewer.odnzkg.nl/?@Lood). In the case of Naples, the most polluted site is close to former oil refinery plants, near the commercial port, where there is a large amount of hydrocarbons. Also, former landfills between Casoria and Afragola have been mapped as degraded-land. All the national/regional environment agencies have to use the same parameters and each of them has a national/regional cadastre. The European Joint Research Centre (JRC) defines the encoding (2014). In the case of Naples, moreover, other kinds of contaminated sites depend on the criminal practice to dispose or recycle waste burning them. This phenomenon has interested some places in the fields between Naples and Caserta, known as the "Land of Fires" (Terra dei fuochi). These places have been mapped and are now monitored by the Regional Authority, under the national Decree-Law no. 136/2013.

- W1.2: **Artificial soils**, when they are degraded because of significant morphological transformations, like quarries, dig and artificial dams. To map this category into the boundaries of the focus-areas, the Urban Atlas provides a basic dataset: cat. 1.3.1. "Mineral extraction and dump sites". More detailed information could be available in regional catalogues and geomorphological studies.

2. **Degraded water and connected areas** (W2)

This category includes both properly degraded water bodies; elements functionally related to them; and territories in crisis for hydraulic reasons. The following subcategories are distinguished:

- W2.1: **Water bodies,** degraded for quantitative reasons (for example because characterized by a scarcity of the flow rate, or from seasonal peaks) or qualitative (contamination) reasons (i.e.: polluted, draining up, overflowing, etc.): rivers, canals, basins, streams, ditches, water pipes, culverts, wells, etc. Water quality degradation is mostly a result of contaminants directly or indirectly discharged into water bodies. It may be the product of a single source, such as a pipe or a ditch. For instance, it depends on inadequate treatments of sewage outfalls. Moreover, degradation of water can be the result of diffuse contamination, generally caused by intensive agriculture and farming - based on the use of pesticides and other chemicals (Moss, 2008). Sometimes, diffuse contamination of water-drains comes from the presence of chemicals used decades ago, especially during the 1940s and 50s: DDT and other pesticides, which are now banned, maintain a long decay time. The assessment of water quality is generally carried out through the measurement of nitrogen and phosphorus, sensors of the presence of plants, algae, microbes and other biological elements necessary for aquatic ecosystems. The Index of Biological Integrity index (IBI) is the measure usually used by Environmental Agencies to assess the quality of water bodies. This scientific tool is used to identify and classify water pollution problems and give a synthetic evaluation of rivers, canals and other basins: an overall rating to give a qualitative description we can all understand (Poor, Moderate, Excellent). Anyway, more specific parameters about contaminants (heavy metals, pesticides, etc.) are generally available for the main water bodies, thanks to the presence of monitoring sites.

- W2.2: banks, shores, tanks, plants, and other **elements linked to W2.1**;
- W2.3: **Flooding zones** characterized by hydraulic hazard and consequent risk for people and things. Flooding typically occurs when prolonged rain falls over several days, when intense rain falls over a short period of time, or when an ice or debris jam causes a river or stream to overflow onto the surrounding area. The most common cause of flooding is water due to rain and/or snowmelt that accumulates faster than soils can absorb it or rivers can carry it away. The origin of the hydraulic crisis can result from human actions: conversion of canals and rivers in pipelines; spread of water wells; concreting of banks and shores; etc. Flooding can also result from the failure of a water control structure, such as a levee or dam. Directive 2007/60/EC on the assessment and management of flood risks - entered into force on 26 November 2007 - requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. As a result, each country member of the EU, today has Flood Hazard & Flood Risk Maps by which the flooding vulnerability is classified into four risk zones. The flood zones are based on the likelihood of an area flooding, with flood zone 1 areas least likely to flood (500 years) and flood zone 4 areas more likely to flood (50 years).

3. **Declining fields** (W3)

This category addresses vacant/under-used fields, vacant parcels, and vulnerable soils. The subcategories are: Abandoned fields and parcels and Vulnerable lands.

- W3.1: **Abandoned agricultural fields** are areas that are no longer used for their planned function or long-time used; they are essentially out of their expected life-cycle, in a waiting condition, ready to be used in alternative ways. Sometimes soils are abandoned because of pollutants present in the ground and therefore no longer suitable for residential or agricultural uses, for example. Fields are open land areas that are free of woods and buildings.

Generally, they are included in rural environments and in fringes with a low rate of buildings. Vacant and underused fields are often former agricultural ones. Nowadays, the soil can be natural or compromised by concreting and asphalting of surface. Parcels are sections or areas of land dedicated (by plans) for buildings. They can be in a condition of "suspension", as an after effect of the financial crisis, since the demand for new building has plummeted. In the case of Amsterdam, many abandoned areas are located in the industrial port area. In the Neapolitan case, large former agricultural fields are located close to big infrastructures like the new High-speed rail station for Napoli-Afragola and they are areas where an unauthorized abandonment of waste is taking place. To map this category into the focus-areas, the Urban Atlas provides a basic dataset: cat. 1.3.4. "Land without current use". This category of the Urban Atlas also includes urban parcels and brownfield that in the Wastescape classification is included into another typology (W.4). For this reason, in the pilot cases a data selection has been operated by crossing this data together with that of the unbuilt; lots external to urban contexts. More detailed information about the abandonment of agricultural fields could be available in agricultural land use maps, elaborated at municipal/provincial or regional scale.

- W3.2: **Vulnerable lands** are characterised by hydrogeological and/or seismic criticality, such as landslide or instability risk. Landslides are complex phenomena that affect urban and peri-urban settlements, infrastructure, and agricultural and environmentally valuable land in many sloping areas in Europe. Nowadays, landslide risk is substantially increasing in these areas as a result of growing urbanization and associated infrastructure together with increasing or changing precipitation trends. So, the industrialized and economically advanced territories, with high density of population, are generally more vulnerable than lower anthropic pressure ones. As mentioned in the case of flood areas, the EU is trying to standardize the catalogues and the maps of the natural vulnerability conditions for all member states. Since 2007, common definitions, parameters and mapping standards: http://eusoils.jrc.ec.europa.eu/ESDB_Archive/eusoils_docs/other/EUR23093.pdf. Moreover, a European Landslide Susceptibility Map (version 2, release: Feb 2018) is available in shape format at this link. The map shows confidence levels of the classified landslide susceptibility on EUROSTAT NUTS 3 regions. The levels have been calculated either statistically or by expert evaluation. Finally, a more detailed level of mapping has been used for the Pilot cases since the presence of specific studies by the Dutch and Italian competent authorities. For the Naples case, for instance, see: http://www.adbcampaniacentrale2.it/. A similar argument relates to the earthquake and volcanic vulnerability (hazard and risk). But, in this case the level of the available studies and maps, elaborated by ESPON, has a more general scale:
- https://www.preventionweb.net/english/professional/maps/v.php?id=3832 and, furthermore, the level of mapping on a regional scale is quite backward. So, for the pilot cases only the Volcanic main risk of Vesuvius and

Campi Flegrei has been indicated. Those areas are in a “red zone” of National Civil Protection and Regione Campania intends to promote the decreasing of inhabitants in those areas in the next decade.

4. **Settlements and buildings in crisis** (W4)

The subcategories are: Vacant/underused, neglected or obsolescent buildings and settlements, Urban settlements suffering from fatigue, Informal settlements, Urban lots in transformation, Unauthorized buildings and settlements, Confiscated assets.

- W4.1: **Vacant/underused buildings and settlements.** Vacancy and underusing phenomena can be the direct consequences of the urban decline, due to several factors in the organization of the territory. Economic changes/crisis could also cause abandonment of settlements, or of some parts of them. In this category, abandoned, vacant, underused, dismissed industrial, commercial, military buildings are also included. Examples are: a) brownfields; b) abandoned historic buildings (farms, houses, mills); c) building blocks with high percentages of apartments and / or offices and / or commercial premises not leased; d) agricultural products (such as greenhouses or shelters). Different process models could be indicated to map this category: 1) the first procedure is based on the use of the Urban Atlas: using the remaining part of the category 1.3.4. "Land without current use", cut for the W3.1 mapping; 2) the second procedure uses the statistical data provided by Eurostat for any census units, about vacancy and underuse; 3) finally a catalogue of brownfields or other specific studies could be available, for instance at a municipal scale (this refers to the pilot of Naples, a catalogue of brownfield that has been provided by both by Comune di Napoli and by Comune di Casoria). Either way, all the illustrated procedures are to be intended as complementary tools, to be used critically to point out this specific Wastescape category.
- W4.2: **Urban settlements suffering from fatigue**. Urban areas in socio-economic suffering that is advanced or affected by filtering phenomena. They are often accompanied by the degradation of building finishes (plasters, fixtures and windows, etc.) and when the underutilization has spread to neighbouring buildings the abandonment and depletion of public space follows. Economic changes/crisis could also cause abandonment of settlements of their portions. Sometimes, underutilization and vacancy of some parts of buildings pushes the neighbourhood to ‘filter down’, as degrading dwellings can be used by vulnerable groups: immigrants, refugees, low-income and low-educated people. The process model defined in the pilots uses two composite indicators based on statistical data provided by Eurostat on the basis of the census units. First, the indicator of urban suffering, stemming from the Prin research Postmetropolis and its web atlas of postmetropolitan territories (Atlante dei territori post-metropolitani). This is a composite indicator defined as the average of the following variables: structural dependency ratio; unemployment rate;

lower secondary education rate; overcrowding rate. Urban suffering can be: extremely high, high, medium, or low. Second, is the indicator of poor housing and is based on the data on conservation status of residential buildings. Areas with almost 80% of residential buildings in bad status of conservation present a high level of poor housing; areas with almost 60% of residential buildings in bad status present a medium level of poor housing.

- W4.3: **Informal settlements** made to cope with emergencies of urban poverty, segregation, and migratory peaks: “Roma camps," slums "for migrants, etc. These areas can be mapped thanks to data provided both by institutional actors (i.e. Municipality or Provincial/Metropolitan Authorities, as well as Prefecture), associations and citizens in the PULLs. Moreover, statistical data by Eurostat that refers to the migratory rates, can be used, even if they might not be recently updated.
- W4.4: **Urban lots in transformation / tampered** are subject to improper use (deposits, logistics, etc.) with respect to the environmental context (agricultural or natural areas) are often characterized by soil sealing, fencing, light construction, and are sometimes the subject of unauthorized abandonment or storage of waste. They could be intended as light form of unauthorized settlements that are often used as logistic platforms or open-air depots (i.e. for containers) with deep impacts on the surrounding natural/rural environment. These kinds of areas are not easily identified through the use of European databases. In fact, their extension is often smaller than what is recognized in the Urban Atlas. At the scale of the focus-area they can be indirectly recognized. For example, by assessing the degree of fragmentation of the agricultural territory on the basis of the size of the cadastral parcels rather than for the areas of greater sensitivity. It is necessary to carry out elaborations of the cartographic database provided by the regional authorities or by the municipalities (i.e. mapping fences, fences, etc.) and proceed in parallel with a work of photo-interpretation of satellite images. This category can therefore be more easily mapped to the scale of the "samples", as explained in the following paragraph "scale matters".
- W4.5: **Unauthorized buildings and settlements are** built to differ from the provisions of the planning instruments in force. Some of the buildings that make up these settlements may have been regularized as a result of "building amnesties". The process model was defined as result of the work on the Naples-pilot, since in the Amsterdam case this kind of Wastescape is not relevant. The procedure is based, also in this case, on a dual level of reading. On a general scale, looking at the focus area, the illegal settlements have been identified through a perimeter survey of all existing settlements that do not comply with the forecasts of expansion of urban plans. Therefore, on the scale of the "sample", a more detailed work has been carried out on the basis of the data provided by the municipal administrations, photo-interpretation, and the interpretations of the year of construction of each building located in unauthorized contexts (in Italy only the buildings constructed illegally until 2003 can receive the amnesty). The non-condonable buildings and the land with illegal subdivisions were

acquired by public ownership, contributing to the definition of the following W4.6 category.

- W4.6: **Confiscated assets**. In the Naples peri-urban area, many buildings and settlements are built-up without permission. That is a condition of informality common all over Southern Italy. In the case of Naples, there are several hundred thousand buildings unauthorized. In Italy, all the unauthorized buildings after 2003 are not legal: they are to be confiscated by municipalities that have the authority to decide between reusing or demolishing them. Another category of confiscated buildings and areas are those subtracted for judicial reasons: confiscated as result of bankruptcy, scams, corruption or because owners are affiliated with criminal organization (in the case of Naples confiscated from mafia organizations).

5 **'Dross' of public facilities and infrastructures (W5)**

This category includes: **dismissed or underused Infrastructures and Facilities** as well as - both active and dismissed – **boundaries of infrastructures.**

W5.1: In peri-urban areas there are **neglected - dismissed or underused - infrastructures such as roads, railways, pipelines, power lines, sewerage, etc.** In Campania, they are often places in which waste is illegally disposed. The availability of this data depends on the presence of regional or metropolitan lists or sector studies, such as traffic and mobility plans. These types of plans are generally drawn up on a communal scale, which is why this information generally seems to fit the scale of the sample.

W5.2: Also, **dismissed or underused public facilities,** like parking areas, petrol stations, service areas, plants, etc., are included. In this case, the availability of this data depends on the presence of regional or metropolitan catalogues or sector studies as well.

W5.3: Moreover, **interstitial spaces (or "buffer zones") of infrastructure networks, both active and neglected ones**, are also challenging to map (because they are often publicly owned and lack of use): road intersections and slopes, areas under viaducts, railway embankments, buffer zones of pipelines, aqueducts, power lines, and plants. This type of space can be mapped by starting from areas classified as "Road and rail network and associated land" (cat. 1.2.1) by the Urban Atlas.

Moreover, W5.3 includes some intangible Wastescapes that can be mapped and are not immediately recognized spatially: the noise, light and the odour landscapes. For instance, in the case of Amsterdam, the noise landscape is mainly the result of two activities: the airport noise and the port/industrial noise; this overlap makes the selected area within the focus area very problematic in this respect. Of course, active railways and roads also produce noise impacts. Municipal or Metropolitan Authorities generally map noise pollution. Alternatively, if this data is unavailable, a map with buffer areas proportional to the type of infrastructure or production activity can be generated. Odour pollution can be the result of agriculture and farming, as well as productive activities. People react in different ways to odours;

as a result, in addition to data, a perceptive dimension is necessary to investigate in the peri-urban living-labs about this last category. Finally, light pollution is linked to the presence of main commercial malls, productive areas, and infrastructures. Light pollution can be mapped on the basis of satellite images at night.

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6. Operational infrastructure of waste (W6)

Operational infrastructures of waste are related to the facilities dedicated to the waste storage and management. Therefore, they are quite easy to be located and mapped as dots spread in the peri-urban areas. REPAiR includes in this category the waste collection and storage points, incinerators and landfills, the site for waste dismantling, and processing, recycling depots, and any other equipment related to the waste cycle. However, only active waste infrastructure falls into this category.

Together with the roads and the infrastructures that connect these dots, operational networks emerge. Therefore, this topic, in particular can be considered the point of contact between spatial mapping and its implementation in the field of material flow analysis.

2.1.2.1 From Wastescape to Regenerative-scape

Regenerative design (Mang, 2015; Svec et al., 2011) is a process-oriented approach. Its purpose is to promote processes of resources development, with the aim of building resilient systems, integrating the needs of society in balance with natural cycles.

According to Gibbons et al. (2018), the regenerative design can both respond to and transform values and belief systems on a scale that ranges from individuals to society; such systems are the basis of human–human and human–nature relationships and are the ultimate drivers of sustainability: 1) integrating descriptive, analytical, and transformational sustainability research and practice; 2) transforming landscapes to both sustainable and thriving living systems.

While regenerative development determines the correct phenomena to give form to and build regenerative capacities in systems, providing a framework to guide actions, regenerative design applies a system of technologies and strategies rooted in an understanding of the inner workings of living systems to generate healthier life-promoting patterns in a place between social and biophysical components. Regenerative development is necessary to catalyse a systemic shift toward regenerative sustainability and includes appropriate regenerative design technologies and strategies (Mang et al., 2012, 2016; Hes and duPlessis, 2015).

REPAiR, considers not only the wastescape, but also the resource-places or "regenerative-scape": ecosystems, designed to allow the co-evolution of human and nature (Dias, 2015), which together hold wastescape and physical, social and metabolic resources useful for activating regeneration processes. So, those kinds of places define a closed spatial topology, made by territorial systems that tend to be self-sufficient in terms of the balance of resources and waste.

In general terms, the regenerative-scape reflect the processes of *regenerative medicine*, which avoid replacing what in the human body is no longer able to function, providing the necessary elements for its in vivo repair; identifying substitutes and safeguards able to stimulate the intrinsic capacities to regenerate and heal itself (Greenwood, 2006). By analogy, regenerative-scape can trigger new territorial healings: resilience protections that can stimulate change of the status quo, recognizing the "resource" character into the local contexts (Brown et al., 2018).

2.1.3 Scale matters

Deliverable D3.1 defines the methodologies for the development of spatial analysis in relation to the study and representation of flows and socio-economic conditions. Focusing on task 3.1, it also contains a list of data to be recovered, a general survey about data sources, and their availability and relevance for the pilot cases of Naples and Amsterdam.

D3.1 points out how the three fields of analysis (spatial, material flow, and socio-economics) are strongly interconnected and how the fields of each task are partially overlapping each other. For REPAiR purposes, spatial analysis takes full meaning only in relation to material flows and the socio-economic realm. The mutual dependence of spatial, temporal, physical and social dimensions has not only theoretical but also practical consequences. Particularly in relation to the Map of Wastescapes, the process model for the pilots integrates the Wastescapes categories collected in D3.1 and presented, at last, a consortium meeting with: 1) socio-economic critical issues to be analytically and spatially represented on a cartographic basis; and 2) issues related to subjective perception that are not objectively quantifiable, but are derived from the reporting of impressions collected in the PULLs, and by listening citizens and stakeholders (for example: the visual impact of a chimney or a viaduct, etc.). Both topics of knowledge have direct consequences on the question of scale, as better explained below.

In this regard, the topic of scale has to be preliminarily placed in the general framework of Geodesign, from which the process model for the pilots follows. Indeed, the issues related to the scales of representation are a relevant topic for Geodesign: the scales are chosen in relation to the relevance of the different topics investigated in order to make sure that they can be properly visualized, interpreted and understood. According to Steinitz (2012, pp. 19-20) it could be useful to work at a regional scale that could be considered an intermediate scale; this avoids the risk of the large scale having 'authoritarian' character, as well as to evading the chaotic tendency of the small local scale. To do so, within the D3.1, and starting from these considerations, it has been decided to work at the intermediate scale of the focus area for a spatial analysis of the pilot cases.

The scale of the focus-area, related to the two pilot cases of Amsterdam and Naples, includes several municipalities of the two metropolitan areas and its dimension is about a hundred of kilometres. As described in D3.1, both the focus areas present characteristics typical of the peri-urban territories of Amsterdam and Naples, and also because they offer crucial elements of reflection on the relationship between waste-management, Wastescapes and ongoing territorial transformations. This intermediate scale of representation is valuable for an overview of the challenges as well as of the proposed strategies; it is useful to technically manage the issues related to the different streams, and to evaluate the solutions at an adequate scale in relation to the entity of the problems observed. It is also significant to facilitate the interaction with the institutional actors and with the other stakeholders that have very deep knowledge and technical capacity of understanding and to manage the territory (e.g. entrepreneurs, environmental experts, etc.).

However, to promote the participation of citizens and associations it may be useful to expand the scale to local samples while performing verification-implementations of knowledge frameworks, and of specific Wastescapes within the focus areas, and to be able to manage the discussion with locals about solutions and strategies. Expanding the scale means going beyond the intermediate scale of the focus area to deepen the study in smaller 'sample' areas. Stakeholders and citizen groups have a greater possibility to influence a documentation and knowledge framework as well as to concretely affect the co-creation and co-evaluation of situated solutions and local strategies when the definition of the territory in which they are operating is clear.

This integrated approach that crosses different scales and is strongly site-specific is not just a theoretical manner to operate for a spatial analysis. On the contrary, it is a very practical way to work that puts the necessity to deepen the analysis in to effect not just at the scale of the focus area, but also on the smaller scale of the 'sample' area. This allows for better interpretation of the problems/challenges, and to envision solutions/strategies in co-creation processes (See Deliverable 5.1).

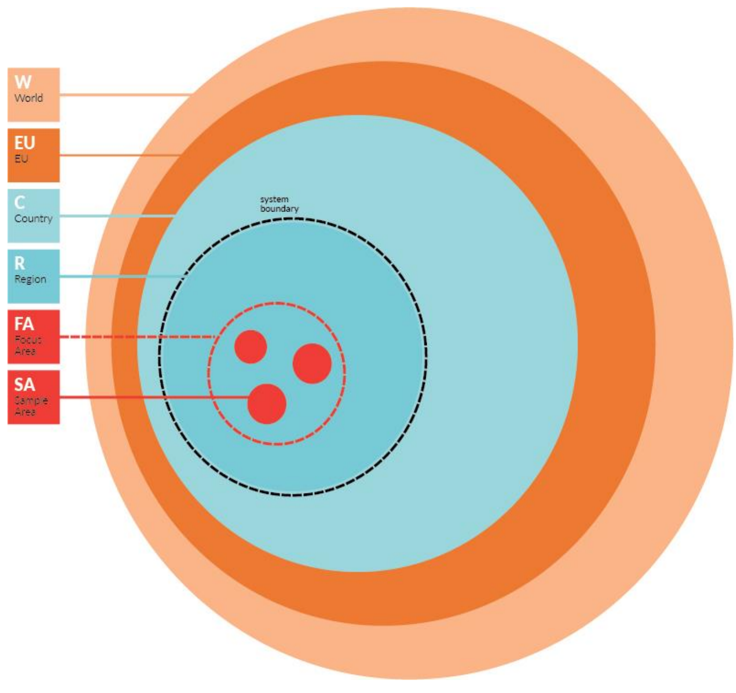

Figure 1: Scale levels within REPAiR

A brief description of the work carried out for pilots at different scales is provided below. Please refer to paragraph 2.1.3 for the detailed description of the individual knowledge layers, for data sources, and the operating methods.

Frameworks at the regional scale

The set of frameworks at the regional scale situates the pilots' metropolitan regions in larger geographical contexts and interprets them as part of large-scale territorial dynamics. These large-scale dynamics are natural and man-made structures from which the urbanisation and waste processes develop. These, however, do not provide a complete overview of whole large-scale spatial frames. However, the set aims to be a base for a general comprehension of the region as well as base for further elaboration. The maps composing the frameworks at the regional scale collect data from a variety of sources: European, National, Provincial and Municipal maps as well as written sources, as described in the reference list (see point 2.1.3 in the Deliverable). For each pilot-case, 5 maps have been created, and are printable in scale from 1:200,000 to 1:750,000 (if resized to the format ISO A4).

Delayering on the focus area

A second series of maps composes an in depth reading of the first series of maps. This reading focused on the selected focused area and is conceived as a usual "archetypal delayering observation of the territory" (see McHarg & Mumford, 1969). A sequence of maps shows different elements or families of elements that compose natural and man-made systems by defining the fundamental layers that compose the physical geography (P) (water infrastructure, soil condition, agricultural land use, natural areas.) and the human geography (H) (road infrastructure, energy infrastructure, waste facilities, pollution, spatial distribution of statistical data on social condition). Each of these maps visualise a theme, a mechanism or simply a system that has and will have a fundamental impact on current and future urbanization processes. The Data on the maps originates from different sources: National, Provincial and Municipal maps as well as written sources, as described in the reference list. For the Amsterdam pilot-case, maps have been created, and are printable in scale from 1:20,000 to 1:50.000 (if resized to the format ISO A4). For the Naples pilot-case, maps have been created and are printable in scale from 1:20,000 to 1:85,000 (if resized to the format ISO A4).

Interrelation

A third and last set of maps, applies the same scale of 1:20,000 and covers the focus area of the pilots (the same as the second series). The maps in this chapter contain material that has been selected, extracted and overlapped from the first two map series. They explore and interpret the dynamic interrelationship between different type of systems and mechanisms of urban developments through different scales. Throughout a selective interrelation based on a systemic reading (Berger, 2009) the last set of maps reviews the focus area in detail. Together the maps attempt to understand hidden territorial logics that have shaped the landscape, offering a series of thematic cuts. The representation of Wastescapes in particular, emerged from the interrelation of seven specific categories extracted from the second set of maps. These seven categories are consistent with the structure explained in the previous paragraph 2.1.1: namely, degraded land (contaminated and potential contaminated land), settlement in crisis (abandoned and underused buildings or industries), areas without a current destination, drosscape (underused areas alongside the infrastructure, operational infrastructure of waste (landfill, incinerators, bio-digesters, recycling facilities) contaminated water, safety and noise contour area for transport infrastructure.

Each cut embodies a projective dimension, questioning the ongoing process of transformations and offering alternative interpretations.

Deepening into the samples

As previously discussed, some samples have to be at the level of the focus-area, in order to cope with the specificities of the problems and sites that are the object of study within the PULLs. The sample-scale seems to allow for better interactions with citizens and local stakeholders; this interaction allows us to verify and enrich geographical data thanks to the direct knowledge of the inhabitants. Furthermore, it is fundamental for the co-development of eco-innovative solutions and for the definition of strategies as well as for their implementation. Therefore, work on the scale of the sample can be seen, in the overall REPAiR framework, as the element that potentially connects the work of WP3 and WP5, in which the model process for pilots will play a defining role in the coming months.

The selection and definition of sample areas is based on the cross reading of socio-spatial dimensions, through constant dialogue with local stakeholders within WP5, and on a multi-scale visualisation of the built environment.

For the **case of Amsterdam**, the selection and definition of sample areas is still an ongoing operation. The peri-urban region of Amsterdam is characterised by a simultaneous, as well as chaotic, presence of multiple spatial systems that overlap and sometimes conflict. Therefore, the sample areas will be selected according to the juxtaposition of specific spatial, social systems and flows. The deliberate editing of a set of single maps elucidates firstly the meaning of each system and flows and secondly, adds nuance to the uni-directional image of a territory by the arrangement of drawings in a sequence. As previously explained, the systematic mapping exercise takes the form of a triptych and features three series of drawings. The maps within the different series interact and form a multi-angled point of view through which they, 1) examine the specific urbanization phenomena, 2) identify the "sample" areas and, 3) define the enabling context on which to test eco-innovative solutions.

For the **case of Naples,** a 'sample' scale of analysis has already been tested in the last PULL workshops. The Neapolitan 'sample' extents to 3 sq. Km (300 ha) and involves part of four of the eleven municipalities in the focus area. Its perimeter is fuzzy and does not coincide with administrative limits, and can be modified according to the considerations that will emerge in the next PULLs. Its scale allows for zooming into the detail of geographies, plans and developing programs as well as to discuss eco-innovations that can be modulated in strategies extended to the broader focus area. This 'sample' area has been chosen after the first interaction in the PULL workshops on the larger scale of the focus area as it, 1) is strongly representative of the focus area's general issues such as density matters, waste-scape geography and relationships with the main city, 2) is characterised by relevant dynamics of ongoing transformations, with a considerable presence of Wastescapes, 3) it has been raised repeatedly in the discussions carried on in the first phase of the PULL workshops, 4) shows interest in the ongoing research process as the institutional actors of the municipalities involved in this perimeter (five municipalities) were all present at the first round of PULL workshops.

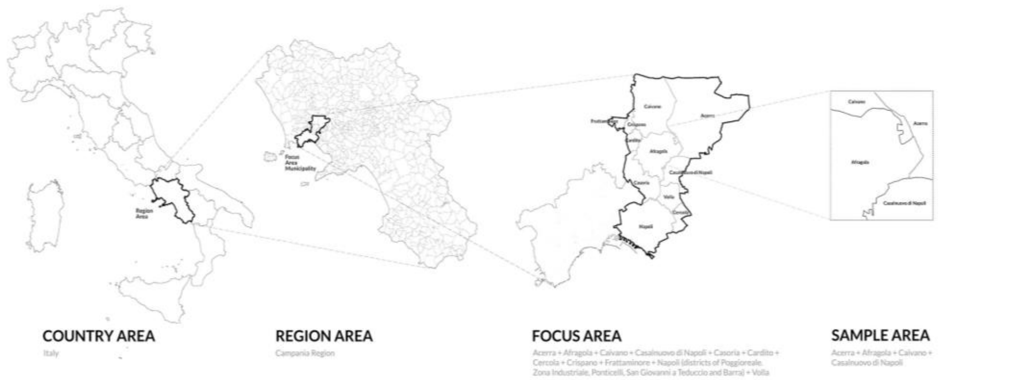

Figure 2: Country, Region, Focus area, and Sample area scale levels

2.1.4 Maps: informative layers, data sources and graphic

The work carried out within WP3 is continuously used as a basis for both WP2 and WP4 as well as interacting with the participatory PULL workshops organised within WP5. It is not just a foundation for WP5 but on the contrary, should be specified and implemented during the PULL workshops. Moreover, the WP5 workshops will also take place thanks to the interactive methods allowed by the new technologies of the Geodesign Decision Support Environment (GDSE) (WP2). In that virtual environment - consisting of a touch-enabled panel or pad - an open source web-GIS interface will be the mechanism by which the knowledge layers created in WP3 will be shown and used. The different levels of information shall be switched on or off and combined from time to time on the screen, according to the occurring need, following and helping the discussion with the stakeholders in the different PULL workshops.

The completion of Deliverable 3.3 does not only mean the definition of datasets and their systematisation with the identification of basic activities necessary for the impact assessment process and the correct running of GDSE software. It is also concerned with the production of several maps and summary posters that have a strong communicative character, and need to be used for dissemination and interaction with stakeholders as well as for educational and academic purposes.

Informative layers and posters

The general physical and human geographies are described through *informative layers*, articulated according to different scales and topics. Each informative layer is made up of cognitive elements, defined by a main source as well as by possible alternative sources that are hereby identified. The *informative layers* can be combined in *posters*, to be used for presentations and/or exhibitions during PULL workshops or during other public events. They can also be used in conjunction with the representation of the flows and/or the socio-economic issues in order to generate more complex maps and interpretative scenarios.

The following is a list of informative layers and their possible articulation in posters. It is advisable that the articulation of the information in different layers is uniform between the different case studies, using the same graphics and colours proposed for the pilots. Greater flexibility is possible with regard to the articulation of the posters, which depend more on the real presence of certain geographical features of the sites.

Posters are identified with the following code:

CSTn.Title

C = case = Naples (N), Amsterdam (A)

S = scale = Region (R), Focus-Area (F), Sample (S)

T = topic = General (G), Physical (P), Human (H) that includes Waste-specific informative elements (W)

Title = Short text

The i*nformative layers* have different sources as the scale changes, according to the demonstration table - related to the pilot of Naples – they can be accessed via the following link. Each layer is marked by lowercase letters according to an alphanumeric code similar to that of the posters. The numbering can be double-digit if it is necessary to further distinguish the nature of a particular element. For example, nrp7 refers to Naples; Regional Scale; Physical feature; layer no. 7. Pipelines and related main installations can be divided according to the data available for the single case study as: nrp7.1. aqueducts and connected plants; nrp7.2. connected pipelines and plant, etc.

See annex for a complete list of the *posters* and the related layers used for the pilot-cases.

Notes for the standardisation of graphics

The posters are composed of coloured layers corresponding to the list previously described. Moreover, other (even aggregated) informative layers related to the settlement (i.e. urban blocks) as well as infrastructural (i.e. road network) or environmental systems (i.e. rural mosaic), can be placed in greyscale in the map background. Some reference and details regarding colour are outlined after the scale articulation. Please refer to the maps of both pilots for a practical demonstration of the results.

Frameworks at the regional scale. Following Cattoor (2013), one predominant colour is chosen for each map. The representational colours seek to mimic those found in nature and simultaneously follow the corporate identity: light blue for water, brown for soil, black for infrastructure, dark red for urbanisation, grey for the model of the terrain, green for the waste facilities, etc.

A (archetypal) delayering on the focus area. The colour pattern is consistent with the colors used in the first map series, in addition to other colours used in the corporate identity, with each of the maps displaying all of the colours, as far as they are relevant.

Interrelation and sample area. The colours are, likewise, combined per map according to the spatial features that have been overlapped.

2.1.5 Enabling contexts.

Enabling contexts can be defined as specific locations within the focus area that are more suitable for developing the eco-innovative solutions and strategies. One of the results of the spatial analysis is therefore to indicate the system of areas in which the experimentations can be more easily applied and where the general process of regeneration can be tested and implemented as of prime importance.

Enabling conditions are the premise for the identification of an enabling context (Nonaka et al., 2000; Choo & Alvarenga Neto, 2010) and can be related to:

1. Social/behavioural: social relationships and interactions based on norms and values such as trust, care, empathy, attentive enquiry and tolerance;

2. Cognitive/epistemic: the need for both epistemic diversity and common knowledge or shared epistemic practices and commitments;

3. Information systems/management: the use of information systems and information management processes to support knowledge activities;

4. Strategy/structure: the need for the organisation and its management to provide direction and structure.

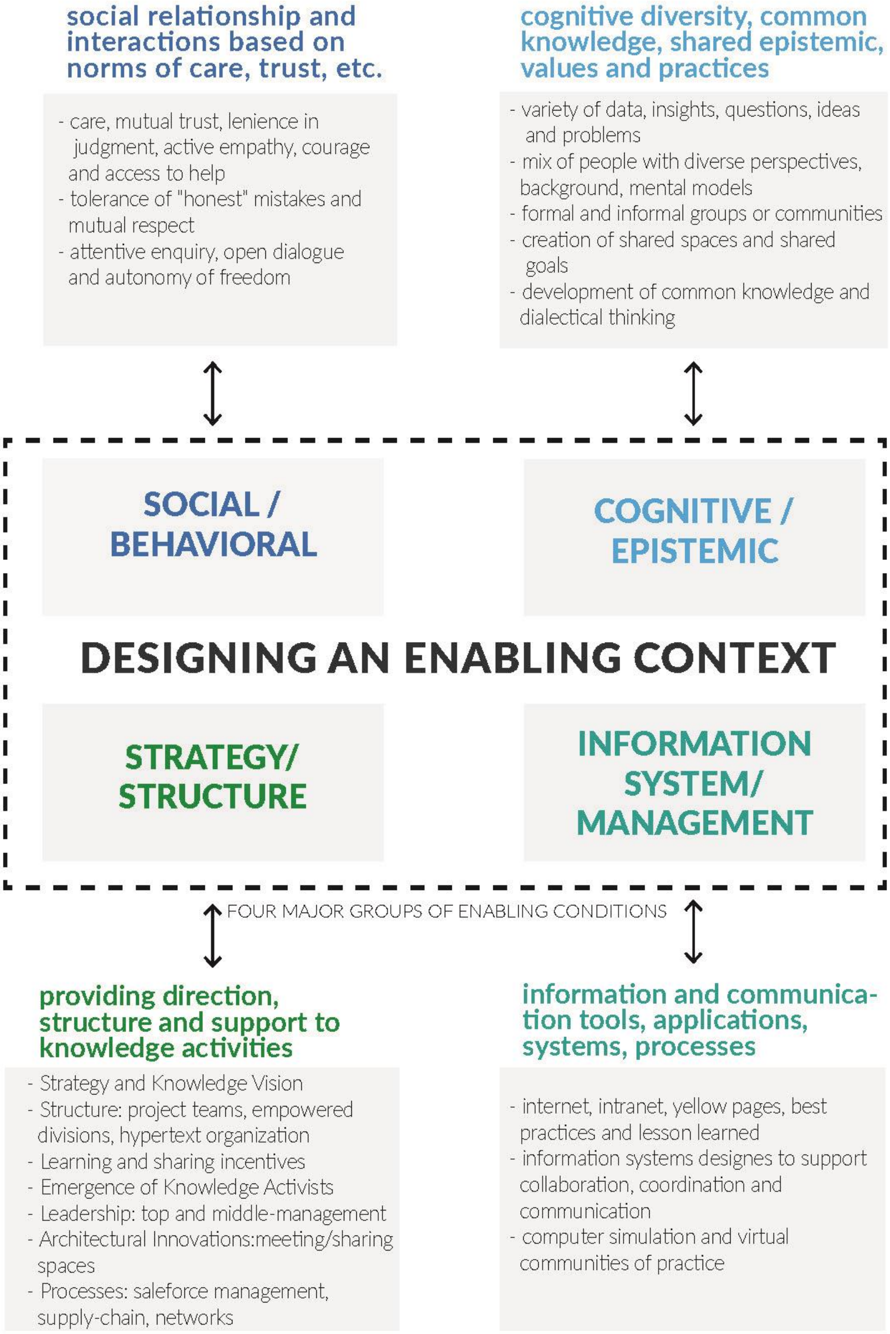

Figure 3: The four major groups of enabling conditions. Source: C. Mazzarella elaboration based on Choo & Alvarenga Neto, 2010

According to the above reflections, enabling contexts can be defined considering the following parameters:

1. They may be Wastescapes: depending on the factor of use, underused areas might more easily accommodate new eco-innovative processes;

2. They may be public or private areas. In fact, abandoned public areas could be re-used more easily as compared to similar private areas. Moreover, experiments in the public areas could be a catalyst for the private areas, where the owner could follow the example of the public initiatives.

3. They may be easily accessible. The importance of the accessibility is crucial for the implementation of the eco-innovative solutions; in fact, the possibility to access the area via public transportation, by bike or on foot can determine the choice of one solution over another as well as its success or failure.

4. Local stakeholders may or may not be interested in the transformation of the area. This is a quite clear parameter that guides the selection of a specific location for the implementation of a solution.

5. They may be crucial in relation to the waste-specific geography, as being crossed by relevant flows, sources/delivery points of the waste-flows for which the case study providing deeper knowledge.

The first three points concern issues that are strictly spatial. The 4th point is informed by the MFA analysis developed by task 3.2. The 5th point instead concerns issues more related to the governance and social composition of the actors interested in the transformation of the site. The mixed, socio-spatial character of this mapping thus allows us to integrate, at the scale of the sample, the issues of task 3.1 with those of task 3.3, in line with the structure and functioning of the PULLs on which REPAiR is based.

As for the presence of local stakeholders interested in the transformation of the area, the WP6 activities carried out so far and their current development in the PULLs, provide the testing ground for interest in the implementation of eco-innovative solutions and strategies.

The approach described so far, although still theoretical, has been applied:

1) at the scale of the focus-area in relation to the AMA case (see next Chapter 3).
2) at the scale of the sample-area in relation to the Naples case (see Chapter 4).

The maps will be further developed in the coming months, during the WP5 activities and will be tested in the next PULL workshops in Naples. Beginning with the one planned for the 23rd of April, when specific communicative maps for Wastescapes and of the public properties will be used as the basis of the co-design and local actors taking part in the interaction are directly involved in the implementation of the suggested solutions and strategies.

2.2 Task 3.2 | Material Flow Analysis

In D3.1, the foundations and the purpose of the Activity Based Spatial Material Flow Analysis (AS-MFA) have been laid out. Some of the key notions and modelling choices will be briefly repeated here for the purpose of reading convenience and integration of new insights, in particular regarding data collection and processing.

2.2.1 Brief reiteration of D3.1

A material flow analysis (MFA) is used to study the material flows and stocks of the subsystem in the six case studies: based on consumption patterns and waste production. A new method is introduced for MFA, the aforementioned Activity Based Spatial Material Flow Analysis (AS-MFA). In this method, the actors involved in the material flows and their activities and interrelations to other actors can be identified and localised.

To reiterate from D3.1, the goal of the AS-MFA for REPAiR is to:

- *Determine the qualitative and quantitative waste flow specifications in content, space and time*
- *Identify the specific activities relating material flows & stocks from waste generation in subsystems*
- *Identify the area's major physical and human geographical processes in relation to waste management*
- *Find out how and where the associated processes are interlinked*
- *Illustrate the magnitude of stocks and flows on a map (quantification)*
- *Perform a plausibility check of the available data with regard to these processes*

The modelling choices for the MFA are as follows:

Temporal scope: 1 year

Spatial scope: Case study specific administrative boundaries

Material scope: (bulk) material level; unit = metric tonnes (1000 kg) plus additional information on quality/value/state

System modelling approach: Grey box – network approach balance

Mass flow unit: tonne/year

The AS-MFA provides a systematic way of analysing material flows within regions using the three main system components:

1) Activities
2) Activity-associated materials
3) Actors involved and their interrelations

To collect and process this information that allows for EU-wide compatibility, the following EU classification databases will be used:

AS-MFA	Database
Activity	NACE Rev. 2
Location and actor for activity	Orbis

Classification of products used or consumed in activity	CPA Ver 2.1*
Classification of "waste" produced by activity	EWC-Stat 3

** D3.1 referred to the Prodcom database*

In order to execute the AS-MFA, six methodological steps that should be followed in all case studies are laid out as follows:

1. Determination of material scope
2. Defining the material supply chain
3. Selection of geographical area and spatial scales
4. Defining case specific supply chain
5. Activity-based mass flow modelling (*D3.1 describes this step as mass balancing, while this is one sub-step of the activity-based mass flow modelling)*
    - Flow data collection
    - Modelling decisions based on data availability
    - Downscaling and/or upscaling
    - Mass balancing
6. Visualising the results (in geographical context)

While steps one, two, and three are modelling choices, steps four and five require (intensive) prior data collection and processing. Step four aims to identify the local actors in the material chain within the administrative boundaries of the focus area. In step five, material flow data needs to be collected and/or generated for the data driven model. These two steps may require different approaches per case study to suit the data availability. The following paragraph will address the obstacles of data gathering and discuss methods that can be used to successfully conduct a material flow analysis.

2.2.2 Mass flow data processing

The data requirements stated in D3.1 are the following (in order of representativeness):

1. Actor specific data (i.e. primary bottom-up data)

2. Proxy data by e.g. dis-aggregating top-down or secondary data

3. Flow data generated through assumptions based on expert interviews or literature studies dealing with similar topics

Furthermore, D3.1 states that an aggregation of bottom-up data and disaggregation of top-down data will be needed to verify the two means and ensure a reliable data inventory for the AS-MFA.

The paper by Beloin-Saint Pierre et al. (2017) found that other Urban Metabolism (UM) studies on material flows use both top-down and bottom-up data aggregation levels. The level of aggregation can greatly affect the representativeness of the mass flow simulation and therefore different aggregation options should be considered and, subsequently, compared (Beloin-Saint Pierre 2017). In order for the UM model to be sufficiently insightful for environmental management of the chosen spatial scale, it is necessary to aim for the highest level of representativeness.

It is widely acknowledged that bottom-up data allows for finer analysis. Yet, finding data that is representative (enough) to model the system remains a challenge in UM studies. The only solution is to collect more representative data. However, time and resource restrictions will often not allow this. Top-down data (such as national data) is generally more reliable and usually reported by credible organisations, and is likely to be audited by external organisations, however this is less representative for the area under study. Furthermore, while a model driven by national data can be considerably reliable, it loses reliability when scaled down. This is in contrast to bottom-up data, which is more reliable on a local level but will lose representativeness and reliability when scaled up (Roy et al., 2014). This suggests that, the more spatially disaggregated the spatial scope is, the more useful it is for modelling with bottom-up data rather than downscaling top-down/national data. However, it is still uncertain at which spatial level modelling with bottom-up data becomes less/more valid than modelling with top-down data (Roy et al., 2014).

Beloin-Saint Pierre et al. (2017) state that generally the level of aggregation is not chosen by the researcher. The researcher is rather confined by the availability of data and the authors' expertise. A small number of UM studies use both top-down and bottom-up data to mitigate some of the problems with the unavailability or inaccessibility of input data. The combination of the two is identified as a great challenge, since the different sources of data have different levels of representativeness. Furthermore, top-down/macro data encompasses bottom-up/micro data and thus, double counting needs to be avoided by proper disaggregation and subdivisions. Beloin-Saint Pierre et al (2017) describes that this modelling approach should be considered in future UM studies as it has already has been explored in hybrid LCA studies. Roy et al (2014) argue that the most useful area of research for the future development of spatial allocation of material and energy flow analysis is the exploration of the opportunities for the integration of bottom-up modelling with national MFA accounts. As mentioned in D3.1, the combination of the two will probably be highly dependent on the level of aggregation of the data, however it will be interesting to extract a generally applicable process for doing so, tapping into this need identified in UM studies.

Modelling with bottom-up data

For the EU Fusions project, a method has been developed for quantifying the national food waste per year, to be used by the member states. The project refers to the upscaling methods presented by the Food Loss + Waste (FLW) Protocol (2016), identifying two methods of upscaling bottom-up data (also applicable to other material scopes);

1) Applying the average of a set of companies/households with similar characteristics to the entire group of companies/households that are similar to this set.

2) Scaling up bottom-up data by using normalised quantified waste flows, which delivers a more accurate result than the previous method. In

order to scale up bottom-up (sampled) data with normalised data, a normalising factor is needed. This factor can be produced by dividing the quantified waste by a reasonable metric (available for most/all actors) and, when multiple samples are available, taking the average of those normalised factors. This can result in normalising factors with units such as kg waste produced per capita, kg waste produced per product, etc. The normalisation factor is then multiplied by the total number of units or objects that applies accordingly. To identify an appropriate normalisation factor, it is necessary to explore whether there is a strong relationship with the quantity of the waste generated and the metric employed.

No single normalisation factor is perfect and the one working for one case study might not work for another. Therefore, the scaled-up bottom-up data should be compared to top-down data (if available) to examine whether (at least) this results in the same order of magnitude and seems consistent.

Dealing with missing bottom-up data

The CBS (Central Bureau of Statistics Netherlands) deals with missing data in the bottom-up data inventory on company waste by following the next steps (Van der Stegen et al., 2011);

1) Gathering information through alternative sources, such as annual reports or other types of publications

2) If there is no information to be found in alternative sources, estimations can be made the following three ways

   a) Using a normalisation factor (referred to as ratio-based normalisation) on the basis of the number of employees, with the assumption that the amount of waste produced per employee remains the same regardless of the overall employee size of the company.

   b) When entries are missing for company's year-based, time-series data, a regression model can be used to infer an estimation. This can be done by creating a regression model that fits the existing reported waste data, or to fit the waste data with a regression model based on the product rather than the waste (if there is a strong correlation found in historical data).

   c) Estimate the waste growth or decrease on the basis of national economic data for the relevant production process (ratio-based normalisation on economic data, accounting for deflation or inflation)

3) If it is not possible to make a representative estimation, leave the entry for the company empty.

Weighting when using sampled bottom-up data

To avoid a false representation of the system by scaling up bottom-up data that is disproportionately representative, it is necessary to apply weighting factors to the bottom-up samples to achieve a more balanced result (FLW Protocol, 2016).

Outliers sampled bottom-up data

When modelling with bottom-up data, one must be cautious about applying outliers. These should be taken out of the data used for scaling, as they are not representative enough for the system as a whole. They should still be included in the summation of the entire system (FLW Protocol, 2016).

Downscaling top-down data

The paper by Horta and Keirstead (2017) explores statistical downscaling methods for estimating local or regional resource consumption using socio-economic or other data sources. In their paper, it is acknowledged that metabolic data is often based on a larger geographical (and temporal) scale than is required for most UM case studies. This paper focuses solely on disaggregating the data on a spatial scale, but we argue that the theories can also be applied to the REPAiR downscaling of national data to a finer spatial scale and aggregated (activity group) data to specific actors. A brief description of the six downscaling methods presented by Horta and Keirstead (2017) are;

Ratio-based normalisation - In this downscaling method, the resource consumption is expected to be at a constant ratio by a normalisation factor based on relevant data available for both the upper and lower level. This method is also used to deal with missing data by the CBS.

Linear regression with external calibration - With this method, a linear regression is made based on data points for a higher spatial scale. In order to have more data points on a higher level, it is necessary to use proxy data for similar cities. Assumptions are made that the resource consumption patterns in the proxy areas are similar or follow the same pattern as that of the focus area.

Linear regression with internal calibration - If data points are not available for similar cities, and therefore cannot be externally calibrated on a higher spatial level, it is an option to sample on a lower level and calibrate the regression model based on these data points. Some of the sampled data can be used for training data and the rest can be used for validation.

Spatial regression - It is also possible to downscale data based on a spatial model, making a regression analysis of adjacent geographical areas based on the assumption that consumption patterns are similar.

Multilevel regression model - In the previously described regression model, it is expected that (some) data is available for both the higher spatial level and lower spatial level. When some of this data is only available on the higher spatial level, a multilevel regression model can be applied where a larger set of regression variables are used to shape the regression model for the lower level.

Bayesian Analysis - The last approach uses Bayesian statistics to incorporate uncertain data into an estimated quantity. This is done through fitting the data into a probability distribution function with an unknown mu and sigma to determine the shape parameter.

The study by Horta and Keirstead (2017) suggests that in most cases it is preferable to opt for simpler methods, such as a linear regression of ratio-based scaling rather than the more difficult estimation methods like spatial regression and Bayesian analysis, since the error range for both simple and complex ones have a similar prediction error range (roughly 20%). The choice for a downscaling method is also mostly dependent on data availability and with regard this data, one method will be more attractive than the other or will just leave the researchers with a single option.

Combining top-down and bottom-up data

As discussed earlier in section 2.2.2, it is desirable to collect both top-down and bottom-up data to judge the reliability of the quantified mass flows; the upscaling of bottom-up data or disaggregating the top-down data is always useful as a reliability check to potentially indicate the shortcomings of one versus the other. In MFA studies, a combination of the top-down and bottom-up approach is often used to complement each other by filling data gaps and exposing uncertainties. Furthermore, to reiterate an earlier statement in the paper by Roy et al. (2014), it is still unclear at what spatial scale modelling with bottom-up data becomes less representative than top-down data, so this implies both modelling approaches are necessary when this shift is unclear. Lastly, exploring the combination of both top-down and bottom-up data could be beneficial for tapping into this earlier stated need in UM modelling.

2.3 Task 3.3 | Social Analysis

Task 3.3 of the REPAiR project deals with the linkages between socio-cultural/socio-moral features and social awareness of environmental issues. The basic assumption is that the different agents' understandings and behaviours as related to ecological sustainability in general, and waste and resource management in particular, are embedded into certain, collectively accepted, respected and followed social values, norms, rules, conventions, customs and attitudes. Accordingly, these social patterns influence the agents' way of thinking (perceptions and interpretations, i.e. concepts) and way of doing things (i.e. praxes) about environmental challenges. It is important to note that 'agent' in this research refers to both involved stakeholders (decision-makers, experts, experience-holders, managers, beneficiaries etc.) and any member of the general population therefore, the aforementioned hypothesis is assumed to be true with regard to expert and lay knowledge-holders as well.

To analyse this fundamental question and presumption, the research is focusing on four different tasks within this work package. Firstly, there is a theoretical task that, based on certain value-concepts, aims to provide an explanatory framework for the general assumptions. Secondly, Task 3.3 deals with a multi-phased, comprehensive secondary socio-cultural analysis (SSCA) to empirically investigate the proposed theoretical linkages. Thirdly, the research provides a primer empirical analysis (PSCA) regarding different stakeholder perceptions of the relevance of various factors as well as social, cultural and moral features of waste and resource management. Finally, a socio-economic analysis (SEA) aims to map out crucial aspects of each case study areas. Task 3.3 has a multi-level scope: the secondary socio-cultural inquiries are focusing on national and regional level specificities while the primer socio-cultural stage of the research and the socio-economic investigation is done on the focus area level.

2.3.1 current phase of the social analysis

In deliverable 3.1, the general framework of the research task was introduced with particular focus on the applied value-theories. A brief review of the would-be investigated secondary data sources was also included along with a short summary of the primer empirical inquiry (goals, design, surveying-methods) and some information on the planned socio-economic analysis.

Social analysis is based on two pillars. It comprises on the one hand, the first phase of the secondary socio-cultural analysis (SSCA-1) which proposed the Theory of Planned Behavior (TPB) as a background concept and used Flash Eurobarometer 388 (Attitudes of Europeans towards Waste Management and Resource Efficiency – 2014) as a data source for statistical investigation. On the other hand, though, it also embraces comprehensive socio-economic and socio-demographic profile-inquiries on the two pilot areas – the Dutch and the Italian cases.

As was mentioned above, the indicators came from the Flash Eurobarometer 388 (*Attitudes of Europeans towards Waste Management and Resource Efficiency*) published in 2014. Almost 26,600 respondents from different social and demographic groups were interviewed in the survey on behalf of the European Commission, DG Environment via telephone (landline and mobile phone) and in their first language. The inquiry aimed "to understand citizens' perceptions, attitudes and practices related to efficient use of resources, generation and management of waste, as well as elements of the so-called 'circular economy' (including second-hand products and alternatives to buying new products)" (Report of Flash Eurobarometer 388, 2014:5).

In SSCA-1 we elaborated the 11-item-based composite index of 'Waste-conscious Behavior' (WCB). It had a maximum value of eleven (11) and a minimum of zero (0) as every 'yes' answer to a given item received a value of one (1), while every 'no' received a zero (0). Accordingly, the WCB index used individual responses which were later aggregated on a national level. The applied 11 items were as follows:

Q5a Which of the following actions are you undertaking to reduce the amount of household waste that you generate?

(1) Q5a_2 You avoid buying 'over packaged' goods
(2) Q5a_4 You undertake home composting

Q6 Do you sort the following types of waste, at least occasionally?

(3) Q6_1 Paper / Cardboard / Beverage cartons
(4) Q6_2 Plastic bottles or other plastic materials
(5) Q6_3 Metal cans
(6) Q6_4 Glass
(7) Q6_5 Kitchen waste
(8) Q6_7 Household hazardous waste (paint, chemicals, batteries, etc.)

Q11 Which of the following aspects do you consider most important when buying a durable product, like a washing machine or a fridge?

(9) Q11_3 The product is made from recycled materials
(10) Q11_4 The product can be recycled after you use it

Q11_5 The product is environmentally-friendly

WCB index was the explanatory variable in inquiry of SSCA-1 and social milieu was the independent one. The latter was defined in a pretty straightforward way as the respondents' regional neighbourhood (i.e. the region they live) was used as an indicator for this variable. SSCA-1 presented a regional level investigation of all six REPAiR case study areas. The current deliverable highlights the results of Dutch and the Italian pilot cases below.

The second pillar, the socio-economic analysis, is based on a data template - elaborated for REPAiR - that helps to gather information on the case study areas from country towards focus area level. These data (Table 1) serve as a basis for in-depth analysis that takes into consideration the socio-cultural and socio-economic background and conditions for a successful movement towards the circular economy.

Table 1. Main socio-economic basic indicators for the analysis

Year preferably = 2015					
Data level	Country	Region/County	Focus_Area1	Focus_Area2	Lower, census unit (usually available in statistical offices)
Population size, in millions					
Number of live births					
Number of death					
Inbound migration					
Outbound migration					
Population ages 0-14, percent of total					
Population ages 15-64, percent of total					
Population ages 65 and above, percent of total					
Female population, percent of total					
Urbanisation level (%)					
Land area in sq. km					
Life expectancy, in years					
Fertility rate, births per woman					
Residents with elementary school					
Residents with high school/secondary education					
Residents with university/tertiary education					
Average net salary (per capita)					
Number of income tax payers					
Unemployment rate					
Labour force, million people					

Unemployment rate for females					
Unemployment rate for males					
Long term unemployment (more than 180 days unemployed)					
Employment rate					
Employment rate for females					
Total employment number in different sectors					
Employment number (or rate) in agriculture (of total employment)					
Employment number (or rate) in Industry (of total employment)					
Employment number (or rate) in Service sector (of total employment)					
Total number of businesses					
Number of businesses in industry					
Number of businesses in agriculture					
Number of businesses in service sector					
Value added in the agricultural sector as percent of GDP					
Agricultural land in use by all agricultural farms (ha)					
Forest area, sq. km					
Number of organic farmers					
The share of organic area in relation to the total utilised agricultural land (%)					
Area under organic farming (ha)					

GDP per capita (at purchasing power parity)			Not available	not available	not available
GNI (gross national income)					
Consumer Price Index (CPI)					
HDI (Human Development Index)					
Railway density (km/100 km2)					
number of cars per 1000 inhabitants					
Number of registered crimes					
Early school leaving					
overcrowding rate					

A third analysis elaborated on the waste-awareness of business actors (companies). It is interesting to compare this data to the relevant socio-economic situation. To achieve this goal, we attempted to find indicators of waste or environmental sensitivity. In the EU, there are two possible tools to accomplish this. We investigated the number and rates of the dispersion of ISO14001 (which is a standard providing practical tools for companies and organizations of all kinds looking to manage their environmental responsibilities) and the EU's Eco-Management and Audit Scheme (EMAS) certificates that are a hallmark of the companies' environmental consciousness as they demonstrate a positive relationship between environmental management practices in a firm (for the theoretical approach and for more background and detail, please see REPAiR deliverable 3.2). Unfortunately, due to a lack of data availability, we could only prepare analyses for country and regional levels.

3. Results of the two pilot cases

In this chapter, the results of both pilot cases are presented, starting with a spatial and socio-economic analysis, followed by a material flow analysis. For both cases, a rudimentary spatial and socio-economic analysis on a national level precedes a detailed regional analysis: for the Netherlands, this concerns the Amsterdam Metropolitan Area, and for Italy the Campania Region and the Metropolitan region of Naples.

3.1 Spatial and socio-economic analysis – The Netherlands

3.1.1. Geographical situation and the natural environment

Located in north-western Europe, the country is low-lying and remarkably flat, with large expanses of lakes, rivers, and canals. Land was reclaimed from the sea along the coast while lakes and marshes were drained, especially adjacent to the many rivers (Encyclopaedia Britannica). Due to its favourable position, next to the North Sea and encompassing the estuaries of the Rhine, Meuse and Scheldt rivers, the Netherlands has played an important role in international transport for centuries. The Dutch landscape is strongly influenced by humans and there is almost no natural habitat remaining. This geographical situation and the reaction to it in the form of 1958s Delta-plan, has had a significant impact on historical and contemporary regional development conditions (Encyclopaedia Britannica).

Over half of the country would be vulnerable to sea or river flooding without the dikes and most higher-level sand soils have been converted into farmland through enormous and sustained effort. The Randstad and its "Greene Heart" has indeed become a daily urban system, where a third of the country's 17 million people live in a fifth of its area. The major centres have densities higher than 2,500 persons per square kilometre. Their need for individual dwellings places demand on limited space. In conjunction with the land required for agriculture and expanding industry, recreation and transport, this places pressure on the available land and poses complex planning problems for the future (Khan, van der plas 1999, pp. 371).

3.1.2 Demography

The total population of the Netherlands is around 17 million. Even though the population is growing steadily, this growth cannot be attributed to the number of births but rather, to the increasing number of immigrants accepted every year.

170,510 babies were born in 2015 which is a decrease not only when compared to the previous year, but is equal to the rate in the early 1980s. This may be caused by the fact that the average woman bears 1.7 children (data from 2015) which is not exceptional in developed countries, but it will have several effects on the structure of society in the coming years.

Life expectancy at birth in 2014 was 79.9 years for men and 83.3 for women. While the men's rate is higher than the EU average (78.1), the women's rate is under the EU average (83.6 years). Even though there is a considerable gap between men and women's life expectancy, this gap closes if you look at healthy life expectancy (research from the early 2000s has shown that the difference for healthy life expectancy between men and women is very little (Groenewegen P. et al. 2003)). This indicator also displays a regional pattern for healthy life expectancy (later referred to as HLE). For men aged 65 years, the highest rates are in the northern part of the country. The rate of men's HLE at birth shows roughly the same pattern, but women's have a much more scattered arrangement.

Annual mortality is expected to rise by an average of 1.5 thousand, mostly because of the ageing population. The men/women ratio is close to equal, a small surplus can be observed on the women's side, as 50.45% of the Dutch population is female.

In January 2016, there were about 5 million people under the age of 25; they make up approximately 29% of the population which was just above 17 million according to the Statistics Netherlands. Even though the number of young people has showed a slight increase, their share of the whole declined due to longer life expectancy and immigration (Annual Report 2016 Youth Monitor). One-quarter of the population under 25 can be connected to immigration; the main issuing countries vary, from Poland to Belgium and even North African countries such as Morocco.

The youth have an excellent perspective according to the Annual Report Youth Summary 2016 which shows that 90% of people from 15 to 21 are satisfied with their living conditions and education and that they have a strong relationship with their parents. 64% of the people between 15 to 26 years were in permanent employment during the time of the research. This is more common among people who have already left the public funded education system. The main jobs taken by the group mentioned are part of the retail market, such as shop assistant, shelf stacker, unloader, etc. Besides the youth, the middle aged and ageing population should not be forgotten either considering that they will be a highlighted part of the Dutch population in the coming years.

Younger, more highly educated people tend to move from rural areas to urban areas. The average Dutch person travels a minimum of one hour a day or about 30 km. This occurs mainly because of the better working conditions and salaries in more remote areas but it cannot be traced back to a single cause. The mobility is facilitated by a good quality railway and road network however, on the other hand, it causes high traffic situations and pollution as well.

One of the main reasons behind the well above average living conditions in the Netherlands is probably their outstanding education system. According to the 2015 PISA test, Dutch pupils perform above the OECD average in science, mathematics, and reading (although the first two have been decreasing since 2006). The most important of all is probably tertiary and higher education. The Netherlands is in a solid position in the top 10 of the 28 European countries, with an increase of 0.91% since 2014. Even though the country is well developed, the amount of people having below upper secondary education is fairly high, but it is constantly decreasing.

3.1.3. Labour force

The labour force indicators for the Netherlands show the typical characteristics of a developed country. The GDP per capita is one of the highest among European countries (it was 39,300 EUR per capita in 2014 according to Eurostat and the provisional data for 2016 is 41,300 EUR per capita) and the gross labour force participation is 70,1% (Statistics Netherlands 2017). According to Statistics Netherlands, 9,010,000 people were involved in the labour force in May 2017. As the population is constantly ageing, this number will slowly decrease and therefore, more product per person will be needed to maintain the same rates and to support the silver hair generation.

The total unemployment rate was 5,1 % in May 2017, for men it was slightly lower at 4,7 %, while for women it was 5,5 %. This represents a decrease of 1,1% as compared to the previous year. As is also the case for most of the world, the Netherlands felt the effects of the economic crisis which caused an increase in long term unemployment that especially affected older groups in the labour force. In the Netherlands, the long-term unemployment (people are unemployed more than 180 days) rate was 7% in 2015. 40% of the long-term unemployment people were over the age of 50 (Graaf-Zijl M. et al. 2015), while in the EU, or in the US, this percentage is 20% and 25%. This may affect their chances of getting a job again as they are on the margins of the labour market. The average annual wage in 2016 was approximately 46 300 EUR (3,858 EUR in monthly breakdown) according the OECD.

3.1.4. Economy

After two years of stagnation, the Human Development Index (HDI) of the Netherlands finally began to slowly grow and in 2015 reached a rate of 0,924. This indicates the development of the country from a different perspective, it includes both the Gross National Income (GNI) as a general economic indicator but also takes into consideration the progression of the population. It summarises many population aspects such as life expectancy at birth and the education level (expected years of schooling). This rate provides evidence of the development of the Netherlands, compared to the other pilot country (Italy) which reached the score of 0.887 in 2015. The Netherlands possesses one of the lowest rate of the GINI coefficient in the world. According to the United Nations Human Development Reports, the country is fourth on the world chart with a rate of 0.303 (2015). This indicator shows how equally the incomes are distributed. Zero means total equality 1.0 would indicate that everything is concentrated in one person's hand. As has already been mentioned, the GDP per capita was 39,300 EUR in 2014.

Gross domestic spending on R&D was 2.015% in 2015. This is only a slight increase of 0.015 in regard to the previous year but is still above the EU average of 1.950%. GDP is a bit crude on its own but GDP per capita at purchasing power parity takes into account the costs of living and inflation rates so it gives a better perspective about a country's standard of living. This rate was 46,353 USD in 2015 and has been constantly increasing since 2013. The Gross National Income differs somewhat in 2013 when it was 49 360 USD whereas the provisional number for 2015 is 49,390 USD. This rate includes the income of those who work abroad but spend their income inside the country which is most common amongst those who live close to the borders. The economic advancement of a country can also be examined by observing the share of its main sectors. In the 1800s, industrial activity was the main indicator of development whereas today it is the service sector.

Especially in the case of the Dutch service sector, this includes transportation is an essential part of the country since its foundation. In 2015, the annual quantity of transportation via road freight was 641,538 thousand tonnes, which is a slight increase as compared to 2014 but it is still below the highest rate in the last ten years (658,030 thousand tonnes in 2011). Even though the data is almost eight years old now, the average road density of the Netherlands is one of the highest in the world. It was 5000 km/km^2 in 2010 while the length of the state, provincial and communal roads were 129,436 km in 2014. Although not related directly to the economic indicators, it should be mentioned that there were 471 cars per 1000 inhabitants in 2013. This is a relatively low number and the Netherlands is somewhere in the middle among European Union countries, while Italy had the 4th highest rate with 608 cars per 1000 inhabitants. The maritime transportation industry moves the highest gross weight of goods amongst the European Union's countries. This amount is constantly growing and in 2015, the gross weight of goods handled in all ports was 594,272 thousand tonnes as reported by Eurostat. Transportation via train is far less than those previously mentioned and in 2015 was 41,721 thousand tonnes. Besides the high numbers, due to the economic restructuring and the change and modernisation of the transport infrastructure, several ports and warehouse had not been used anymore. This meant there was a need for finding new functions and redevelopment of these areas.

3.1.5. Waste sensitivity

Recently, there is a high demand on environmental certification where companies can prove their awareness for corporate environmental responsibility.

Based on the ISO 2016 survey, taking into account ISO 14001, we can see a significant increase of certification in The Netherlands. In 2016, the absolute number certification was 2667 in The Netherlands that means 915 companies out of one million have ISO 14001 certificate.

As in the outline of social analysis was described above, SSCA-1, on the one hand, aims to map out individuals' waste-conscious behaviour (WCB), while on the other, it inquires if there are differences respective to these waste-related perceptions and attitudes in various social milieus understood as regional neighbourhoods in the research task.

On national level the composite index of WCB in the case of The Netherlands shows a 6.32 mean value (note: the possible value could be between 0–11). This refers in European comparison to an average value. Our analysis found that Romania has the lowest value of 3.76, while the highest with 7.81 belongs to Austria.

Having regarded everyday people's environmental consciousness, the Eastern region of The Netherlands has the less WCB score. The analysis revealed that the differences between the Dutch regions is significant (Figure 4). It means that regarding to the questions of reducing the amount of household waste and selective waste collection everyday people's waste sensitivity is quite low in the analysed part of the country.

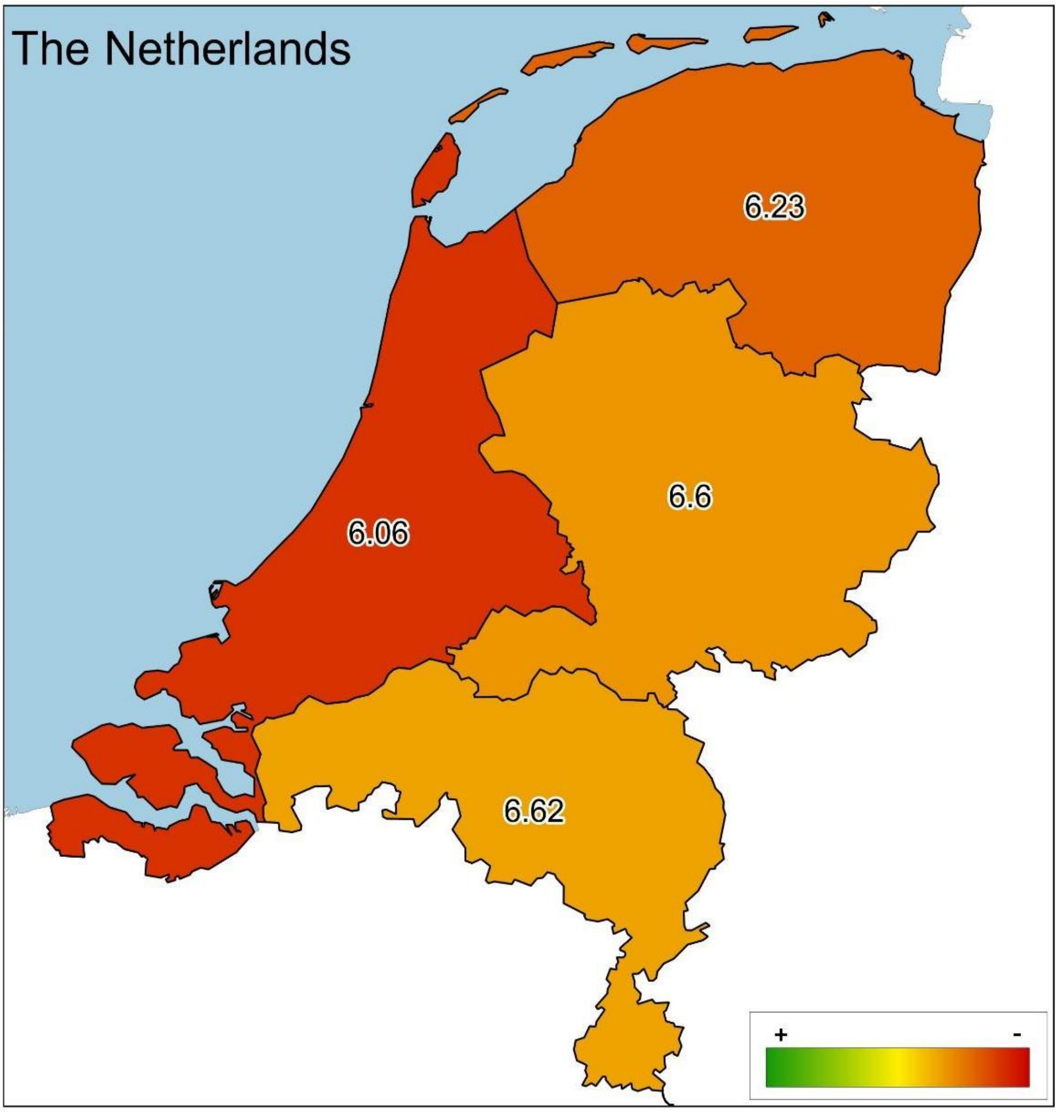

Figure 4: WCB index, mean values by regions in The Netherlands
Source: Authors' elaboration based on data from Flash Eurobarometer 388

3.2 Spatial and socio-economic analysis – Amsterdam Metropolitan Area

Having regarded the statistical units towards a socio-economic analysis of the region and the focus areas, we must draw the readers' attention here to the fact that for the socio-economic analysis COROP (***Co****ördinatiecommissie* ***R****egionaal* ***O****nderzoeks****p****rogramma*- Coordination Commission Regional Research Programme), units are available that include the focus areas although it does not overlap entirely with the area of AMA. Following the description of COROP the AMA touched two provinces in the COROP statistical classification: Flevoland and Noord-Holland. The province of Noord-Holland includes the Groot-Amsterdam region – among other regions. The Amsterdam Metropolitan Area and the Groot-Amsterdam region are covering the focus areas we are analysing in the REPAiR project, however, the two 'layer', AMA and Groot-Amsterdam are not precisely overlapping. Therefore, statistics in this deliverable refers to Groot-Amsterdam, while mapping and other analysis are made for AMA. This slight discrepancy does not affect the results of our analysis.

The bordering issue will raise questions again in the Material Flow Analysis therefore, there is a need to rethink borders.

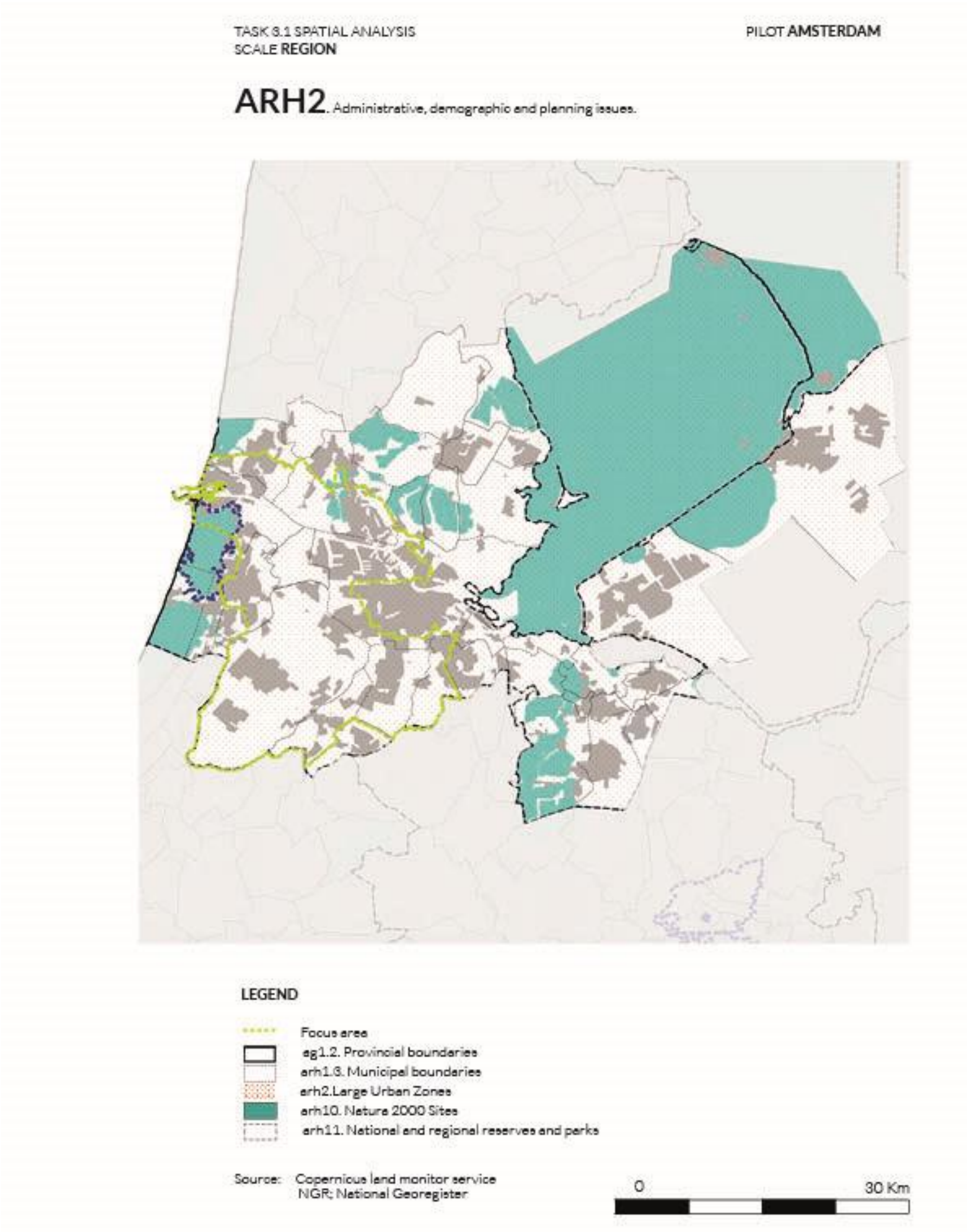

Figure 5: Boundaries of the pilot area. Source: UTJ_MapLab

3.2.1. Geographical situation and the natural environment

The Amsterdam Metropolitan Area (Metropoolregio Amsterdam) is located in the north wing of the larger polycentric Randstad region, spans the boundaries of two provinces (North-Holland and Flevoland) and encompasses the city of Amsterdam as well as 32 municipalities (Metropoolregio Amsterdam, 2017). Amsterdam is the leading economic centre of the country whose golden period was the 16-17th centuries as the most frequented financial and trade centre of Europe. After 1600, Amsterdam grew to become the trading centre of Europe and during the first half of the seventeenth century, the city's population rose from 50,000 to 200,000

inhabitants. The urban economy declined between 1700–1850 but despite the downturn, centralised administration made the construction of a supra-regional infrastructure, which included the building of the North Holland Canal, possible. This was followed by the Amsterdam to Haarlem railway line (1839) and the rail links to Cologne and Rotterdam. Around 1850, all areas of the country were also linked by good quality, hard-surface roads (Khan, Van der Plas 1999, pp. 372).
Amsterdam's importance decreased in parallel with an increase in the size of ships (although its central financial and trading position remained). The region is responsible for a range of policies including economic development, transport, and aspects of spatial planning related to urbanisation, landscape management, and sustainability (Metropoolregio Amsterdam, 2017).

Besides the former port areas, its airport is a crucial part of the AMA. Amsterdam Airport Schiphol is located 9 kilometres southwest of Amsterdam in the municipality of Haarlemmermeer and is the third busiest airport in Europe by passenger numbers (www.aci.aero).

In an earlier city profile, Kahn and Van der Plas (1999) depicted Amsterdam as a patchwork of large-scale development projects and infrastructural improvements, a breeding ground of housing renewal interventions and a growing regional economy. At that time, the city's main policy concerns were centred around the strengthening of regional cooperation, dealing with land development during demographic growth, the renewal of the inner city and post-World War II neighbourhoods, and positioning Amsterdam in the international marketplace (see also Savitch, Kantor, & Vicari, 2002). Fifteen years later, Amsterdam's city development model shows continuity with its mid-90s policies as well as certain peculiar and unexpected discontinuities as a result of experimental approaches to urban development, housing and regional politics (Savini et al. 2016, pp. 103). These processes resulted into a very densely populated area characterised by a unique dispersed urbanisation of town clusters and open spaces (Koomen el al. 2008, pp 363).
Today the economic growth of this region has led to an ever-increasing spatial demand for residential, business, recreation and infrastructural uses, with a consequent shrinkage of open spaces, both natural and rural (Koomen et al 2004) .

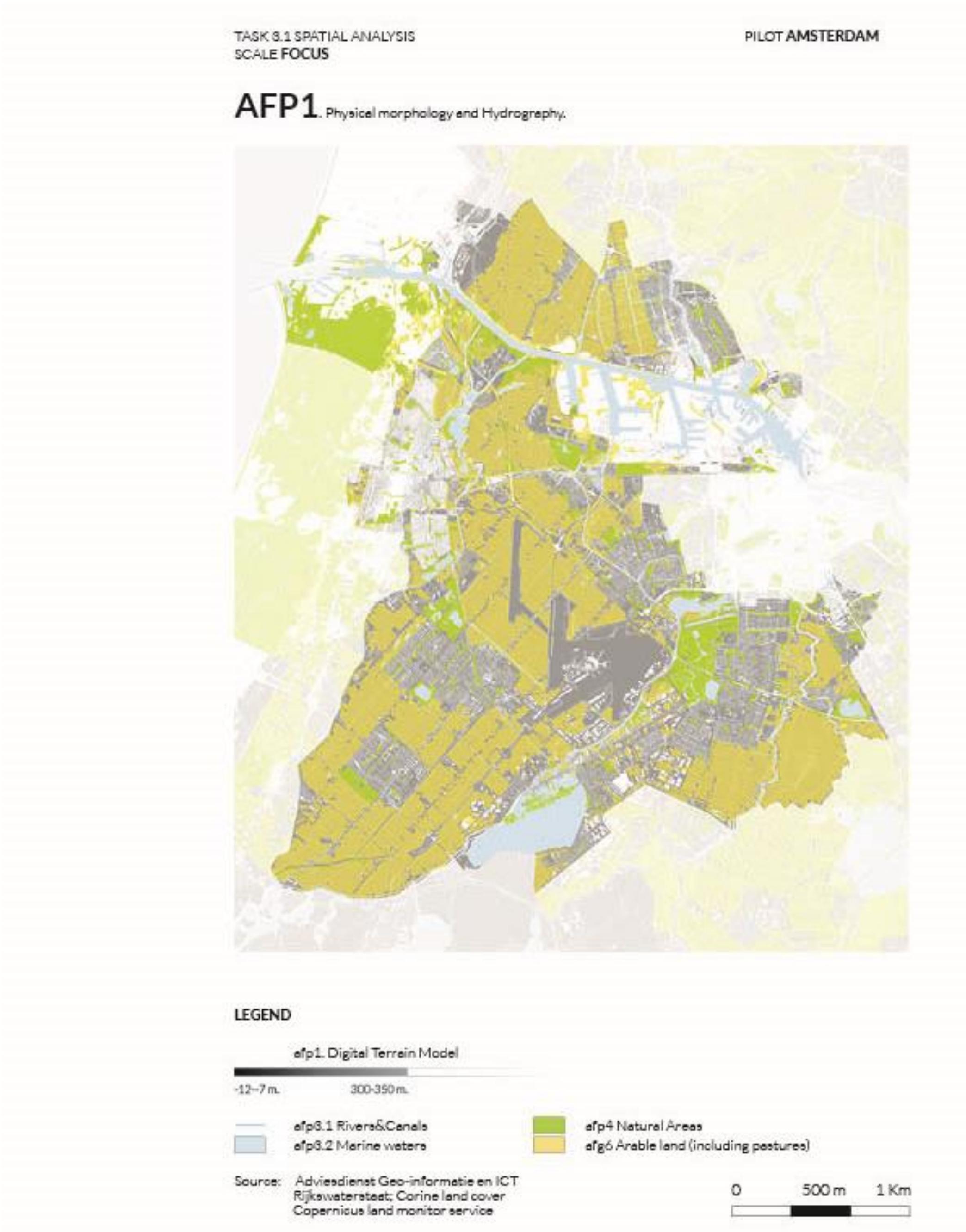

Figure 6: Main land covers in AMA. Source: UTJ_MapLab

Nature protection in AMA

In a context in which the urbanisation pressure is very high, rural and natural areas are at risk of gradual shrinkage and a series of measures were undertaken by the Dutch government in order to preserve the quality and quantity of open spaces.

In particular, natural areas are generally protected by national regulations that stress the value of the present species and habitat qualities: such as the EU Bird and Habitat Directives and specific regulations applying to woodlands, natural areas or National Parks (Koomen et al. 2008, 365). These laws significantly slow down the conversion of natural areas into urban land and in addition to protecting existing natural habitats, the Dutch Government (LNV, 1990) initiated strategies to create new natural areas. According to this strategy some agricultural areas can be converted into natural habitats by changing the land management as well as other conditions, for instance raising groundwater tables and allowing regular flooding. The target – although the details has been changing through time – is to establish a coherent ecological network across the country and its boundaries by 2018-2020 (Koomen et al. 2008, 365).

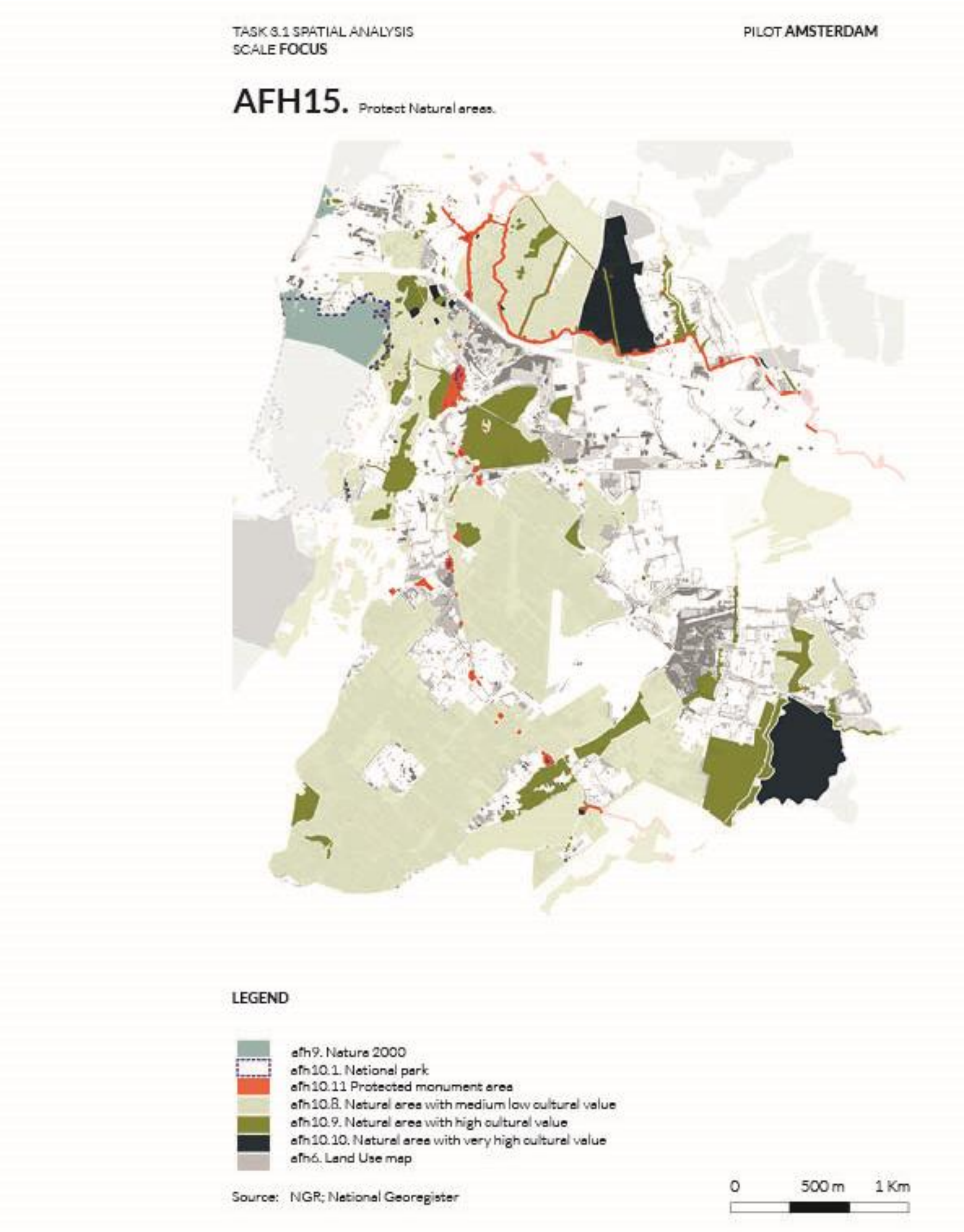

Figure 7: Nature protection in AMA. Source: UTJ_MapLab

3.2.2. Demography

Flevoland and Noord-Holland provinces are home to 3.8 million people, a little less than 20 percent of the country's population. Given the fact that so-called Groot-Amsterdam (1,335,980 people) lies in the province of Noord-Holland (more than three times larger than the whole province of Flevoland), the population is concentrated here. The population development shows little difference as the provincial population of Noord-Holland increased by 1.0083% from 2015 to 2016 while Flevoland's increased by 1.0056%. A slightly greater difference can be seen in the number of live births which is a result of the higher level of urbanisation in Noord-Holland and the more rural character of Flevoland. The number of births in Noord-Holland decreased by 0.015% in 2015 while in Flevoland it dropped by 0.037%. In the smaller Groot Amsterdam region this rate dropped 0.007%, which is a moderate setback compared to Flevoland. The reason for this might be connected to the progression of net migration. While the more urban province has a decent amount of growth (16,392 people), Flevoland had a loss of 210 people in migration in 2015. The Groot-Amsterdam area contributed substantially to the growth of Noord-Holland province with an increase of 9,435 in 2015.

Today, Amsterdam is characterized by a few important and highly distinctive trends. The city is more diverse than ever, both ethnically and socially. Moreover, the social geography of Amsterdam shows a growing core–periphery divide, which underlines important economic and cultural asymmetries. The central quarters of Amsterdam are a growing pole within the city, and within the country, selectively attracting affluent middle classes connected to its cognitive-cultural economy. The housing market appears to follow these trends' (Savini et al. 2016, pp.112) The distribution of immigrants has a spatial pattern (Figure 8) that influences the land use as well as urban development challenges and strategies.

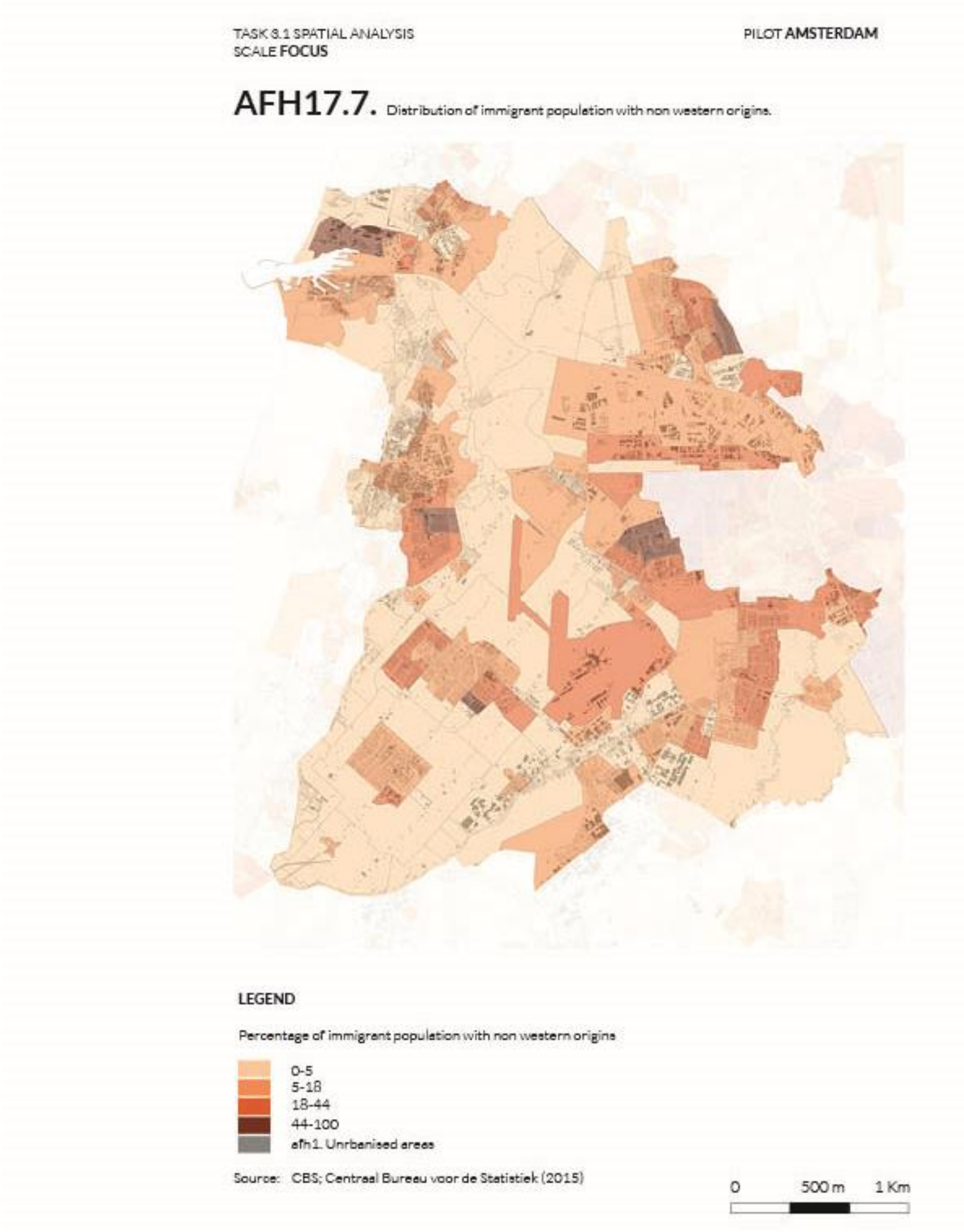

Figure 8: Distribution of immigrant population with non-western origin. Source: UTJ_MapLab

As the metropolitan areas can provide a better livelihood, population concentrates here as is demonstrated by the numbers. This concentration is also a huge challenge for urban planning, not least regarding quality and quantity of housing, and has resulted in the designation of expansion areas for AMA (Figure 9).

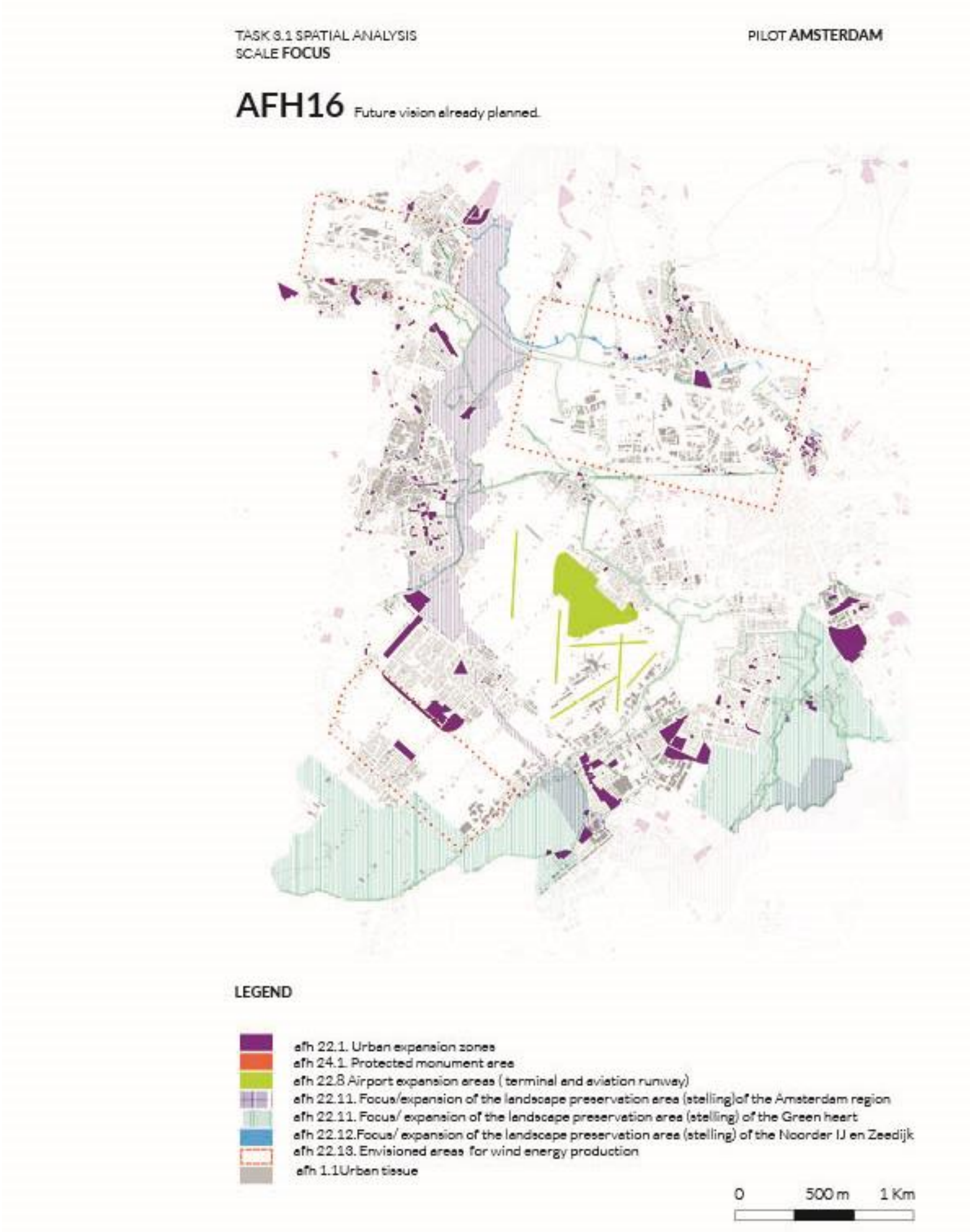

Figure 9: Future expansion areas for AMA. Source: UTJ_MapLab

No significant difference can be observed in the number of deaths and as the population is ageing, it is growing in all three examined areas by 1.04-1.06 percent. As has been mentioned, the Netherlands is among the most developed countries in the world, but many aspects of developmental differences still occur between its provinces. A good example of this is the change in fertility rate, which is much lower in the urban region. In Noord-Holland the fertility rate was 1.57 while in Flevoland it was 1.82. It is particularly low in Groot-Amsterdam with a rate of 1.49 in 2015. This trend is common among metropolitan areas where women tend to focus more on their career, bear fewer children every year and also postpone motherhood. The life expectancy also differs somewhat and while women tend to live longer in both provinces, men have a shorter life expectancy in the Noord-Holland region.

The characteristics of the two provinces are also visible in the educational data. In Flevoland, the number of those who attended only in secondary or lower level education is higher than the number in the more urbanised Noord-Holland. From another perspective, people in Noord-Holland enjoy a tertiary level of education. This is also usual, especially with the Amsterdam Metropolitan Area in the centre of the province, where the higher education institutions are concentrated. Compared to the national rates the Noord-Holland province has better percentage in tertiary education, while the Flevoland is under the that by 5 percent.

3.2.3. Labour force

With regard the labour force, the first characteristic that must be mentioned is its size. In the vastly more populous Noord-Holland, the labour force is also larger with 1,526,300 people between the age of 15 and 75 years in the labour market while in Flevoland, the number is only 221,900 people. The unemployment rate is higher in each case than the national average (5.1) as in the more urban Noord-Holland it was 5.5 in 2016 but in Flevoland was 8.0 percent. The distribution of unemployment has a clear pattern in the Amsterdam area where concentrations can be found at the edges of the AMA (Figure 10).

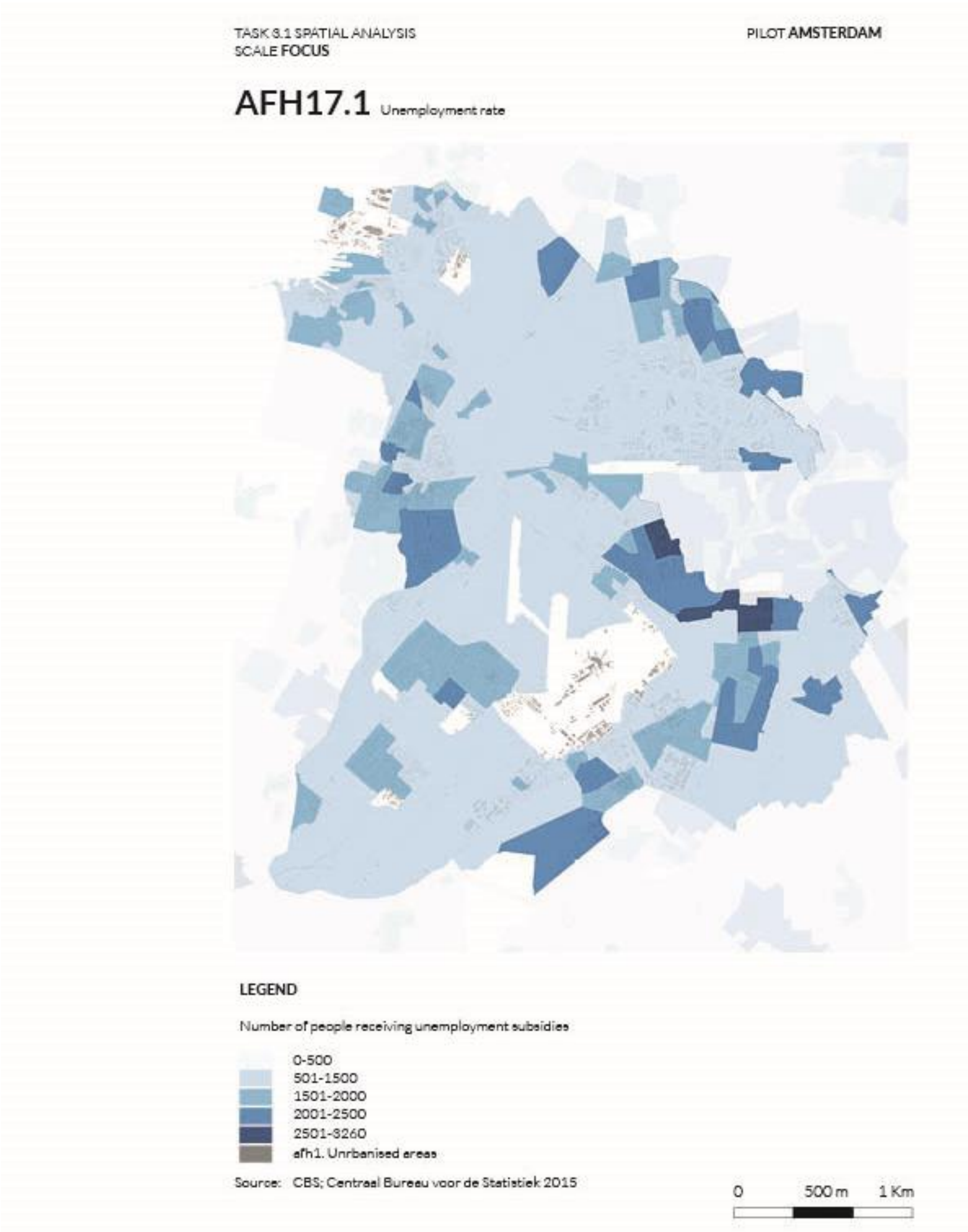

Figure 10: Unemployment distribution in AMA. Source: UTJ_MapLab

3.2.4. Economy

Amsterdam is the capital as well as the principal commercial and financial centre of the Netherlands. The GDP per capita (data from 2014) differs quite a bit in each of the two examined provinces, the more developed Noord-Holland shows a higher rate (51,100 EUR) than the national average while Flevoland is well under that rate (30,600 EUR). The area of Groot-Amsterdam generated a rate of 71,100 EUR.

Amsterdam is a service centre, with only about one-tenth of its workforce employed in manufacturing. The most vibrant and expanding part of the dominant service sector is its business services component, including consulting, information and medical technology as well as telecommunications. The consistent lifeblood of the city for the past seven centuries has been international trade and transport, which together account for about one-fifth of employment. Banking and insurance also have been a mainstay of the Amsterdam economy, together accounting for about one-eighth of all jobs, while about one-sixth of jobholders are employed in health, cultural, and social services. Another important part of the city's economy, tourism, accounts for about one-tenth of all jobs (Encyclopaedia Britannica).

3.2.5. Transportation

Transport is a key factor of the economy in the Netherlands. Correspondingly the country enjoys a very dense and modern infrastructure, facilitating transport with road, rail, air and water networks (World Economic Forum, 2014)

Amsterdam's seaport also ranks amongst the most important in Europe but, overshadowed by the huge Rotterdam-Europoort nearby, the Amsterdam docks underwent a gradual decline in traffic during the late 20th century (Encyclopaedia Britannica).

Schiphol Airport is a crucial part of the AMA, located as it is nine kilometres southwest of Amsterdam in the municipality of Haarlemmermeer. It is the third busiest airport in Europe in terms of passenger numbers (www.aci.aero).

3.2.6 Wastescapes of the AMA

The previous paragraphs and associated maps highlight specific physical characteristics and urbanisation processes related to the AMA region and the selected focus areas. Each map shows the contemporary result of an extreme and long lasting urban development of the AMA territory. As Lynch (1990) clearly states however, in any type of urban environment there is no growth without the generation of waste, from both the material and spatial perspective.

If the generation of material waste is more easily identified, the spatial dimension of waste is often a hidden element. Generally having negative connotations, the spatial dimension of waste (Wastecape) is often a neglected issue in the majority of the cartographic representations.

Through mapping as systemic exploration, this part of the project makes explicit what is normally invisible and often overlooked in official cartographies and land use blueprints (Furlan 2017). The following series of maps of the focus area are a first attempt to pictures the Wastecape dimension, going beyond the official means of representing wasteland, in which wastelands are merely associated with contaminated sites (brownfields). The maps are composed according to the methodologies described in point 2.1.2. Practically, they visualise different types of neglected, wasted and underused spaces, namely: contaminated land, transport safety and noise areas, contaminated waterbodies, infrastructures, abandoned buildings, land and industries, unused greenfield next to infrastructure and the operational infrastructure of waste.

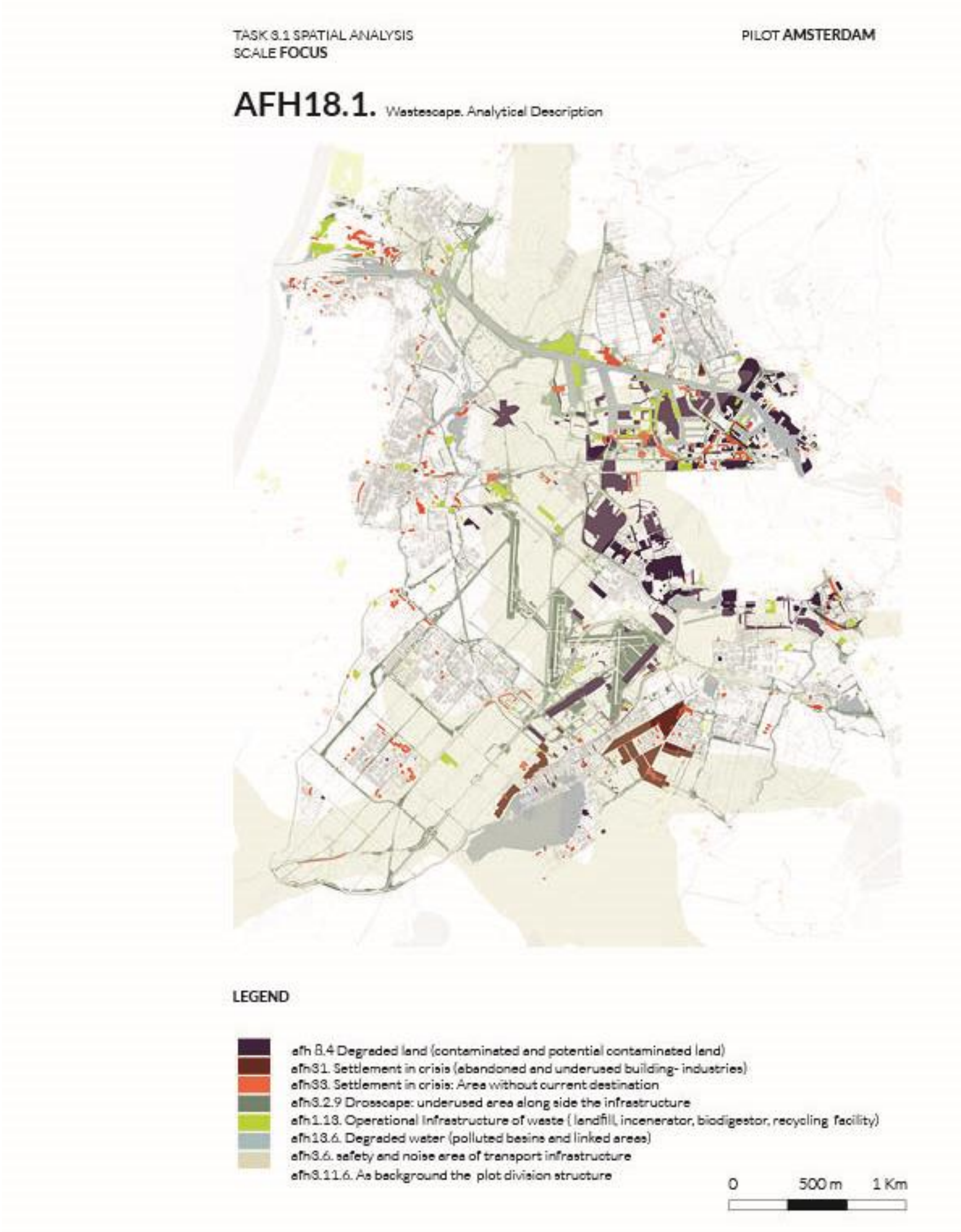

Figure 11: Wastecape distribution in the AMA. Source: UTJ_MapLab

From an urban perspective, the construction of a Wastescape map visualises the unexpected results of urban growth though, unfortunately without providing additional information to the expert eyes of local urban planners and administrators.

The observation of the territory from a circular perspective however, obliged urban planners and local administrators to preserve green and agricultural environments, reusing previously developed landscapes and slowing the generation of land consumptions processes (Viganò 2014; Di Simini, Pileri, and Ronchi 2013). From this perspective, Wastecapes obtain new value towards a more sustainable urban setting, questioning the location of current building expansion and landscape protection areas. What if we consider Wastescapes as a kind of land bank to be revalued? And what if wasteland dynamics were to be the starting point in the reflection on the future of the city territory, instead of being one of the last issues to be solved? However, as Berger (2006) affirmed, focusing on wasteland with a protective eye does not mean envisioning a world without wasteland (Furlan 2017). Therefore, Wastescape revaluation entails a whole series of actions: new reclamation methods have to be worked out, land has to be restored, agricultural fields and forests protected, energy systems transformed, agreements reached that will be explored with the PULL meeting and in WP5.

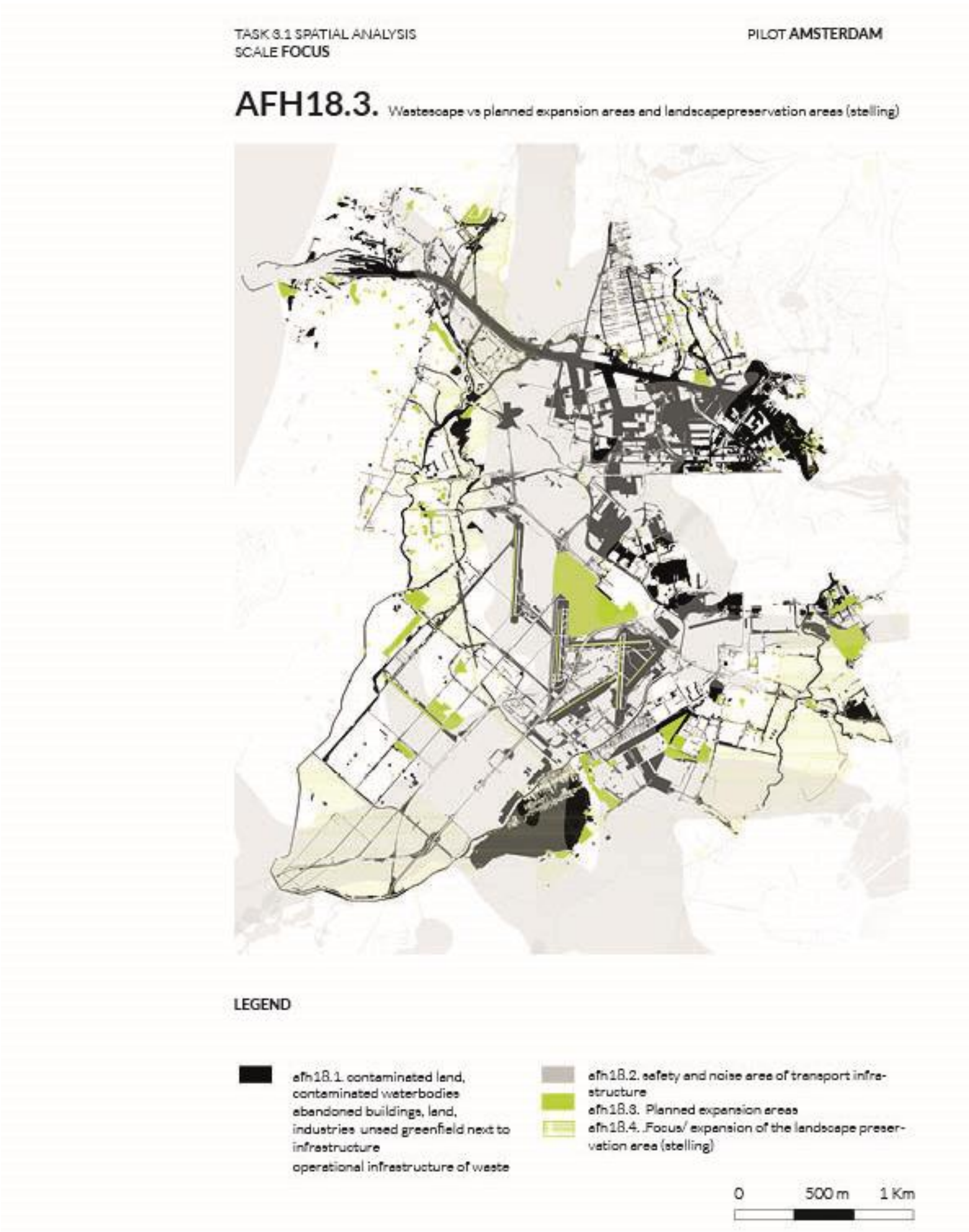

Figure 12: Wastecape distribution in relation to already planned expansion areas and protection zones. Source: UTJ_MapLab

3.2.7. Development strategy & waste sensitivity towards circularity

The Amsterdam case is embedded in the Dutch national ambitions to transition towards a CE, which were formulated in the policy report 'Nederland Circulair in 2050' that states the necessity to strive for a transition towards a circular economy for three reasons: substantial growth in resource use, dependency of the Netherlands on other countries for resource supply and the relation to climate change in the form of CO2 emissions. Next to facing these problems, the national government saw many benefits in transitioning to a circular economy, such as economic opportunities (Rijksoverheid, 2016).
Although the strategy is very ambitious and there are several initiatives dealing with circular economy, there are only two companies in the Netherlands who have a recent EMAS certification (2016 or later): one based in Maastricht and the other in Rotterdam. Referring to the NACE code, we see that one is a manufacturer of paper and cardboard while the other is in taxi operations (unfortunately, we do not have information on ISO14001 certification relating to the focus area).

The municipality of Amsterdam has high ambitions for this subject and wants to be one of the leading transition cities. Amsterdam's CE ambitions already began in 2009 with the initiation of circular Buiksloterham (Metabolic, 2014), an urban regeneration project testing and implementing CE principles. Within this new housing development, circular concepts were used to develop a zero-waste neighbourhood. Afterwards, Amsterdam adopted circular economy within their 'sustainability agenda' and promoted the concept of CE as one of the biggest opportunities to facilitate sustainable growth in the future (Gemeente Amsterdam, 2015a). After including the transition within their sustainability agenda, a roadmap towards CE, 'Amsterdam Circulair' was presented in 2015.
The roadmap emphasized the importance of two value chains for the CE transition: organic residual streams (waste category: Organic Waste, OW) and the construction and demolition value chain (waste category: Construction & Demolition Waste, CDW).

3.3 Material Flow Analysis Amsterdam case

3.3.1 MFA of Food waste

During the interviews conducted with stakeholders in the region (WP6) and the PULL workshops in the co-exploration phase (WP5), the importance of both CDW and OW value chains has been confirmed and further specified. With regard to the OW flow, the subcategory Food Waste (FW) was pin-pointed as a primary concern. Regarding the CDW flow, the focus shifted from specific renovation & transformation-related CDW to CDW in its entirety. Due to time restrictions and intensity of data collection and processing, the focus regarding the Amsterdam pilot in Deliverable 3.3 (D3.3) was initially focused on FW alone. The CDW case has been put on hold until completion of the FW case study, and is now available as a separate addendum to D3.3.

Within the recently published evaluation of Amsterdam's circularity programme, several perspectives for action are identified regarding a shift towards circular food systems (Municipality of Amsterdam, 2018). These perspectives concern more qualitative than quantitative targets but do provide valuable points of attention for policy makers. For example, concerning a more evidence based understanding of the regional potential for avoiding food waste, recovering nutrients from food waste, and streamlining logistics of supply and demand in the food system (ibid). On a national level, more elaborate objectives are formulated in the *Transitieagenda Biomassa & Voedsel*, for example by proposing the reduction of food waste (-50% by 2030) and a public/private investment agenda for research and demonstration activities (Dutch Ministry of Infrastructure and Water Management, 2018).

The choice of food waste as a material scope for the AMA region is further supported by the following:

- Roughly 30% of anthropogenic GHG emissions are caused by the food system (Garnett, 2016).
- In the 2009 '*nota duurzaam voedsel*', the Dutch ministries of Economic Affairs, Infrastructure and the environment have set the goal of decreasing the food waste produced in the Netherlands by 20% in 2015 compared to 2009. It was found however, that the FW generation only decreased by 1% and no new goal was set by the government as they acknowledged that the tools to analyse FW reduction strategies and the means to measure their impacts are absent (interview with previous State Secretary of Economic Affairs Van Dam in TV show De Monitor in 2017).

Given this last statement by State Secretary Van Dam, the developed representation and process models are the first step within REPAiR to provide the necessary decision-making support tools for FW.

The work done for the Food Waste (FW) material scope in Amsterdam will be covered according to the 6-step structure proposed in D3.1, ending with the additional steps of interpretation and reflection.

3.3.1.1 Step 1: Determination of material scope - results

In D3.1, a preliminary selection was made. From the five REPAiR categories, i.e. Construction and Demolition Waste (CDW), Organic Waste (OW), Post-Consumer Plastic Waste (PCPW), Waste of Electronic and Electrical Equipment (WEEE) and Municipal Solid Waste (MSW), it was decided that one of the material scopes for the AMA case study would be Food Waste (FW) as a part of OW. The REPAiR definition of OW, adapted from the European Commission, is as follows: "*Biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, and comparable waste from food processing plants. It does not include forestry or agricultural residues, manure, sewage sludge, or other biodegradable waste such as natural textiles, paper or processed wood. It also excludes those by-products of food production that never become waste (EC, 1998, 2016)*". The working definition for FW is determined as: "*food removed from the food supply chain to be recovered or disposed, including liquid food waste, vegetal food waste, animal food waste, and mixed food waste* (see also Figure 13 below).

Based on the available data (from Landelijk Meldpunt Afvalstoffen, 2018) and following the aforementioned definition, a waste hierarchy was defined. This is important, because the specific data set and related description on each waste transport varied according to how detailed the waste collector described the waste. Furthermore, to inform the development of eco-innovative solutions (EIS) it is crucial to be as precise as possible. It is important to note that the hierarchy is not complete, but based on the data that was inserted into the GDSE.

The first step was to separate non-food organic waste from food waste. Figure 13 shows the result of this process. And distinguishes, liquid and mixed food waste from vegetal based and animal based food waste.

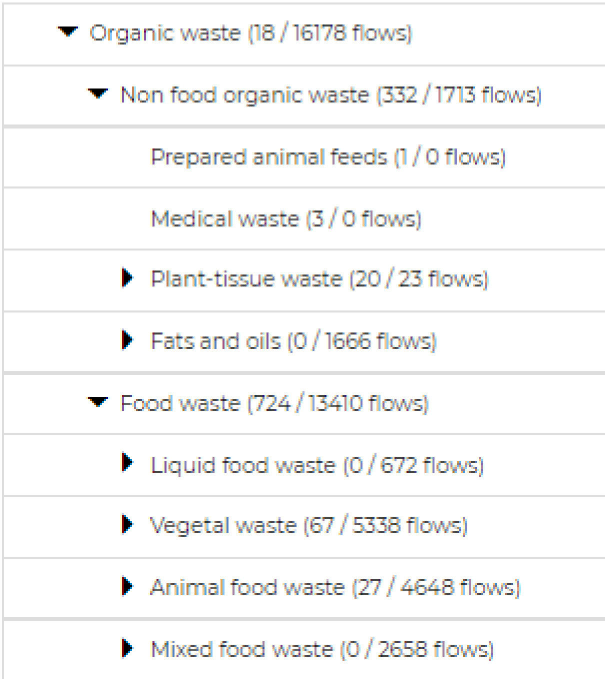

Figure 13: the highest levels of the organic waste hierarch with the distinction of food waste from non-food waste and introducing the top hierarchy level of food waste.

The four categories above were further subdivided into more categories using a hierarchical relation that allows to aggregate all waste to the four above named categories. The following figures present these subdivisions.

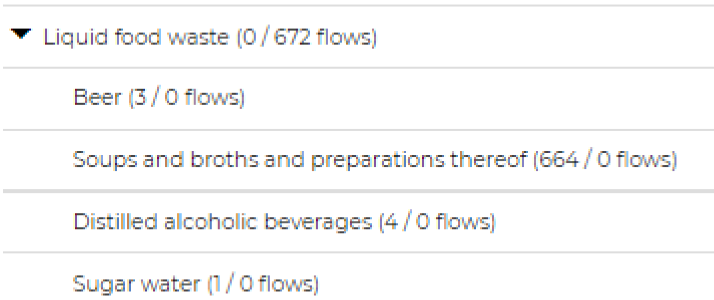

Figure 14: The food waste flows under the category liquid food waste.

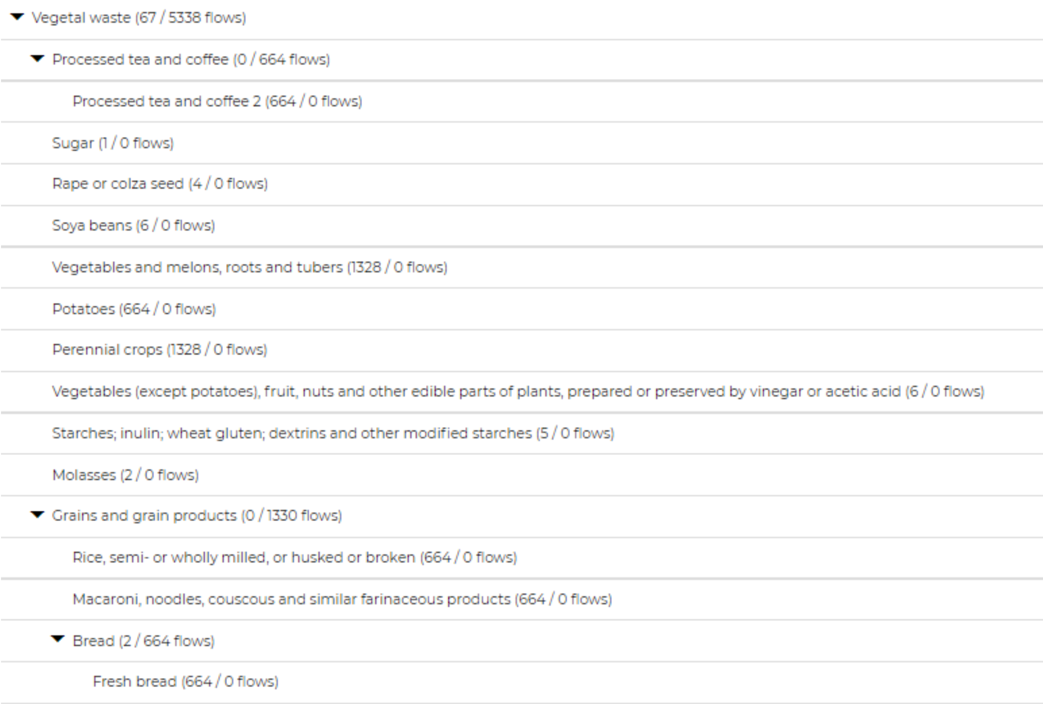

Figure 15: The food waste hierarchy under vegetal based waste.

Figure 16: The food waste hierarchy under animal based food waste as well as mixed food waste.

3.3.1.2 Step 2: Defining the material supply chain - results

Based on the working definitions applied in this project, a set of NACE codes were selected to represent the food waste network, subdivided into Activity Groups (AG) of specific activities which act as nodes in the food waste generation and treatment system. In addition to the AG for economic activities, the AG 'H' which stands for FW production by households was introduced. Therefore, the following AG have been identified;

P1 - Primary Production - 34 NACE (level 4) codes
P2 - Processing and manufacturing - 11 NACE (level 4) codes
W - Wholesale and logistics - 11 NACE (level 4) codes
R - Retail and markets - 8 NACE (level 4) codes
F - Food service/preparation and consumption - 8 NACE (level 4) codes
H - Food preparation and consumption at households - (not an NACE activity)
WM - Waste Management - 7 NACE (level 4) codes

The NACE codes selected for the activity groups as well as the interrelations between activity groups are displayed in the comprehensive system diagram in figure 17 below.

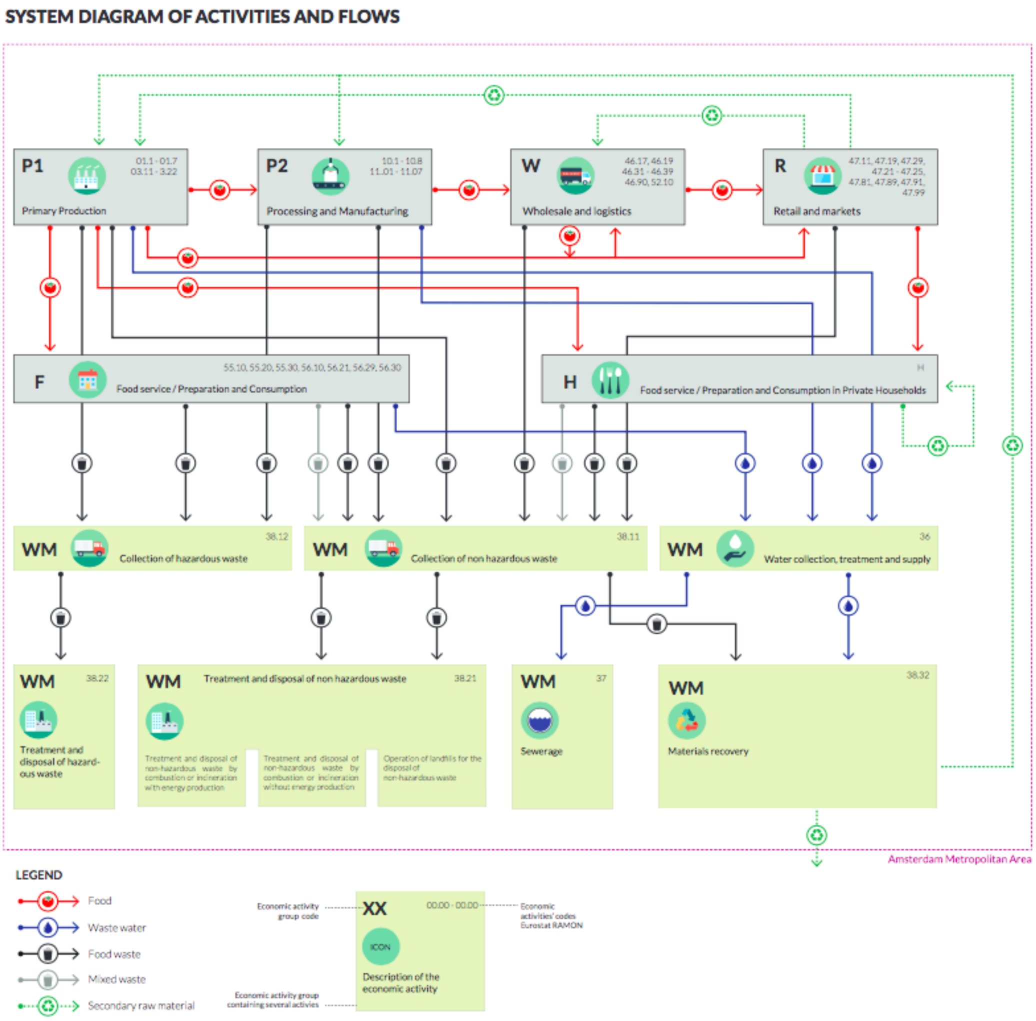

Figure 17: The system diagram of activities and flows that build the system of the food value chain in the Amsterdam metropolitan area. Click here for larger image

3.3.1.3Step 3: Selection of geographical area & spatial scales - results

A As detailed in D3.1, the Focus Area (FA) as a boundary is not relevant for the MFA as the FA is not an administrative boundary, which would lead to great difficulty collecting (top-down) data. Instead, the geographical area for which data is collected, will be defined by the boundaries of the 33 municipalities in the Amsterdam Metropolitan Region. Table 2 displays these 33 municipalities and, in addition, to which province and COROP region (grouping of municipalities for statistical purposes) the municipalities belong to.

Table 2: 33 AMS municipalities linked to COROP and Province

Municipality	COROP	Province
Aalsmeer	Groot-Amsterdam	Noord-Holland
Almere	Flevoland	Flevoland
Amstelveen	Groot-Amsterdam	Noord-Holland
Amsterdam	Groot-Amsterdam	Noord-Holland
Beemster	Groot-Amsterdam	Noord-Holland
Beverwijk	Ijmond	Noord-Holland
Blaricum	Gooi en Vechtstreek	Noord-Holland
Bloemendaal	Agglomeratie Haarlem	Noord-Holland
Diemen	Groot-Amsterdam	Noord-Holland
Edam-Volendam	Groot-Amsterdam	Noord-Holland
Gooise Meren	Gooi en Vechtstreek	Noord-Holland
Haarlem	Agglomeratie Haarlem	Noord-Holland
Haarlemmerliede en Spaarnwoude	Agglomeratie Haarlem	Noord-Holland
Haarlemmermeer	Groot-Amsterdam	Noord-Holland
Heemskerk	Ijmond	Noord-Holland
Heemstede	Agglomeratie Haarlem	Noord-Holland
Hilversum	Gooi en Vechtstreek	Noord-Holland
Huizen	Gooi en Vechtstreek	Noord-Holland
Landsmeer	Groot-Amsterdam	Noord-Holland
Laren (NH.)	Gooi en Vechtstreek	Noord-Holland
Lelystad	Flevoland	Flevoland
Oostzaan	Groot-Amsterdam	Noord-Holland
Ouder-Amstel	Groot-Amsterdam	Noord-Holland
Purmerend	Groot-Amsterdam	Noord-Holland
Uitgeest	Ijmond	Noord-Holland
Uithoorn	Groot-Amsterdam	Noord-Holland
Velsen	Ijmond	Noord-Holland
Waterland	Groot-Amsterdam	Noord-Holland
Weesp	Gooi en Vechtstreek	Noord-Holland
Wijdemeren	Gooi en Vechtstreek	Noord-Holland
Wormerland	Zaanstreek	Noord-Holland
Zaanstad	Zaanstreek	Noord-Holland
Zandvoort	Agglomeratie Haarlem	Noord-Holland

3.3.1.4 Step 4: Defining case specific supply chain - results

Now that the activities relevant to the food waste chain are defined in step 2 and the geographical area is set, it is possible to start identifying and describing the actors that generate FW. This will be done separately for companies (Activity groups P1, P2, W, R, F) and households (Activity group H)

Households in the FW chain

A large share of food waste is produced at the household level. Consumption in households is not an activity covered by a NACE code so, as proxy for this activity, we used the number of household and inhabitants at the level of the neighbourhood ('wijk' in Dutch). Since 2004, the Dutch Central Bureau of Statistics (CBS) has provided detailed key statistics for all neighbourhoods in the Netherlands (see online sources - CBS neighbourhood statistics).

For this deliverable, the 2016 statistics are used which show that, in the AMA, there are 33 Municipalities with 339 Neighbourhoods containing 1,157,765 households and 2,410,330 inhabitants.

Companies in the FW chain

With the selection of the NACE codes and the administrative boundary, the Orbis database was used to export all possible actors. The resulting query of companies for the FW network in the AMA region is presented in Table 3.

This first overview allows us to conclude that:

1) For some of the activities, no actors are registered in the AMA. These are primarily activities that are not expected to take place in the Netherlands due to the Dutch climate (e.g. 'growing of tropical fruit').
2) The AG for food service (F) (which includes e.g. restaurants, hotels, bars, etc.) have the most companies registered (see figure 18). This can be explained by the large tourism industry in Amsterdam.

Table 3: Companies for the FW network in the AMA region

Statistical Classification of Economic Activities in the European Community

P1	Primary Production	Count
A-01.11	Growing of cereals (except rice), leguminous crops and oil seed	136
A-01.13	Growing of vegetables and melons, roots and tubers	121
A-01.19	Growing of other non-perennial crops	449
A-01.21	Growing of grapes	4
A-01.24	Growing of pome fruits and stone fruits	15
A-01.25	Growing of other tree and bush fruits and nuts	6
A-01.28	Growing of spices, aromatic, drug and pharmaceutical crops	4
A-01.29	Growing of other perennial crops	6
A-01.41	Raising of dairy cattle	509
A-01.42	Raising of other cattle and buffaloes	89
A-01.43	Raising of horses and other equines	81
A-01.45	Raising of sheep and goats	91
A-01.46	Raising of swine / pigs	9
A-01.47	Raising of poultry	16
A-01.49	Raising of other animals	65
A-01.50	Mixed farming	50
A-01.61	Support activities for crop production	343
A-01.62	Support activities for animal production	104
A-01.63	Post-harvest crop activities	10
A-01.64	Seed processing for propagation	8
A-01.70	Hunting, trapping and related services activities	6
A-03.11	Marine fishing	43
A-03.12	Freshwater fishing	23
A-03.21	Marine aquaculture	4
A-03.22	Freshwater aquaculture	7
Total		**2199**

P2	Processing and manufacturing	Count
C-10.11	Processing and preserving of meat	25
C-10.12	Processing and preserving of poultry meat	7
C-10.13	Production of meat and poultry meat products	63
C-10.20	Processing and preserving of fish, crustaceans and molluscs	30
C-10.31	Processing and preserving of potatoes	5
C-10.32	Manufacture of fruit and vegetable juice	6
C-10.39	Other processing and preserving of fruit and vegetables	14
C-10.41	Manufacture of oils and fats	12
C-10.42	Manufacture of margarine and similar edible fats	1
C-10.51	Operation of dairies and cheese making	34
C-10.52	Manufacture of ice cream	26
C-10.61	Manufacture of grain mill products	5
C-10.62	Manufacture of starches and starch products	7
C-10.71	Manufacture of bread; manufacture of fresh pastry goods and cakes	642
C-10.72	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	30
C-10.73	Manufacture of macaroni, noodles, couscous and similar farinaceous products	11
C-10.82	Manufacture of cocoa, chocolate and sugar confectionery	51
C-10.83	Processing of tea and coffee	34
C-10.84	Manufacture of condiments and seasonings	24
C-10.85	Manufacture of prepared meals and dishes	59
C-10.86	Manufacture of homogenised food preparations and dietetic food	13
C-10.89	Manufacture of other food products n.e.c.	60
C-10.91	Manufacture of prepared feeds for farm animals	1
C-11.01	Distilling, rectifying and blending of spirits	31
C-11.02	Manufacture of wine from grape	7
C-11.03	Manufacture of cider and other fruit wines	2
C-11.04	Manufacture of other non-distilled fermented beverages	2
C-11.05	Manufacture of beer	103
C-11.07	Manufacture of soft drinks; production of mineral waters and other bottled waters	23
Total		**1328**

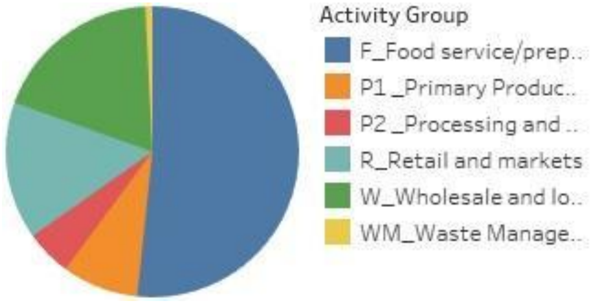

Figure 18; Pie chart for the number of companies registered in the AMA per activity group

Filtering Orbis query results with BAG data

1. Avoid double counting and false actors

To make the NACE codes spatial, they were geo-referenced and linked to the Orbis Database (mentioned in D3.1). Inspection of the Orbis exports showed that the actor (i.e. company) entries can contain freelancers that for example, offer the service of 'working as a chef'. In this case, it is clear that food waste does not occur at the location registered in Orbis. The waste produced by these actors is already accounted for, either in waste from restaurants or in households likely to end up in the household waste. To avoid double counting, these were filtered out of the company dataset. In order to do so, the Orbis exports are coupled with the 'Basisregistratie Adressen en Gebouwen' (BAG) database, which is the Dutch national register of all addresses and buildings and their function, to exclude all companies registered as residential buildings.

A nearest neighbour join was used in ArcGIS to match the Orbis and BAG database spatially. This method was used to compensate for a lack of foreign keys between the datasets and the absence of spatial overlap. In total, this excluded roughly 10,000 companies (44%) from the original ~23,000 entries. The distribution of the excluded entries per AG were as follows: F - 57%; W - 20%; R - 17%; P2 - 6%. The excluded companies were classified exclusively as 'residential' (NL: 'woonfunctie') in the BAG database. Subsequently, based on CBS data, municipality, neighbourhood and district names and codes are spatially joined to the Orbis dataset.

2. Exclude false actors

The Orbis export also contains some false actors that are operating in the FW chain, yet not producing any FW. These actors can be offering administrative/financial/consulting services in the FW chain or are the headquarter office to a company that produces the waste elsewhere. Since the AMA (Amsterdam especially) hosts a significant number of headquarters of (multinational) agro-food companies, it is important to filter out offices from the Orbis list with the BAG data in the same way as described earlier. The excluded addresses were classified exclusively as 'office' in the BAG database (NL: 'kantoorfunctie'). This excluded roughly 1,400 actors of the original ~23,000 companies. The distribution of the excluded entries per AG were as follows: W - 45%; F - 40%; R - 9%; P2 - 6%. It is acknowledged that this method is rather rough and will take out some actors that actually generate FW. However, for downscaling of top-down data in the next step, it is of high importance to take out any large headquarters/offices (see section on downscaling).

3.3.1.5 Step 5: Activity-based mass flow modelling

Data gathering

The data availability is to be presented by exploring and gathering data for the three main stages of FW; 1) generation (data from companies/households), 2) collection (data from waste collectors) and 3) treatment (data from waste treatment plants). The following section will cover the findings separately for households and companies.

HOUSEHOLD WASTE FLOW DATA

On the European level, households are responsible for 53% of FW generated in the entire chain (Stenmarck et al., 2016)

1) Data on food waste generation at household level

- The CBS produces yearly data on the municipal scale per waste category that can be collected separately. The waste categories that can contain FW are GFT (Vegetable, fruit and garden waste) and residual waste. Residual waste (NL:'Restafval') is the waste that is not intended for any recycling other than energy recycling through incineration. This waste should ideally come from products such as diapers, cat litter or laminated bags. However, in reality it is found that residual waste from households can still contain waste that is disposed of incorrectly such as GFT, glass, paper and other renewable sources, that are intended for separate waste recycling infrastructures. The data is normalised by dividing the waste streams for the municipalities by the number of inhabitants. This normalisation factor can then be applied to the number of inhabitants in neighbourhoods to get results for a more disaggregated spatial scale.

- The CBS also produces average data for municipal household waste production regarding number of inhabitants and the urbanisation levels. The latter can especially be applied on the neighbourhood level and produce the GFT and residual waste produced for the AMA region. Modelling with this data is useful as a consistency check on the first approach for quantifying the waste generation at the households.

Conversion factor: There are several conversion factors found to calculate the amount of food waste found in the GFT and residual waste streams. In the case of GFT, what this conversion factor is can vary amongst municipalities, since municipalities with more high-rise buildings produce less garden waste. Conversion factors are found in research papers concerning food waste quantification.

- Rijkswaterstaat (RWS) uses a general conversion factor of 63.1% for FW in the GFT waste stream and a 20% share of the total household waste (Rijkswaterstaat, 2017).

- In the research produced by CREM (2017) the average FW in the GFT and residual waste has been deconstructed with a thorough household waste sorting analysis. This is deconstructed by food categories (e.g. vegetable peels, bread, coffee grounds, etc.) and whether this food waste is avoidable or unavoidable.
- The research by CREM (2017) also presents the share of FW in the GFT and residual waste found for a diverse set of municipalities (separated in unavoidable and avoidable). This data can be used as a proxy for municipalities with similar population densities and can therefore produce a more representative result for FW in GFT on a municipal scale. This data might be more representative for the GFT waste stream than the national conversion factor presented earlier however, it does not provide a detailed breakdown of the (un)avoidable food waste products.

- An older research by CREM (2010) on FW in Dutch households also included the food waste that is ends up in the sewer by being disposed of through the sink or toilet. This is mainly the case for dairy, drinks, soups, oils and fats. To quantify this waste stream, a survey was used to get indicative data, since sampling was not possible. The data presented can be used to calculate how much of the dairy, drinks, soups, oil and fats end up in the sewer as opposed to the GFT or residual waste. However, the research showed that waste quantities of FW in residual waste and GFT from waste sampling is much larger than what is estimated by the households, so this data is likely largely underestimated and therefore not representative. These food waste flows that end up in the sink will thusly not be modelled in the AS-MFA.

2) Collection of the household waste

Municipalities are responsible for the collection of the household waste and delegate this task to private companies. The waste collection partners are contracted and are therefore not permanent partners. For the model, it was necessary to find out which private waste collection companies are currently contracted by the AMA municipalities. To the researchers' knowledge, there is no such document available containing the municipalities and their current contractors, so this had to be sought through desktop research and via contacting the municipalities directly. Due to the reliable data provision by the municipalities, it is not necessary to collect data on waste collected from the private collectors.

3) Treatment of the household waste

When the private collectors for the AMA municipalities are known, it is necessary to find out to which waste treatment facility the household waste gets delivered. This has to be uncovered for the two distinct household waste streams that contain FW, since GFT-waste ends up in composters or digesters and the residual waste is incinerated. For the AMA, the residual waste ends up in three different incinerators - one located in the AMA, one in the Netherlands outside the AMA and one in Germany (just over the Dutch border). The GFT-waste ends up in five different composting and digestion plants - three located in the AMA and two outside of the AMA in the Netherlands. The (technical) information and yearly figures on the waste plants can be found either in the annual reports for the respective WT plants or in the yearly report ‘Afvalverwerking in Nederland’ (EN: waste treatment in the Netherlands) by RWS. Although this document does not state exactly from which municipalities the household waste originates, it does provide a physical upper limit for household waste processed by the WT plant and therefore can either be used for rough mass balancing or a sanity check of the other data provided by the CBS.

COMPANY WASTE FLOW DATA

On the European level, companies are responsible for 47% of FW generated in the entire chain; 12% in primary production, 19% in processing, 5% in retail and 12% in food service

1) Data on food waste generation and collection of company waste

Company waste is generally dealt with by commercial waste collectors. There are multiple licensed OW/FW collectors active in the AMA region. For some municipalities, companies that produce a small, limited amount of waste can apply for the ‘reinigingsrecht’ and have the municipality deal with the company waste in the same way as household waste. In order to prevent double counting, it is assumed this quantity is included in the household waste data.

The CBS (Central Bureau for Statistics Netherlands) has been collecting waste statistics since 1978 on the supply, composition and processing of company/industrial waste in the Netherlands. Through a written survey, the data is collected mainly from NACE B, C and D. Since 2006, data has been made available for NACE, collected from the so-called AMICE-register of the Landelijk Meldpunt Afvalstoffen (LMA), the national contact point for waste registration. The statistics are gathered in the light of the Waste Statistics Regulation (European Union 2002) and used in a yearly monitor for the government’s national waste management plan. Over the years, the Dutch waste codes have been changed into the EWC codes and became more comprehensive, not only asking larger companies with more than ten employees, but also the smaller ones. This data is entered by the collectors and managed by the government. This database provides the most complete data on the waste collected from which company, by whom it is collected, and to which waste treatment plant the waste is sent. The REPAiR project received from the LMA all data entries for the year 2016 for the waste transports corresponding to organic waste generated within the AMA. Using the above described material hierarchy the food waste was filtered from this data base. The database however, holds data that can be considered sensitive to some companies and can therefore, not be made accessible to the public. For this reason, in the following data is only presented in aggregated from.

As the LMA data includes name and address of the company that generates, collects and treats waste it was possible to match the LMA database with the before mentioned ORBIS data base, which allows to locate and map the different flows between waste generation, collection and treatment in the GDSE. There are two significant limitation to this data, as a large part of food waste is collected 'en route'– like on truck picks up the food waste of several restaurant in one go. In these cases, the flows start from the collector, the database includes though the name of the municipality the waste was collected in. The second limitation is that it doesn't include the primary, agricultural sector.
Additionally, it has to be assumed that also in the residual waste of large companies includes to a certain amount food waste. In order to estimate this share of food waste we used studies from Groenstijn (2018) and Gemeente Amsterdam, Ruimte & Duurzaamheid (2015), who state that a ratio of 23% of residual waste in the service sector is food waste, because of lack of data on other sectors we assumed the same for all other economic sectors.

The following tables specify the generated food waste in separated as well as residual waste by economic sector using also the above described food hierarchy.

Table 4: company generated food waste for the manufacturing sector.

MANUFACTURING

	Separately Collected Food Waste t/year	Food Waste in Residual MSW t/year	Food Waste as Generated t/year	Share
MACROCATEGORY				
FOOD WASTE (UNSPECIFIED)	764	1,165	1,929	4%
ANIMAL WASTE	425		425	1%
BAKERY AND FARINACEOUS PRODUCTS	0		0	0%
BEER	0		0	0%
DISTILLED ALCOHOLIC BEVERAGES	0		0	0%
RAPE OR COLZA SEED	0		0	0%
SOYA BEANS	0		0	0%
STARCHES; INULIN; WHEAT GLUTEN; DEXTRINS AND OTHER MODIFIED STARCHES	0		0	0%
SUGAR	92		92	0%
SUGAR WATER	0		0	0%
VEGETABLES (EXCEPT POTATOES), FRUIT, NUTS AND OTHER EDIBLE PARTS OF PLANTS, PREPARED OR PRESERVED BY VINEGAR OR ACETIC ACID	48,033		48,033	95%
TOTAL	49,315	1,165	50,48	100%

Table 4 shows that vegetable waste accounts for the largest share in the manufacturing sector, and Table 5 shows that unspecified food waste accounts for the largest share in the manufacturing sector.

Table 5: company generated food waste for the wholesale & retail sector sector.

WHOLESALE & RETAIL SECTOR

	Separately Collected Food Waste t/year	Food Waste in Residual MSW t/year	Food Waste as Generated t/year	Share
MACROCATEGORY				
FOOD WASTE (UNSPECIFIED)	488	6,921	7,409	81%
ANIMAL WASTE	374		374	4%
BAKERY AND FARINACEOUS PRODUCTS			0	0%
BEER	45		45	0%
DISTILLED ALCOHOLIC BEVERAGES	8		8	0%
RAPE OR COLZA SEED			0	0%
SOYA BEANS			0	0%
STARCHES; INULIN; WHEAT GLUTEN; DEXTRINS AND OTHER MODIFIED STARCHES			0	0%
SUGAR			0	0%
SUGAR WATER	14		14	0%
VEGETABLES (EXCEPT POTATOES), FRUIT, NUTS AND OTHER EDIBLE PARTS OF PLANTS, PREPARED OR PRESERVED BY VINEGAR OR ACETIC ACID	1,344		1,344	15%
TOTAL	2,273	6,921	9,194	100%

Table 6: company generated food waste for the food service sector.

FOOD SERVICE SECTOR

	Separately Collected Food Waste t/year	Food Waste in Residual MSW t/year	Food Waste as Generated t/year	Share
MACROCATEGORY				
FOOD WASTE (UNSPECIFIED)	38,332	16,177	54,509	91%
ANIMAL WASTE	227		227	0%
BAKERY AND FARINACEOUS PRODUCTS	0		0	0%
BEER	0		0	0%
DISTILLED ALCOHOLIC BEVERAGES	0		0	0%
RAPE OR COLZA SEED	0		0	0%
SOYA BEANS	0		0	0%
STARCHES; INULIN; WHEAT GLUTEN; DEXTRINS AND OTHER MODIFIED STARCHES	0		0	0%
SUGAR	0		0	0%
SUGAR WATER	0		0	0%
VEGETABLES (EXCEPT POTATOES), FRUIT, NUTS AND OTHER EDIBLE PARTS OF PLANTS, PREPARED OR PRESERVED BY VINEGAR OR ACETIC ACID	4,861		4,861	8%
TOTAL	43,421	16,177	59,598	100%

Table 6 shows that unspecified food waste accounts for the largest share in the food service sector. Table 7 displays company generated food waste for waste flows, that could, because of earlier described ‘en route’ collection not be assigned to a specific sector.

Table 7: company generated food waste not assigned to a specific sector

OTHER

MACROCATEGORY	Separately Collected Food Waste t/year	Food Waste in Residual MSW t/year	Food Waste as Generated t/year	Share
FOOD WASTE (UNSPECIFIED)	161	3,655	3,816	83%
ANIMAL WASTE	7		7	0%
BAKERY AND FARINACEOUS PRODUCTS	0		0	0%
BEER	0		0	0%
DISTILLED ALCOHOLIC BEVERAGES	0		0	0%
RAPE OR COLZA SEED	195		390	8%
SOYA BEANS	390		0	0%
STARCHES; INULIN; WHEAT GLUTEN; DEXTRINS AND OTHER MODIFIED STARCHES	0		0	0%
SUGAR	0		0	0%
SUGAR WATER	0		206	4%
VEGETABLES (EXCEPT POTATOES), FRUIT, NUTS AND OTHER EDIBLE PARTS OF PLANTS, PREPARED OR PRESERVED BY VINEGAR OR ACETIC ACID	206		206	4%
TOTAL	960	3,655	4,614	100%

2) Treatment of company waste

The LMA data base does not only reveal which company treats which waste flow, but also which treatment method is used. Table 8 provides and overview.

Table 8: Waste share per treatment method

	Composting, aerobic	Composting, anaerobic	Fermentation	Incineration with energy recovery (cofiring)	Crushing	Separating chemically / physically	Shred / cut	Sort / separate	Storing	Transshipment / bulking	Use other as raw material	Grand Total
Food waste (kg)	6	0	85.281.617	11.794.864	41.580	46.155	33.560	6.169.120	19.660	2.236.533	51.160	108.420.769
% of total	3	0	79	11	≈ 0	≈ 0	≈ 0	6	≈ 0	2	≈ 0	100

Material flow analysis of the food waste chain

As the system diagram of food waste shows, two subsystems can be identified:

1) food waste from household consumption
2) food waste along the value chain from primary production to waste management with consumption outside of households but nevertheless, located in AMA.

The MFA for both household and companies' subsystems will be presented separately as different methods for data collection and modelling were applied.

Representation & Process Models of the Household Related Food Waste Chain

As there is no detailed data available that would allow us to perform an AS-MFA based on data that is spatially more precise than the municipal level; a model to establish the amount of food waste as well as the flows between households per neighbourhood and waste treatment facilities in the region and beyond, had to be developed.

The model combines data from the CBS (CBS Statline, 2017a), which accounts for waste collected as GFT and residual household waste per municipality. CBS has reported waste figures for 2016 as the most recent year, so the model is built on the flows for 2016 as well. For the small number of municipalities that did not have these figures reported yet for 2016, the other most recent year was used as a proxy. The model uses a study by CREM (2017), which investigated the composition of household waste in relation to avoidable and unavoidable food waste in both GFT and residual waste in 13 municipalities across the Netherlands, including municipalities with different degrees of urbanisation. In order to apply eco innovative solutions in a spatially differentiated manner, we chose the neighbourhood as the smallest spatial unit for the activity, food consumption in households.

The model for food waste is expressed in the following formulae:

$$FW = UAFW + AFW$$

Where FW is the total amount of food waste in tonnes per year, which is the sum of avoidable food waste (AFW) and unavoidable food waste (UAFW).

Food waste from households is collected in two different ways (i) as a fraction of GFT and as a fraction of (ii) residual household waste. Therefore, four separate models were developed:

1. Avoidable food waste from GFT (AFW_{gft})
2. Unavoidable food waste from GFT ($UAFW_{gft}$)
3. Avoidable food waste from residual waste (AFW_{res})
4. Unavoidable food waste from residual waste ($UAFW_{res}$)

The respective waste fraction is calculated with the following formula:

$(U)AFW_{(wt,n)} = (PP_{(wt,m)}{}^* \, Inh_{n,m)})^* F_{(urb,wt)}$

Where $(U)AFW_{(wt,n)}$ stands for the amount of (un)avoidable food waste from waste type (wt) gft or residual in neighbourhood (n) in tonnes per year.

$PP_{(wt,m)}$is the collected waste type (GFT or residual) in t per person in municipality *m*;

$Inh_{(n,m)}$ is the nr of inhabitants in neighbourhood *n* in the municipality *m*.

$F_{(urb)}$ is a factor representing the mean percentage of food waste per urbanisation level *urb.* F has a different value also for the type of food waste as well as collection method, which are shown in Table 9.

Table 9: Percentage of food waste within collected GFT and residual waste per level of urbanisation.

Urbanisation	addresses / km²	F(ua,res)	F(a,res)	F(ua,gft)	F(a,gft)
1	≥ 2 500	14.83	13.00	13.07	5.90
2	1 500–2 500	8.55	15.70	6.55	4.25
3	1 000–1500	9.40	10.70	5.70	2.60
4	500–1 000	9.90	11.83	13.60	6.40
5	< 500	4.90	11.30	17.55	7.65

CBS provides a neighbourhood statistics and maps that indicates for every neighbourhood (wijk), a level of urbanisation (see Figure 19).

In total, there are 339 Neighbourhoods in the AMA. Applying the above formulae allows us to model the amounts of avoidable and unavoidable food waste per neighbourhood as well as per capita in the different neighbourhoods. The following eight maps present the results for the AMA, showing the total amount of a specific waste type per neighbourhood in t per year as well as in kg per person per year.

Food waste from waste collected as residual mixed municipal household waste

The 2.4 million inhabitants in the AMA produce 558,421 tonnes residual household waste per year. Of this waste collected as residual waste 66,234 tonnes can be assumed to be unavoidable food waste and 75,481 tonnes avoidable food waste using the model described above. How the production of this waste is distributed across the neighbourhoods is demonstrated with the following maps.

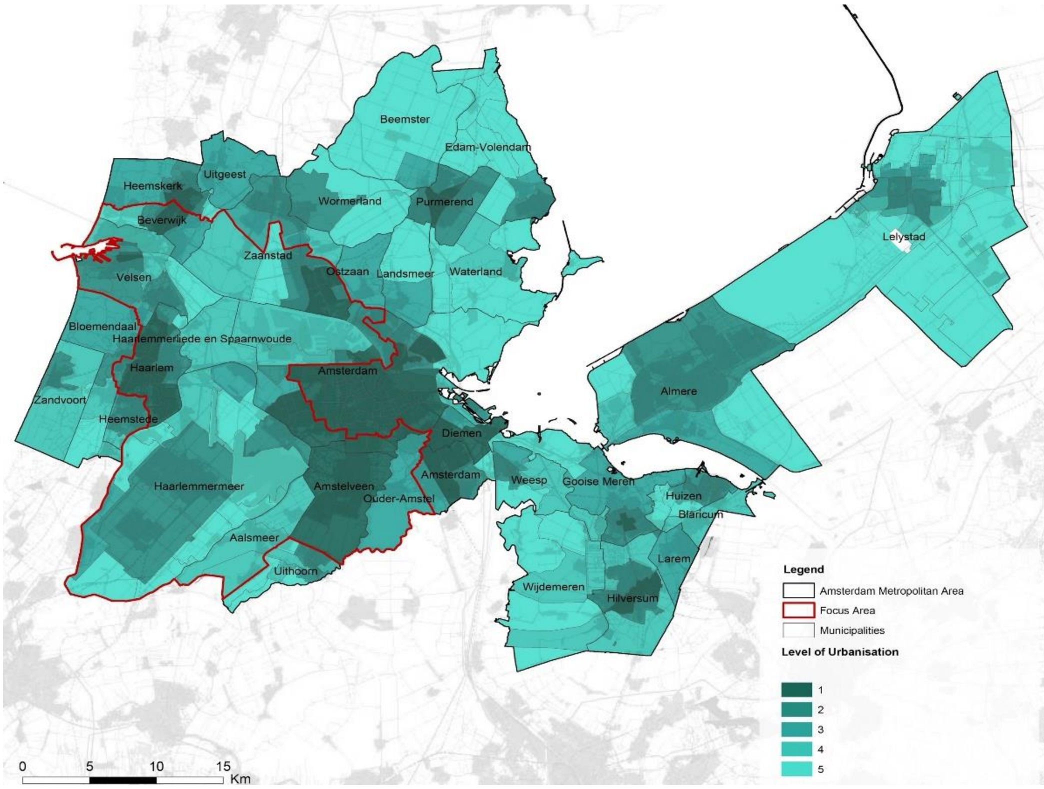

Figure 19: level of urbanisation of neighbourhoods in the Amsterdam Metropolitan Area (Data source: CBS 2016).

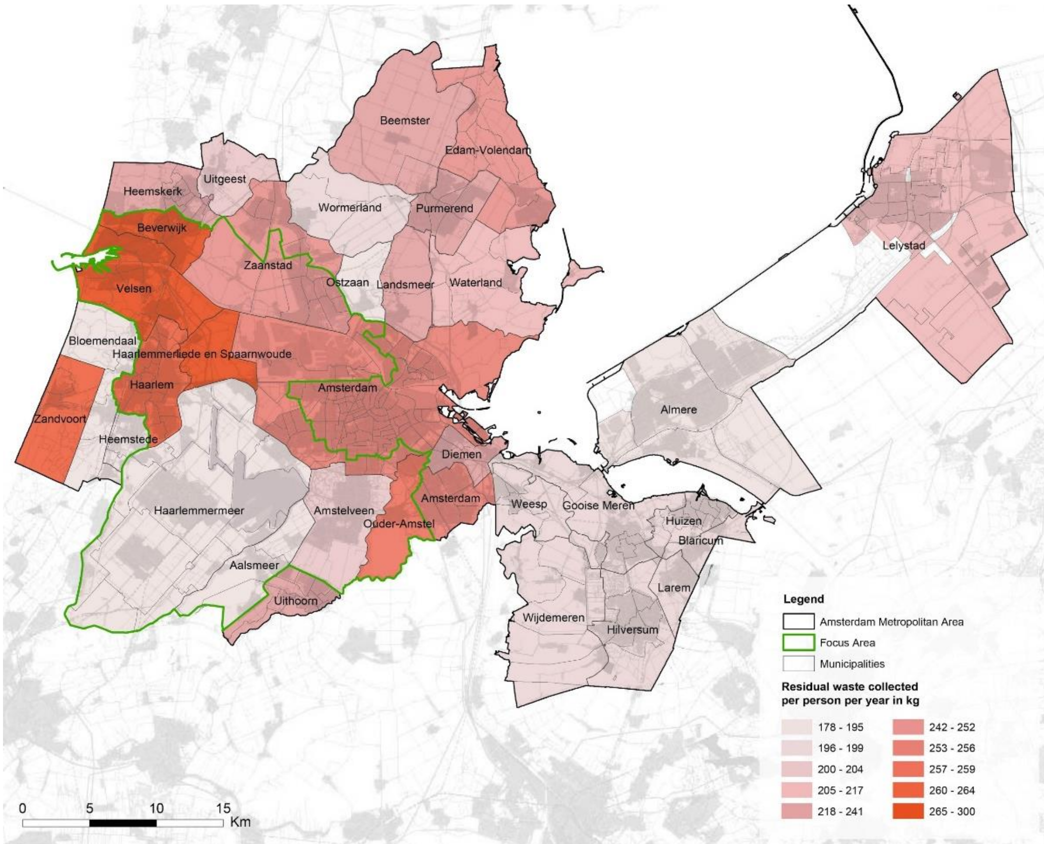

Figure 20: Residual household waste collected per person per year in kg for each neighbourhood in the AMA in quantiles.

Figure 20 shows that the highest amount residual waste with more than 265 kg, per person per year is collected in the west of the AMA, including the municipalities Beverwijk, Velsen, Haarlemmerliede, and Spaarnwoude, which are all peri-urban municipalities. Depending on the municipality, the household waste can also contain waste from small companies that applied for the '*reinigingsrecht*', and therefore have their waste collected with the household waste when their waste production is under a certain limit (as is mentioned in the data collection process).

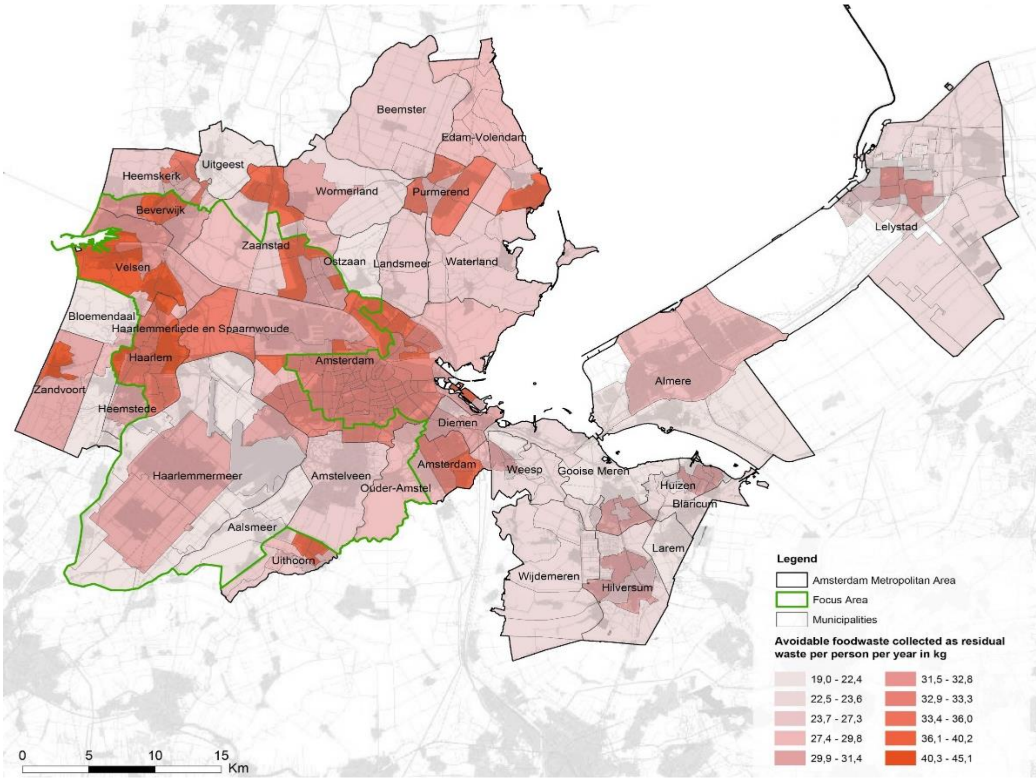

Figure 21: Avoidable food waste collected as residual waste per person per year in kg for each neighbourhood in the AMA in quantiles.

Figure 21 shows that the 10% of neighbourhoods with the highest avoidable food waste from residual waste - higher than 40.3 kg per person per year - are located in the west and northwest of AMA within in the focus area of REPAiR.

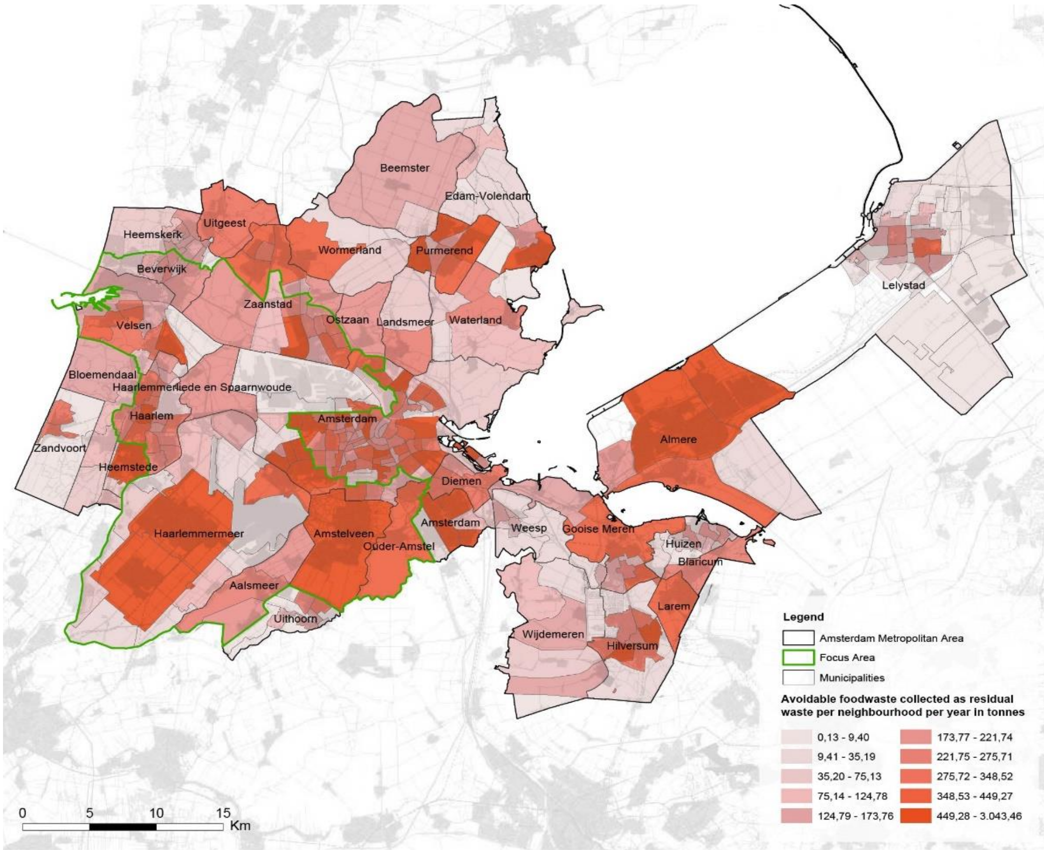

Figure22: Avoidable food waste collected as residual waste per neighbourhood per year in tonnes in the AMA in quantiles.

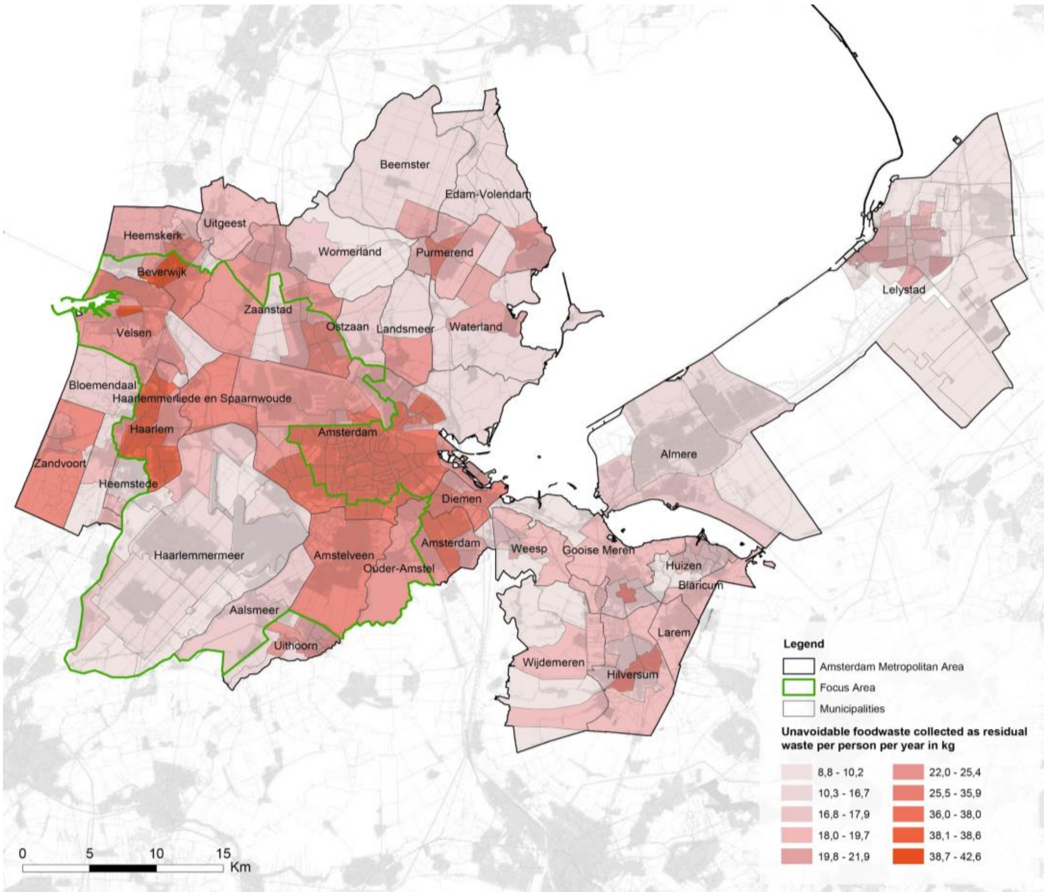

Figure 22: Unavoidable food waste collected as residual waste per person per year in kg for each neighbourhood in the AMA in quantiles.

Figure 22 shows that the highest values of unavoidable food waste are in rather urban areas specifically in Haarlem and Beverwijk and, of course, in Amsterdam.

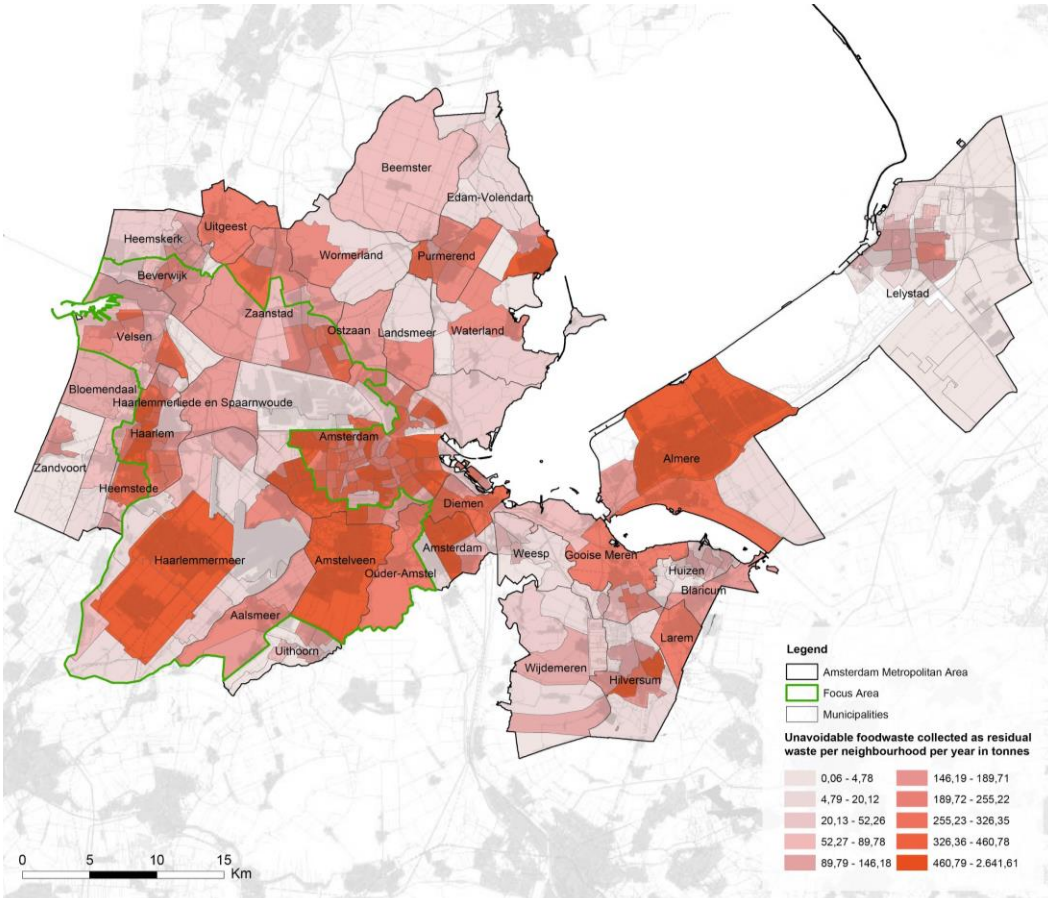

Figure 23: Unavoidable food waste collected as residual waste per neighbourhood per year in tonnes in the AMA in quantiles.

The neighbourhoods with the most of unavoidable food waste from residual waste are the large neighbourhoods with a high population density in Haarlemmermeer, Haarlem and Amstelveen.

Food waste from waste collected as GFT

The 2.4 million inhabitants in the AMA produce 107,437 tonnes of GFT household waste per year. Of this waste collected as GFT waste and using the model described above, 9,854 tonnes can be assumed to be unavoidable food waste and 5,144 tonnes, avoidable food waste. How the production of this waste is distributed across the neighbourhoods is demonstrated with the following maps. It is important to note that in the city of Amsterdam, GFT waste is hardly collected.

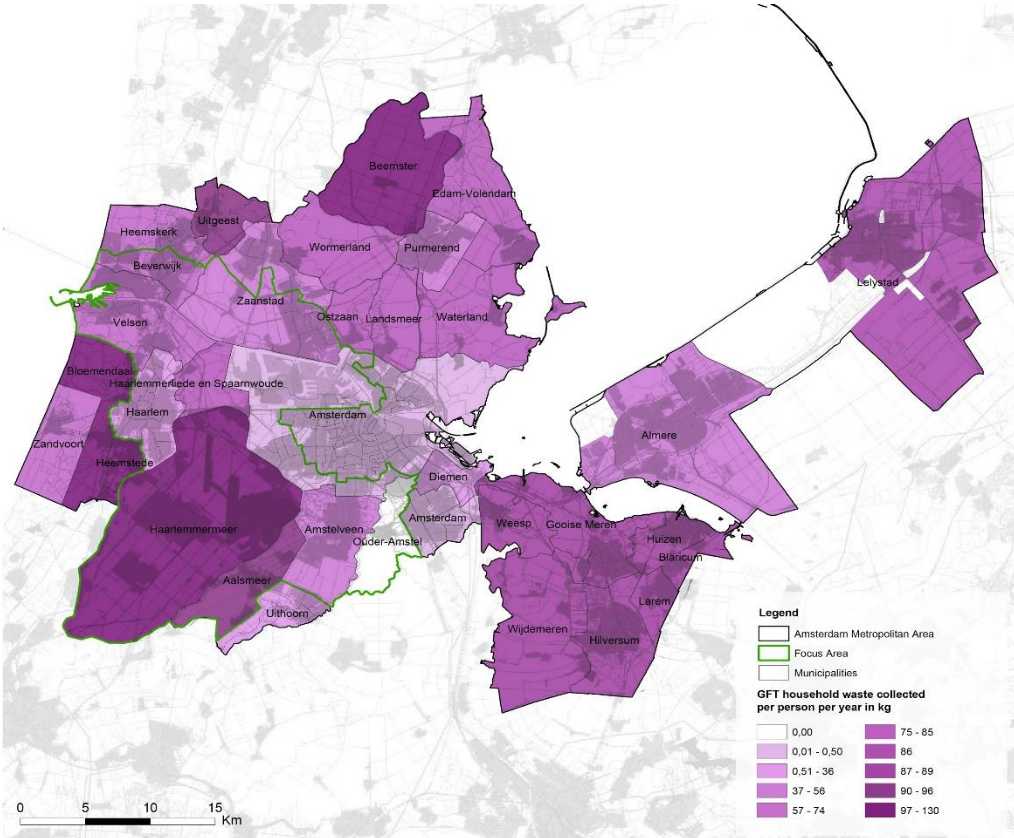

Figure 24: GFT household waste collected per person per year in kg for each neighbourhood in the AMA in quantiles.

The highest amount of GFT waste per person per year is collected in Haarlemmermeer and Amstelveen when looking at the focus area, as well as the directly adjacent, but situated outside of the focus area, municipalities of Heemstede and Bloemendaal.

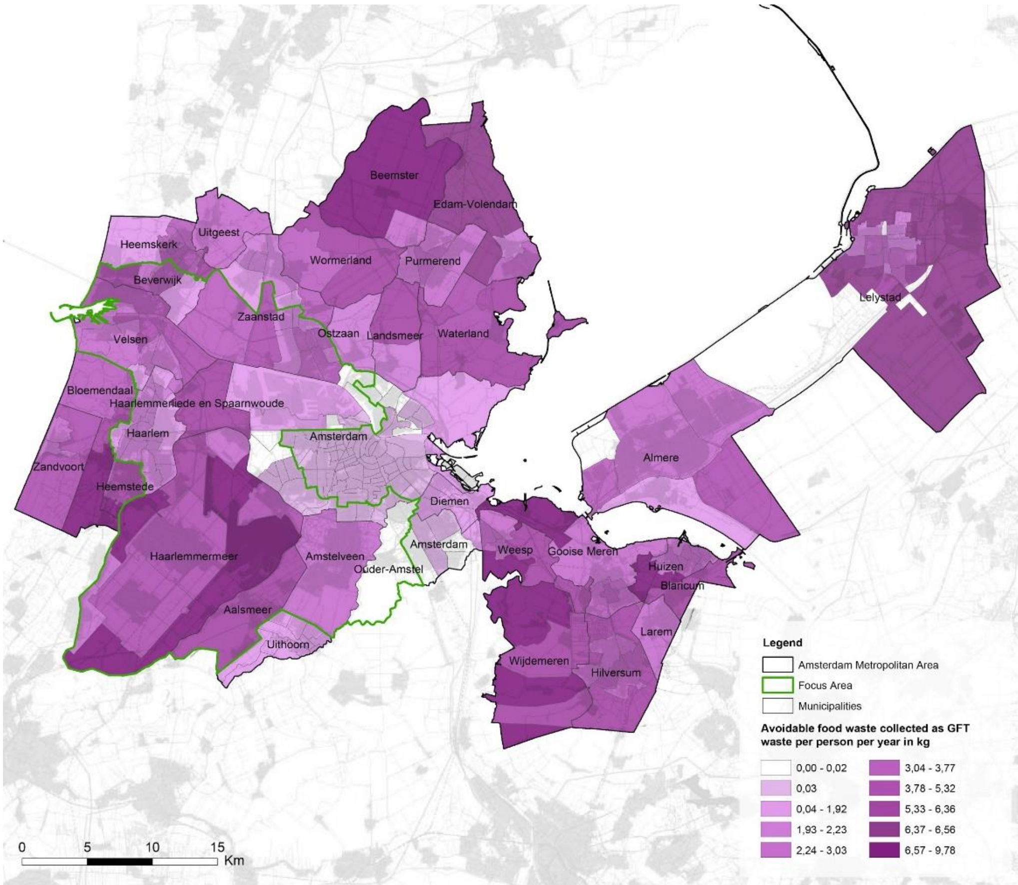

Figure 25: Avoidable food waste collected as GFT waste per person, per year in kg for each neighbourhood in the AMA in quantiles.

The most amount of GFT per person, per year is collected in the neighbourhoods around Schiphol with rather low population densities, i.e. Heemstede, Weesp and Beemster.

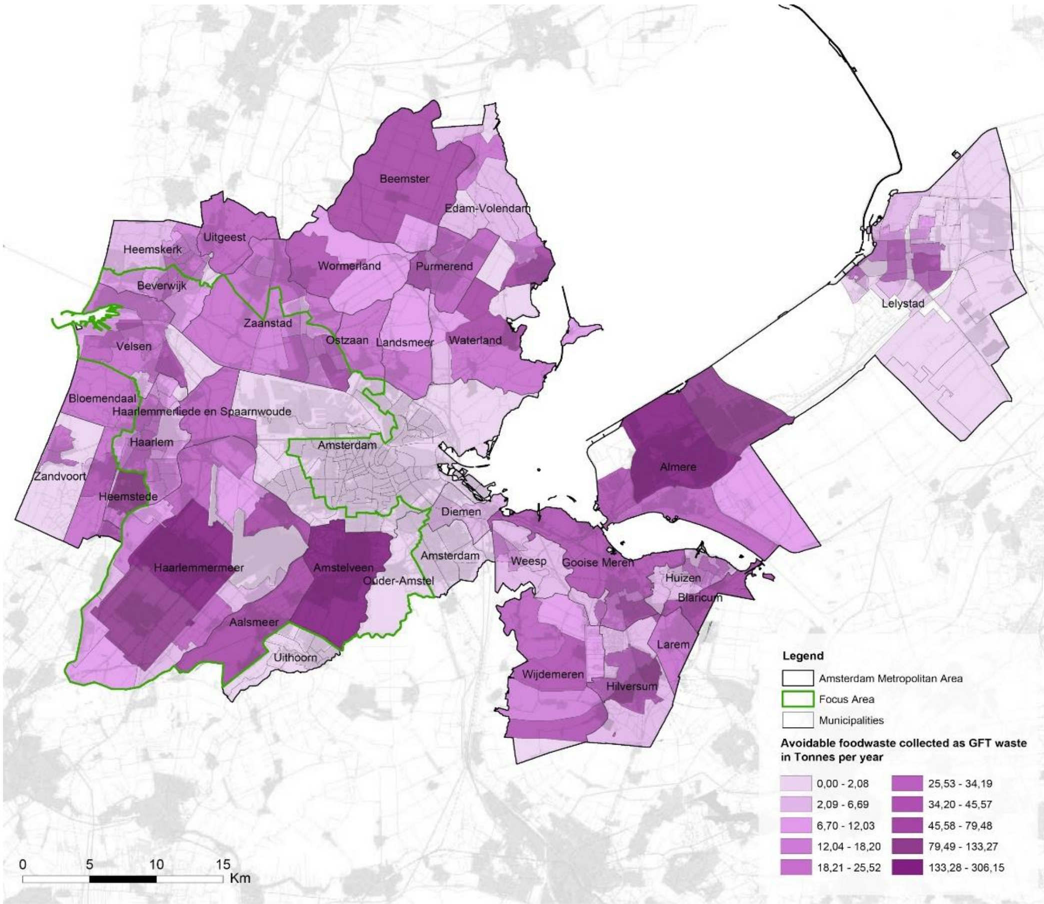

Figure 26: Avoidable food waste collected as GFT waste in tonnes per year for each neighbourhood in the AMA in quantiles.

The neighbourhoods with the highest amount of avoidable food waste in tonnes per year, within the focus area are situate in the municipalities of Haarlemmermeer and Amstelveen

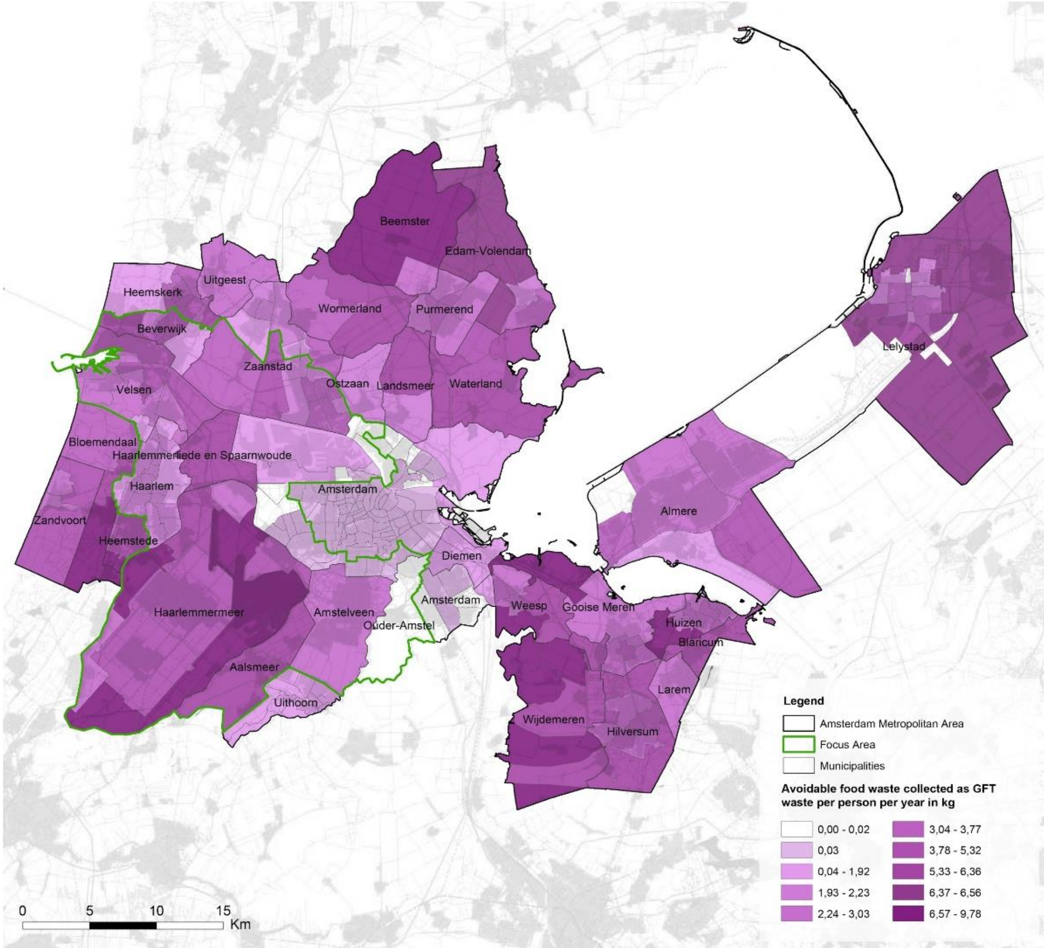

Figure 27: Avoidable food waste collected in as GFT waste per person, per year in kg for each neighbourhood in the AMA in quantiles.

Within the focus area, the neighbourhoods around Schiphol and Heemstede have the highest amount of avoidable food waste per person, per kg. Outside of the focus area, the highest amounts are produced in Beemster and around Weesp.

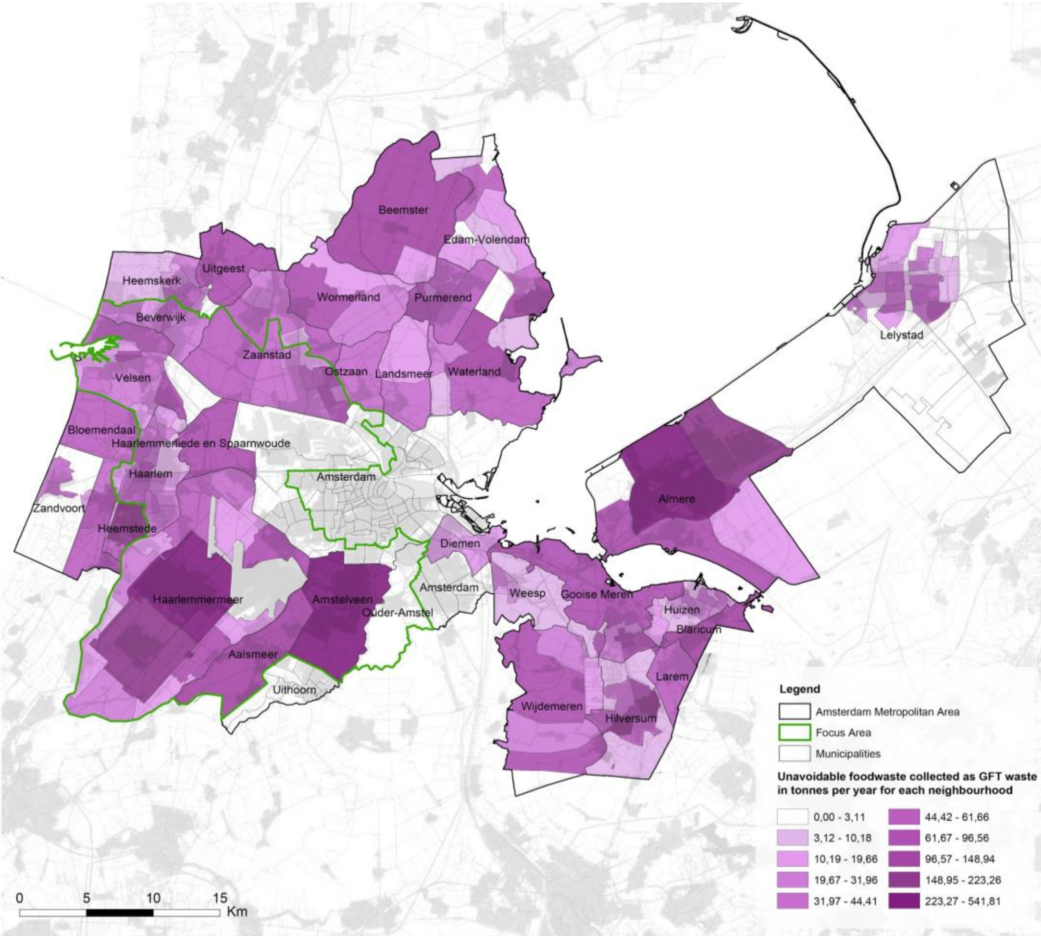

Figure 28: Unavoidable food waste collected as GFT waste in tonnes, per year for each neighbourhood in the AMA in quantiles

The neighbourhood with the highest amounts of unavoidable food waste in tonnes per year are within the focus area and are situated in the municipalities of Haarlemmermeer and Amstelveen, outside of the focus area they are concentrated in Almere.

Food waste related waste treatment in the AMA

The residual household waste produced in the AMA is treated in three plants, one company (AEB) is located in the port of Amsterdam, one outside of the AMA in Alkmaar and the third is just across the German border in Laar. GFT waste is treated in five different plants, three of them within the AMA, HVC compostering in Purmerend, De Meerlanden compostering B.V. and Orgaworld Compostering in Lelystad. The two other plants are outside of the AMA namely, HVC compostering in Middenmeer north of the AMA and Indaver Compost in Alphen aan den Rijn, south of the AMA. Figure 29 shows the location of the plants in relation to the AMA and focus area.

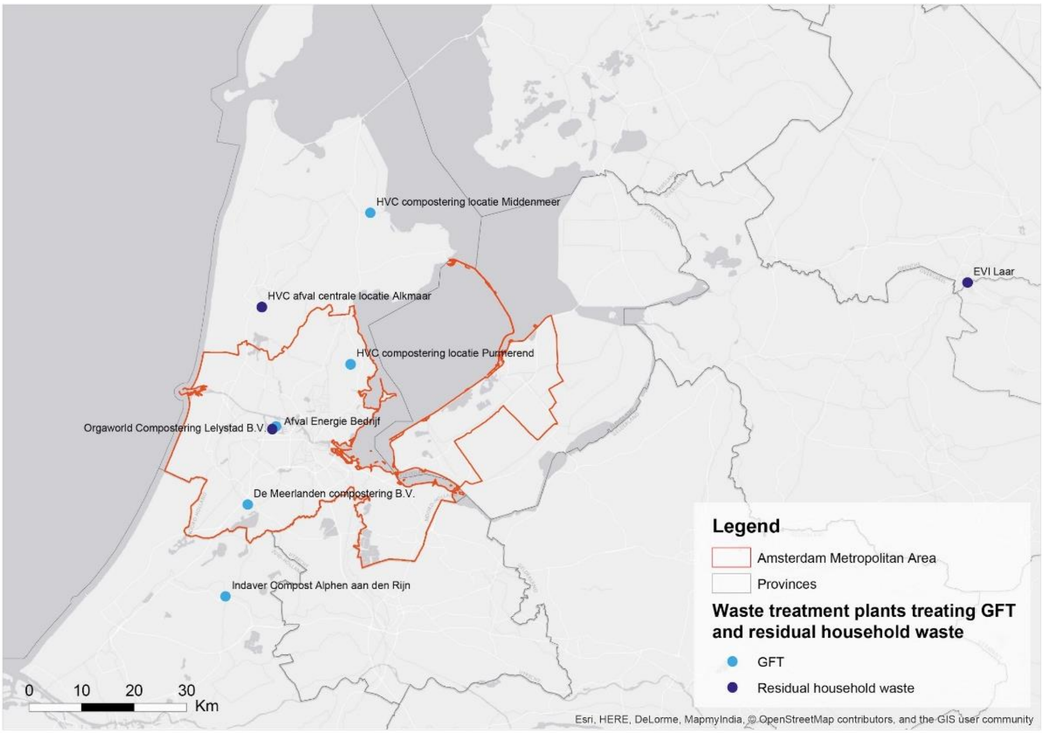

Figure 29. The locations of the waste treatment plants treating GFT and residual household waste from the AMA.

Table 10: Waste treatment companies for residual household waste

Name of the Company	Location
Afval Energie Bedrijf (AEB)	in the AMA
EVI Laar	Germany
HVCafvalcentrale locatie Alkmaar	in the Netherlands

Table 11: Waste treatment companies for GFT waste

Name of the Company	Location
De Meerlanden compostering B.V.	in the AMA
HVCcompostering locatie Middenmeer	in the Netherlands
HVCcompostering locatie Purmerend	in the AMA
Indaver Compost Alphen aan den Rijn	in the Netherlands
Orgaworld Compostering Lelystad B.V.	in the AMA

The combined information about the food waste generation and treatment is summarised in the Tables below.

Table 12: food waste from GFT and related production of biogas and compost in the case of Amsterdam. More detailed data is stored in the GDSE.

Input		Output	
Food waste from GFT in t/year		share sent to anaerobic digestion	Share sent to composting
13,976			
avoidable	unavoidable	18%	82%
5,523	8,453		

Table 13: food waste from residual household waste and related production of biogas and compost in the case of Amsterdam. More detailed data is stored in the GDSE.

Input		Output	
Food waste from RES in t/year		Electricity on GWh/ year	Heat in TJth/year
139,343			
avoidable	unavoidable	0.247	0.144
70,803	68,543		

The output of valuable products produced by FW from the WT plants (i.e. biogas, compost, electricity and heat) is determined by calculating the share of the entire input for the WT plants that is FW. This total input, and types of waste processed by all the WT plants in the Netherlands, is reported in the RWS annual report. The script for the calculation and the processed files can be found in this folder. For the composters/digesters, it involved a simple calculation of biogas/compost from FW produced in the AMA= (FW t produced in the AMA) / (OW t processed in WT plant) * biogas-compost output from WT plant.

For the incinerators, the output cannot be calculated as a weight-based ratio as for compost/biogas, since the Lower Heating Value (LHV) of FW dictates the share of electricity and/or heat in the incinerator. Each type of waste input has been coupled to a LHV [MJ/kg], found in this document.

Heat/electricity from incinerating FW for plant X= $(input_waste_{FW}\ [kg] * LHV_{FW}\ [MJ/kg]) / \sum(input_waste_n\ [kg] * LHV_n\ [MJ/kg])) / $ total heat-electricity produced in plant X

Two different forms of representation of the relation between waste production and treatment and are illustrated in the following paragraphs, wastesheds and a spatial Sankey diagram, in order to provide stakeholders in the PULL meetings with a spatially differentiated understanding of the data and thereby a spatial sensitivity for the development of eco innovative solutions.

The wastesheds of the AMA

The information about which waste treatment plant treats which kind of waste for which municipality defines the food wastesheds for the AMA. The following maps present the GFT and the residual waste based food wastesheds.

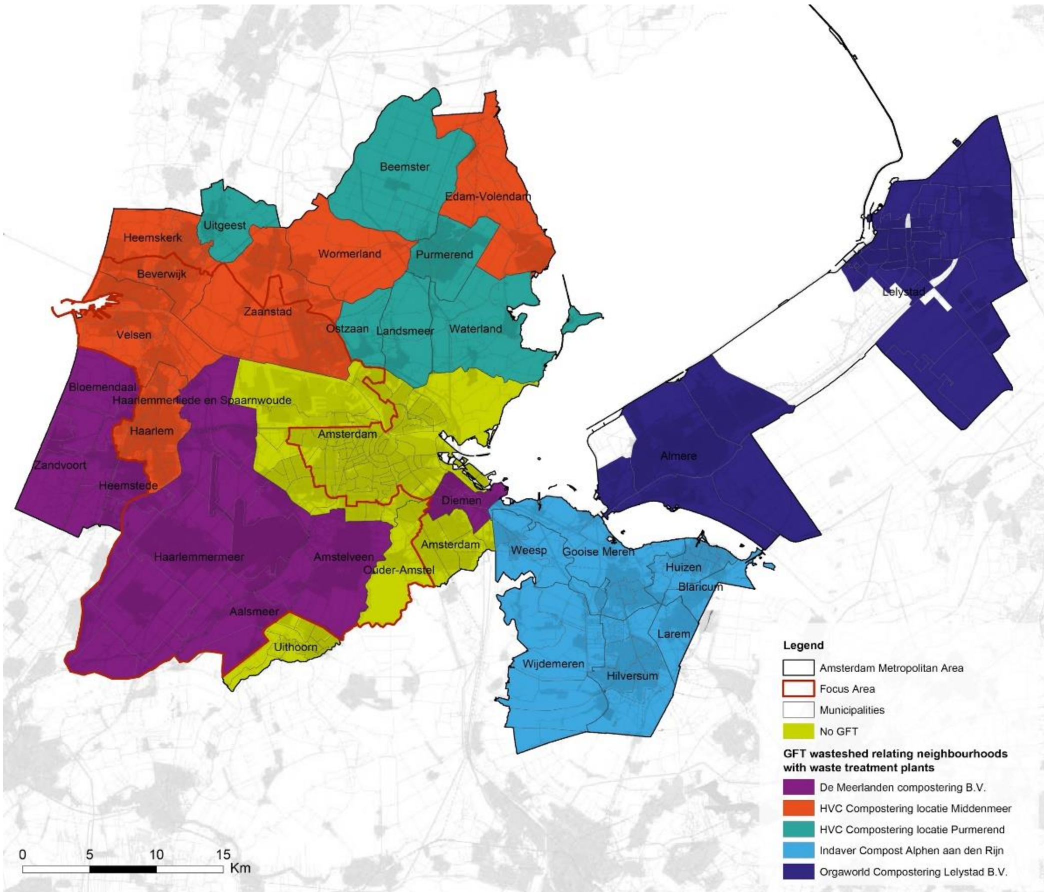

Figure 30: The GFT wasteshed relating neighbourhoods with waste treatment plants.

In the focus area, two GFT food wastesheds have been identified, one for *De Meerlanden compostering B.V.* and one for *HVC compostering locatie Middenmeer*. Note that the amount of GFT collected in Amsterdam is so minimal that it was omitted.

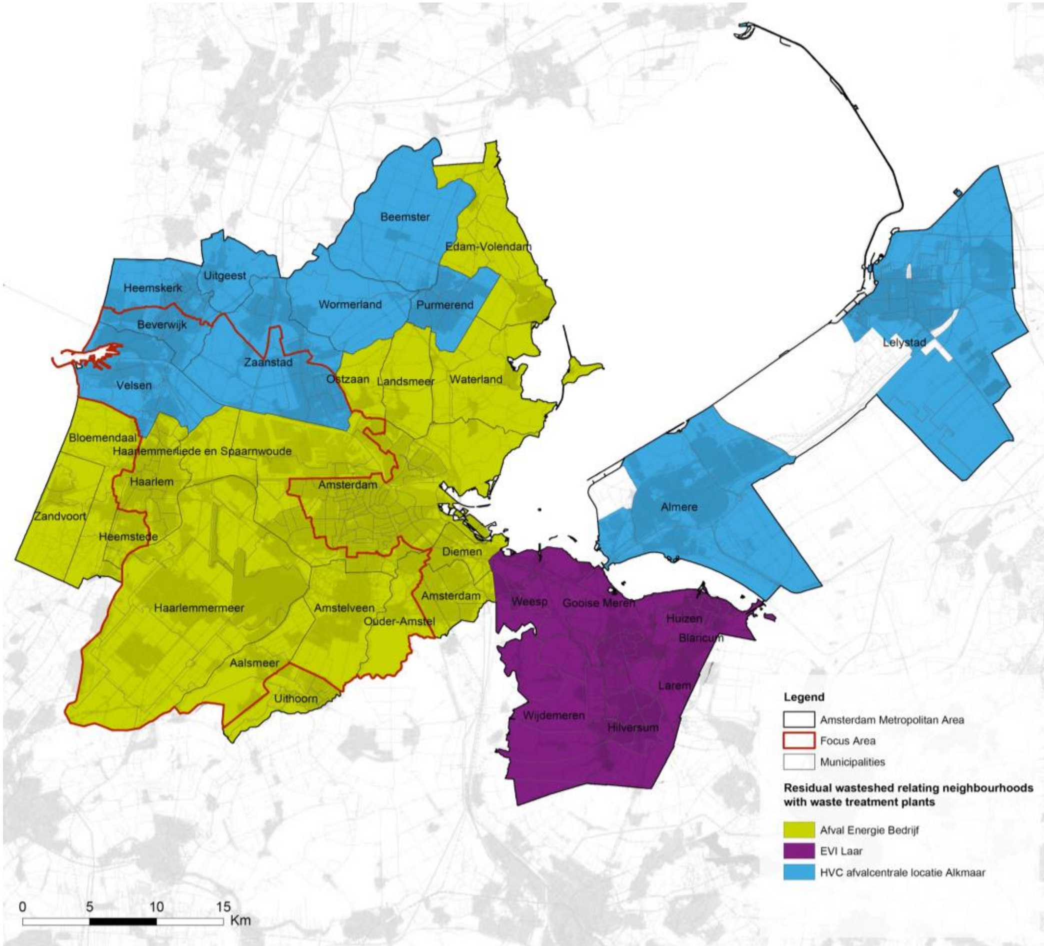

Figure 31: The wasteshed relating neighbourhoods with waste treatment plants for the food waste collected as residual solid household waste.

For food waste from waste collected as residual household waste, two wastesheds have also been identified, one for AEB and one for HVC waste plant in Alkmaar.

Sankey diagram and flow map

Knowledge of the geolocation of food waste generation (neighbourhoods) as well as geolocation of the treatment plants, allows us to build an origin destination network over the AMA's street network. This builds the geometric backbone for the activity based spatial MFA and the spatial Sankey diagrams used in the GDSE.

As an example, the spatial Sankey diagram for GFT waste generated in the neighbourhoods of the focus area and treated in the waste facility Meerlanden HVC is presented below.

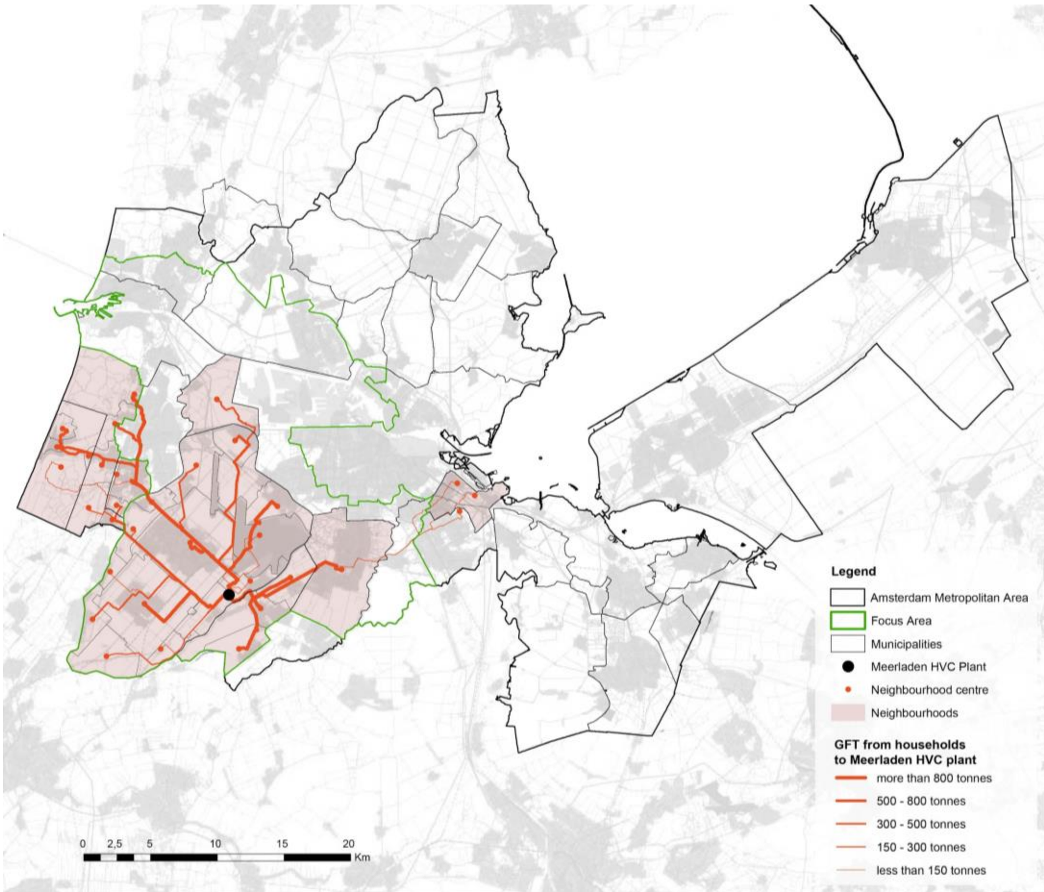

Figure 32: The material flows collected as GFT waste in the wasteshed of De Meerlanden composting facility in kg per year, per neighbourhood and its locations in the AMA.

Around 11,800 tonnes of food waste are generated in the households within the wasteshed of De Meerlanden which is collected and treated as GFT in the Meerlanden digestion facility. This process results in an output of about 186,000 cubic meters of biogas and 880 tonnes of compost per year.

Food waste generated by households at the product level

The data modelling allows us to go one step further as the single flow can be split into fractions according to specific products, again building on the study by CREM (2017). The food waste components identified by CREM (2017) can be related to the CPA classification. Table 14 shows the food waste in tonnes per year according to the CPA category in relation to food waste in GFT and residual waste. This information is valuable for the identification of specific eco-innovative solutions and the following LCA.

Table 14: Food waste in tonnes per year according to CPA category in relation to food waste in GFT and residual waste

Household											
		Separately Collected Food Waste in t/year			Food Waste in Residual in t/year			Food Waste as in t/year			
Macrocategory	**Approximated with**	**Total**	**Avoidable**	**Unavoidable**	**Total**	**Avoidable**	**Unavoidable**	**Total**	**Avoidable**	**Unavoidable**	
Preserved meat and meat products	*Average meat*	226	226		7,028	7,028		7,254	7,254		**5%**
Processed and preserved fish, crustaceans and molluscs	Average Fish, FI	57	57		724	724		781	781		**1%**
Dairy and cheese products	Average Cheese, CH	46	46		860	860		906	906		**1%**
Fresh bread	Average Bread, BA	858	858		15,560	15,560		16,418	16,418		**11%**
Eggs in shell, fresh	Average Egg, FDP	231	57	174	8,184	6,267	1,917	8,415	6,324	2,091	**5%**
Potatoes	Average Potato,	710	710		4,691	4,691		5,402	5,402		**4%**
Vegetables and melons, roots and tubers	*Average Vegetables*	4,226	1,206	3,021	19,235	1,556	17,680	23,462	2,762	20,700	**15%**
Perennial crops	*Average Fruit*	4,259	1,427	2,832	26,057	8,369	17,689	30,316	9,796	20,520	**20%**
Cheese and curd	Average Cheese,	122	57	65	2,666	2,137	529	2,788	2,194	594	**2%**
Rice, semi- or wholly milled or husked or broken	Average Rice, DSA	226	226		4,990	4,990		5,216	5,216		**3%**
Macaroni, noodles, couscous and similar farinoceous products	Average Pasta, DSA	215	215		5,235	5,235		5,450	5,450		**4%**
Rusks and biscuits: preserved pastry goods and cakes	Average Pastry and cakes, PA	46	46		3,496	3,496		3,542	3,542		**2%**
Other food products	*Mixed (redistributed)*	2,096	320	1,775	11,216	3,614	7,603	13,312	3,934	9,378	**9%**
Chocolate and sugar confectionery	Average Cake, DSW	36	36		2,219	2,219		2,255	2,255		**1%**
Processed coffee	Spent Coffee	432		432	21,276		21,276	21,708			**14%**
Processed tea	Processed tea	154		154	1,849		1,849	2,003		2,003	**1%**
Condiments and seasonings	Vegetable food waste	36	36		3,197	3,197		3,233	3,233		**2%**
Soups and broths and preparation thereof	Vegetable food waste	-			860	860		860	860		**1%**
Total		**#####**	**5,523**	**8,453**	**######**	**70,803**	**68,543**	**######**	**76,326**	**76,996**	**####**
Share		**100%**	**40%**	**60%**	**100%**	**51%**	**49%**	**100%**	**50%**	**50%**	
Animal waste		**682**	**443**	**239**	**19,462**	**17,016**	**2,446**	**20,144**	**17,459**	**2,685**	**13%**
Vegetable waste		**#####**	**5,080**	**8,214**	**######**	**53,787**	**66,097**	**######**	**58,867**	**74,311**	**87%**

As table 14 shows, the biggest share of material within food waste, independent from way of collecting are bread, fruit, vegetables and coffee grounds, with bread having the largest share in the avoidable waste category.

Aggregation of data for Household and companies food waste

Table 15 present the aggregated waste generation in the Amsterdam Metropolitan Area across all sector combining waste generated in household and companies. It shows that households and the included companies have a nearly half share in the waste generation.

Table 15: overview of food waste generated by sectors.

SECTOR	T FW/YEAR	SHARE
HOUSEHOLD	153,319	55%
MANUFACTURING	50,480	18%
WHOLESALE & RETAIL SECTOR	9,194	3%
FOOD SERVICE SECTOR	59,598	21%
OTHER	4,614	2%
TOTAL	**277,205**	**100%**

3.3.1.6 Step 6: Visualise waste flow data

The GDSE, developed within WP 2 allow to visualise the waste flows in two forms a Sankey diagram and flow map. The following figures present and are directly exported from the GDSE. The GDSE allows to specify a selection of flows, according to materials, economic actors and locations. The following maps are some examples, generated during the REPAiR peri-urban living labs. Here, the stakeholders made specific maps according to the information they needed to develop eco-innovative solutions.

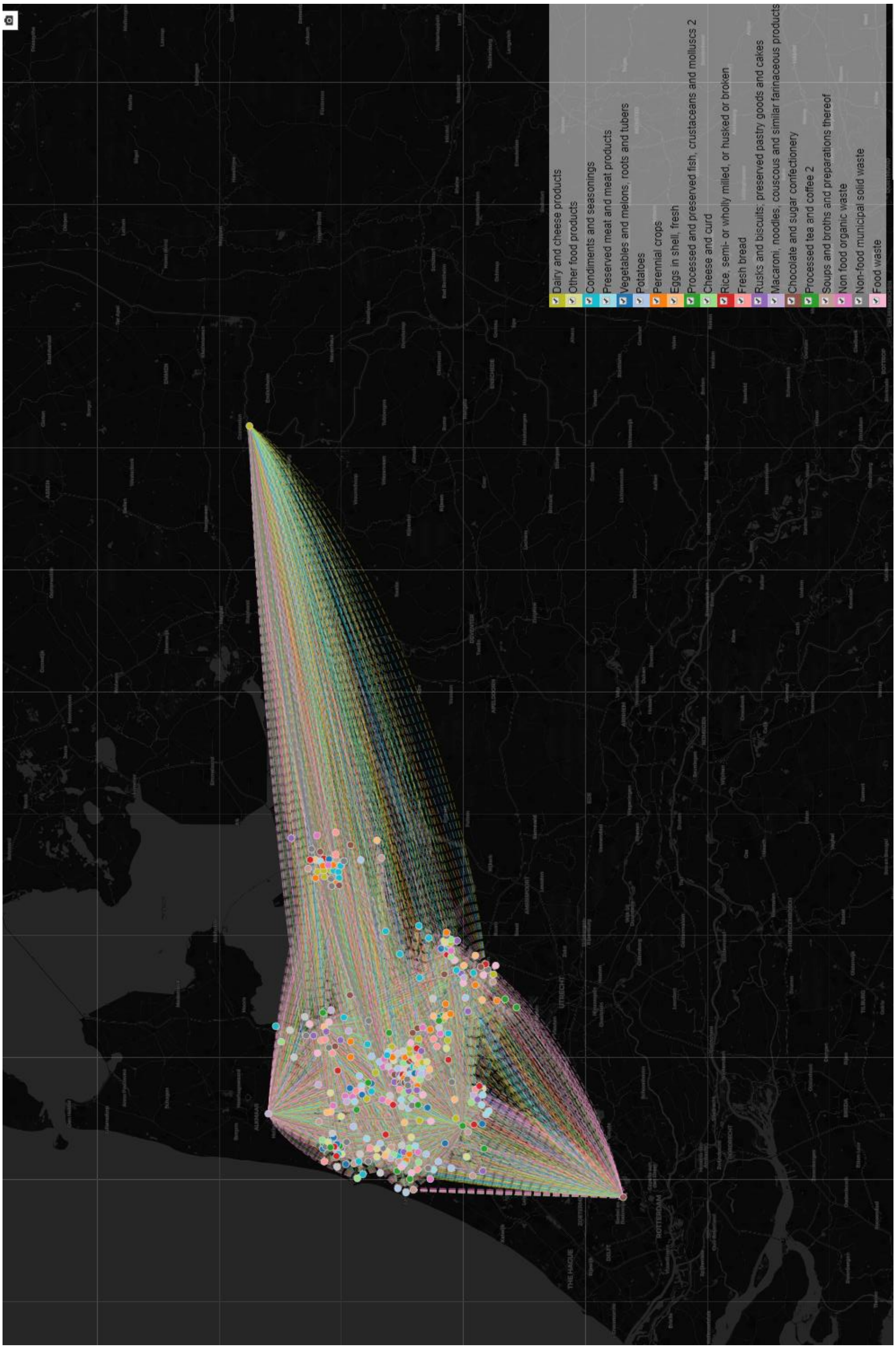

Figure 33: Flow map of food waste generated in households including the material composition of the food waste. The map shows how household generate food waste is treated all over the Netherlands as well as in Germany.

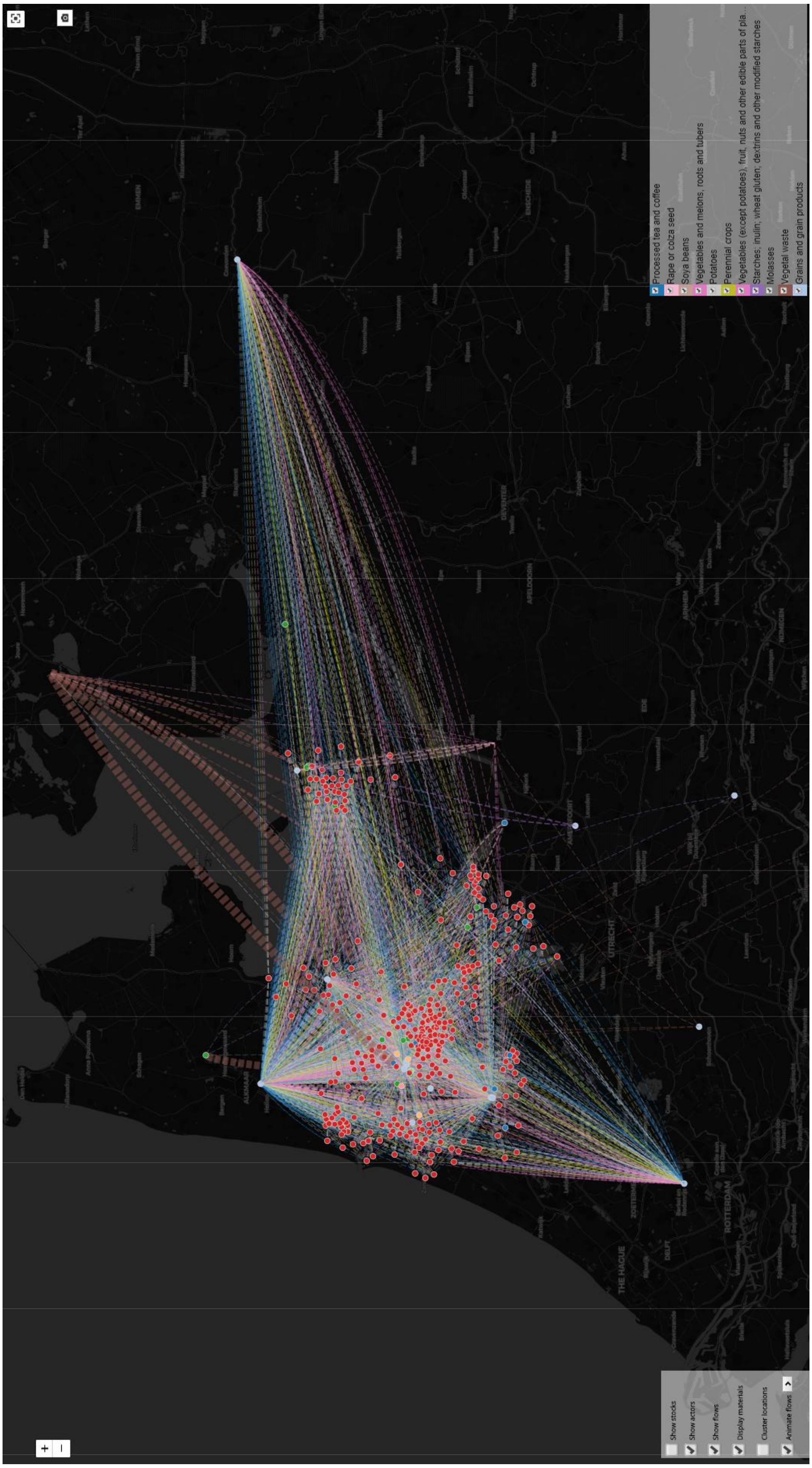

Figure 34: Flow map of the vegetable waste flows generated in households and companies. The map shows the increasing spatial complexity of relation between waste generation collection and treatment.

[INSERT FIGURE 35]

Figure 35: Flow map showing the company generated food waste and material composition.

3.4 Enabling contexts within the AMA

The construction of a series of cartographies at the AMA regional and focus area scale, enables us to unfold and visualise the complexity of spatial, social and material flow analyses.

Firstly, the physical territorial analysis figures show how urbanisation essentially consumes land: land occupied by buildings and infrastructures to begin with, but also an ecological hinterland feeding it natural resources such as food, drinking water, building materials, energy infrastructures as well as receiving its wastes. The Wastescape map is an attempt to summarize in one abstract cartography, the land consumed in the AMA by past and present processes'.

The material flow analysis highlights that the amount of food waste collected as residual household waste is significant, and that there is a large potential for more efficient and sustainable collection and treatment. Harvesting the material value of food waste can thus be done more optimally than is the case in the existing situation. The spatial analyses reveal that, next to the well-known fact that this potential is high in Amsterdam (limited GFT collection), the per capita amount of food waste is also high in the area from Velsen to Haarlem, in parts of Oostzaan, Zaanstad and Beverwijk.

The spatial analysis of the company related food waste production reveals that a small amount of companies produces more than half of the food waste. Most of those companies are concentrated north of Amsterdam, in Zaanstad. The activity group P2 (Processing and Manufacturing), which is responsible for more than 90% of the food waste, is concentrated in four locations, 1) the harbour of Amsterdam and Zaanstad to the north, 2) around Ijmuiden in the western AMA, 3) in and around Haarlem and 4) in Amstelveen.

A quantitative knowledge about waste material flows however, has to be linked to specific social and economic dynamics of space in order to understand "how particular things, such as urban forms, lifestyles, and infrastructural landscapes, lead to metabolic differences" (Castan Broto 2012: 854). Therefore, the main trends for social dynamics have been mapped onto the urban region to highlight spatial variation.

The sequence of socio-spatial cartographies visualises a suburbanisation pattern of people living in "stressed" conditions (for example high unemployment rate, low income, low education) in relation to the surrounding regions. According to Hochstenbach & Musterd (2017: 40), "Compared to the total population, the low-income groups are overrepresented among movers to/within the region for the 2004–2013 period, and increasingly so [...]". Moreover, Hochstenbach & Musterd's study shows that patterns of population that are currently living in "stressed" conditions are located in the peri-urban areas of Amsterdam.

The three different analyses show distinctive patterns of interest. As previously mentioned, if the territory is similar to a network of synergistic relationship between landscape, infrastructure and flows, the identification of common patterns reveals enabling contexts, corresponding to a new form of territoriality.

Practically, the process to identify the enabling context consists of the systematic overlapping of different hotspots of interest with the planned urban expansion areas.

The overlap used the following characteristics:

-The area with the highest concentration of wasteland

-The area with the highest index of social stress (with the highest levels of low income population, unemployment, low education, non-active working population)

-The area with the highest concentration of unavoidable and avoidable food waste collected as residual waste, per person, per year

- Location of the companies in which 80,500 out of 87,500 of total tonnes of food waste are produced

-The urban expansion and transformation areas ('woningbouwplannen')

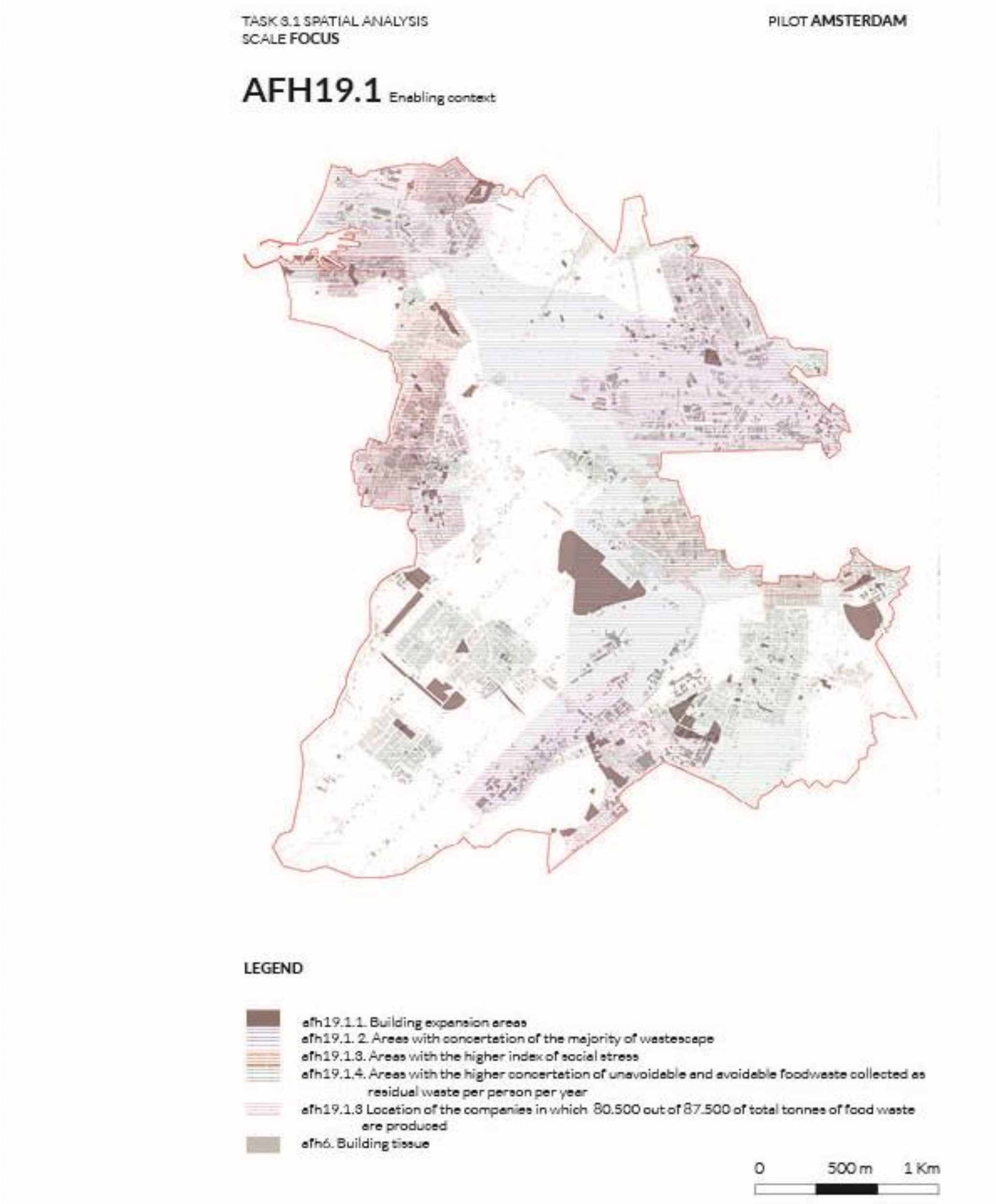

Figure 36: Preliminary enabling context map Amsterdam Metropolitan Area

The resulting enabling context is presented in the figure above. It is important to consider that these contexts are sensitive to different actors and interests in the territory and can therefore, only be understood as a guiding map to develop place specific eco-innovative solutions.

3.5 Results – Pilot case No.2 – Italy, Naples

3.5.1 Spatial and socio-economic analysis - Italy

3.5.1.1 Geographical situation and the natural environment

The country of the Apennine peninsula in Italy has 301,000 square kilometres. From the viewpoint of regional geography, it can be distinguished into two parts; Northern-Italy, which has a high value in industry and agriculture and Southern-Italy, which is less so but is slowly catching up with the north part.

3.5.1.2. Demography

Italy is composed of 20 regions that are currently experiencing population increase, except for the region of Molise. The current population of Italy is over 60 million according to latest Eurostat statistics (2016), stating Italy as the 6th most populated European country. Approximately 69% of this population is urban dweller, which means this proportion raised 10% since 1960. The female population-as usual in Europe-has a slight majority (51.7%) of the total. The country experienced massive and steady growth in the 20th century as its population doubled between 1901 and 2017. Although the natural increase declined in the past decade as a result of the numbers of annual deaths exceeding the annual live births. In the year 2016, the natural decrease was -141,823 people (Eurostat). The demographic growth is largely due to external immigration, ever since 1970's, making the population density unevenly distributed in the country.

In 2015, 280,078 immigrants entered the country from which 9.3% was native, 20% came from another EU-member country, while the significant 70% came from a non-EU-member land. The population of Italian coastal cities, land consumption and urbanization rates have increased consistently from the 1950s to the 1990s and at a much higher pace than in other areas of the country (Romano & Zullo, 2014; ISPRA, 2015a). As of 1st January 2013, Italy had a total of 8092 municipalities, however, over a quarter of the Italian population (over 16 million people) lived in 644 coastal municipalities with a population density (388 capita/km2) twice as high when compared to inland municipalities (166 capita/km2) (ISTAT 2013a).

Italy is the most rapidly ageing society within Europe, with a 1.43 birth/women fertility rate (well below the OECD average) and life expectancy of 82.2 years that is among the highest in the OECD. Concerning the specifics of age groups in Italy, the population of ages 0-14 constitutes 13.69% of total, those between the ages 15-64-meaning the active work class-has a share of 64.93%of the whole population. Regarding the share of persons aged 65 or older in the total population, Italy has the highest share in Europe (21.37%). The median age of the society is 45.5 year while the life expectancy is 82.2 years, one of the highest within Europe, after Switzerland and Spain.

There is a high elderly dependency ratio, which is 35.1%, while the population growth rate is 0.23%. The steady increase of the elderly, especially in Italy where the cultural habits include generations living together, puts the younger shrinking working class under greater pressure. This proportion of ageing is an alarming indicator that implies economic consequences. According to ISTAT population forecast over the coming decades the Italian economy will experience an ageing process that will lead to a significant decline in the growth rate of the labour force and consequently lower productivity rate. Apart from labour force pronounced ageing society also has a direct impact on the consumption structure. Increase in the share of old people produces a shift in consumption towards a more energy intensive mix of goods and services (Garau et al. 2013). There are also environmental implications to account for, as there is evidence that older people use more energy than younger people (Brounen et al., 2012; Faiella, 2011; Oneill & Belinda, 2002).

3.5.1.3. Labour force

In today's society, future growth and social welfare depend on knowledge-intensive industries and services (Dumciuviene, 2015), therefore low qualification contributes directly to poverty and it inhibits the development and competitiveness of a country.

'Early leavers from education and training' refers to young people between the ages 18-24 who only achieved lower secondary education or less (equivalent with ISCED 0-2 levels) and are no longer in education or training. In Italy, the compulsory age for leaving school, is 16 years old. This is synchronized with the age one can legally pursue a fulltime job. However, leaving school early still has high individual, social and economic impacts. Young people only having lower secondary education or less are more likely to be unemployed. The economic costs include lower productivity, lower tax revenues and high social costs. The target set by the European Union is that by 2020 this rate should be below 10 %. In Italy, the current rate in this matter is 13.8% (in which male has a considerably larger share with 16.1%, compared to female school leavers with 11.3%), although it has effectively decreased from 19.5% since 2007. Young people with migrant background in Italy are over-represented within the ESL. In 2016, 53.4% of ESL young people were foreign born.

After 2008, several cycles of state rescaling are seen mobilizing in the wake of the crisis (Lobao et al., 2009). When the global financial crisis resulted in sectors such as real estate, construction and the automotive industry to collapse, industries reacted in various ways; one of them was to reduce the number of full-time, and permanent jobs they offer. While growing unemployment mainly affected young and low-paid workers, dismissal of higher-paid permanent staff was rare (Bugamelli et al., 2009: 20), at least in large and medium-sized firms. Ever since, unemployment and nonperforming loans (NPLs) have declined somewhat from their crisis-driven peaks. Nevertheless, Italy's strong divide into south and north is measurable in many socio-economic meanings. For example, out of the 943,000 Italians who became unemployed between 2007 and 2014, circa 70% were southerners; this also reflects the structural differences between north and south.

The active working age class (people between the ages 15-64) constitutes the 65% of the Italian society. To find labour market observations, we examine the specifics of this very same age group. Among this part of population, 41.6% has less than primary or lower than secondary education (in Europe only Spain, Turkey and Portugal have higher rate), 58.4% of the residents have high school/secondary education, and 15.7% finished university/tertiary education. Although, when it comes to tertiary education attainment, its logical to examine an age group between 25-64, in which 17.7% of Italian pursued the degree, this is well below the EU main indicator of 30.7%. The Italian labour force counts 25.28 million people and the unemployment rate is 11.7% of the active population. It is slightly higher among women (12.4%) than among man (10.6%). This 11.7% rate is the third highest unemployment indicator in the EU, after Greece and Spain. The long-term unemployment rate (more than 180 days are unemployed) is 6.7%.

As the Italian population ages, one of the potentials for increasing labour supply lies in bringing more women into the workforce. The participation of the female labour force out of the total female population that is between the ages 15-64 years is 39%, up against the male participation rate, which is 58%. Out of the total labour force, 42% of the workers are female. Considering the earnings, the gender pay gap is 7.3%, slightly fairer than the EU average (16.4%). A typical diagnosis points out underlying reform gap in Italy that has produced a stagnant economy and a labour market in which average earnings are largely decoupled from productivity and demand conditions (Triffin, 2014).

The medium equalised annual net income is 15,846 euro, (means a monthly salary ~€1321.33). The Gini index stands at 32.4 (on a scale 0-100), somewhat higher than the average of the European area (31).

A new kind of economic indicator is the so-called 'Creative Seed' in the labour force. This connects to the much contested, yet increasingly considered factor of the "Global Creativity Index" that was influenced by Richard Florida, which is a broad-based measure for advanced economic growth and sustainable prosperity. We are witnessing the emergence of a new economic order that faces more challenges due to the globalization, deindustrialization, and depletion of resources. Therefore, the presence of the super-creative seed in a labour force is essential. According to Florida (2002), these creative members primary function are innovative and creative, and apart from problem solving, their work can also be problem finding. The "super creative seed" includes a wide range of professionals from science, engineering, and research, to even art and design.

Italy is currently the 21st in the world ranking of Global Creativity Index, and 12th in Europe. This index has a wide range of components concerning technology, talent and tolerance. Technology is a key factor for an efficient and productive economy, essential for biotechnology or innovation in manufacturing. To assess the technology capacity, financial and human investment in R&D and the patents granted per capita (as measure of innovative output) are considered. Italy's share of R&D in GDP is 1.33%, while the number of granted patents in 2016 was 3207, more than in the Netherlands or in Sweden (despite both countries have a higher investment in R&D)

Previously we examined the human capital in Italy, but we must add an extra notice. It seems the human capital itself is not a guarantee of economic stability and presumable quick recovery from crisis. On the contrary, we see countries like Spain or Cyprus where the level of human capital, expressed as a percentage of tertiary educated population, is relatively very high but the unemployment level reaches critical lows and economic growth is weak or negative. Human capital must reflect the economic structure to foster the economic growth (Čadil et al. 2014).

3.5.1.4. Economy

Since the global crisis in 2008, Italy's economy continues to struggle with modest recovery and slow growth. According to IMF, growth is projected (on current policy settings) to moderate at around 1% between 2018 and 2020; but the uncertainty of U.S. policies and Brexit implications created added risk. Traditionally it has been surging exports that have pulled Italy out of recessions, but since the euro crisis the country export rate is disappointing when compared to its former proportion and euro-area average; although it shows mild prosperity since the relative economic upturn in 2015 (The Economist, 2016). Export market share losses appear to be associated with rigidities in resource allocation (sectoral, geographical, and technological) relative to peers and lower productivity gains in high value-added sectors (*Lissovolik*, *2008*). Viewed in a long-term perspective the market shares of Italian exports, which have tended to shrink in the last twenty years between 1990 and 2010, have stabilized in the past few years and the country is still ranked among the world's leaders in merchandise export (ranked as 9th in 2016, according to WTO, with a 2.9% of share). The current export rate of the registered businesses is 26.1%, while the import rate is 24.2%.

The main trade partners of Italy are Germany, France, and the United States. Italy's surplus of trade in May of 2017 was 4.34 billion EUR, which is a decline from the previous year (5 billion).

Comprehensively, most substantial component of the Italian export is the specialized-supplier sector, where small to medium sized firms (often family owned) are the dominant. This sector develops and produces equipment tailored specifically to a particular production process or need. This sector has continued to remain competitive despite adverse developments across Italy's price-based competitiveness indicators.

The specialized-supplier sector remains dominant over the past decades; the scale-intensive sector (which, in Italy, has a majority in resource based-scale intensive sector, like industrial chemicals) is growing extensively, while traditional products (agricultural goods, textiles, and furniture) declined to the third main component in exports. Italy thus went through structural changes from being an agricultural based economy to being the second largest manufacturer in Europe (behind Germany) that currently holds 453 industry enterprises (this number is excluding construction).

However, even today Italy remains as a substantial agricultural producer, possessing 1621 agricultural holdings, a territory of 128,560,50 ha utilized agricultural area (UAA) from which 1,492,579 ha area is under organic farming. This is, in Europe, the second largest organic surface area after Spain. The share of this organic area out of the usable agricultural area is 11.8%.

Organic agriculture in the world is evolving at a rapid pace in response to increasingly marked deterioration of health of the environment, the decreasing availability of natural resources and the deterioration of the quality of the food. An indicator of this dynamic process of growth and development is especially visible in economically developed countries (*Roljević et al. 2017*). Italy holds a remarkable number of organic producers (52,609 farmers), with the highest number in Europe.

In the same way that Italy is significantly separated into north and south in many other aspects, the transport infrastructure is also separated between the north and south. In Italy there is a stance that a high degree of decentralization in the transport sector is particularly important. The main argument is that devolution is more sensible when there is a lot of heterogeneity between regions both in terms of per capita income and in terms of corruption (Carlucci et al. 2017). The country has a total 255,000 km long road network with a density of 850 m/km2, an uneven distribution of motorways, and is characterized by 610 cars per 1000 inhabitants, a high motorization rate. The annual road transportation (in ton = 1000 kg) was 957,006 last year, while the transportation on rail was 92,273 (in ton) and the railway density 5.69 km/100 km2.

Investments in transport infrastructure have been widely used by decision makers to encourage economic growth, particularly during periods of economic downturn (Melo et al. 2013). Examining the evolution of transport policy in the EU and in the US, it appears that institutions for planning, financing, and operating transport systems were initially motivated by mobility and productive efficiency. Later, “external goals” became important political objectives. Safety, economic development and technological innovation are examples of external goals (Stough & Rietveld, 1997). In any means, greater transport infrastructure doesn’t only imply more output.

One of the objectives of European transport policy and many national policies is a decoupling of the environmental pressures and impacts from transport and economic growth.

3.5.1.5 Waste sensitivity

Based on the ISO 2016 survey and taking into account ISO 14001, we can see a significant increase of certification in Italy. In 2016, the absolute number certification was very high (26,655). The trend in Italy is exponentially increasing, whether we project the numbers per capita or per company. The EMAS certification shows a similar trend.

Respective to Italy the composite index of WCB proposed by SSCA-1 shows a 6.98 mean value. In European comparison, this is an average value, yet significantly higher than the Dutch one.

The Italian regions SSCA-1's findings stress that there are statistically significant differences. The northern regions have [Nord-Ouest (7.37) Nord-Est (7.33)] significantly higher mean values than the central (Centro shows 6.83) and southern one (Sud shows 6.74), and especially higher than the islands of Sardinia and Sicily (Isole has 6.21). It is important to note that the regional disparities in Italy are much higher than in the Netherlands.

3.6 Spatial and socio-economic analysis – Naples (Campania)

3.6.1 Geographical situation

Naples, the main city of Southern Italy and the third one in Italy, is located in the Campania region by the Amalfi coast that consists of rocky coastal cliffs and formations such as caves, arches, stacks, the coastal landscape, and the volcanic area of Mt. Vesuvius. While the importance of Naples as the principal port of southern Italy is at last in decline, the city remains the centre of the nation's meridional commerce and culture. Since World War II, during which Naples suffered severe bombardment, modernization has increasingly altered the city's setting and character; a measure of long-deferred but often speculative prosperity is reflected in new suburbs now proliferating in once-rural surroundings (Encyclopaedia Britannica).

Naples belongs to the volcanic region of Vesuvius and Campi Flegrei and is set in one of the most remarkable stretches of the Italian sea coast. The city's urban setting lies between a curving coastline and a parallel curve of inland hill ridges that run from West (Posillipo) to East (Capodimonte and Poggioreale). These hills represent a demarcation line, even if discontinuous, between the city centre and the periphery (De Seta, 1994); in the past, they have acted as a barrier for the city's expansion toward the heartlands. Therefore, between the hills and the sea Naples occupies two main types of natural space: the system of uneven highland in the North-West area and rural flat land that is partially made up of alluvial sectors, in the East area. Within the city area there are also spurs from the main hill ridges that run toward the sea. Two of the most important touch on the historic centre: those running from Vomero to Posillipo and from Vomero to Pizzofalcone (Mazzeo 2009; pp.363-364).

The city of Naples has a rather limited extension, about 117 kmq, with a million of inhabitants. However, it is integrated in a much larger Large Urban Zone (as defined by Eurostat) where 4,2 million people live, and it is expanded towards other two cities in the Campania Region: Caserta and Salerno. Only one part of this urban region (or "Functional Urban Area") is recognized at an institutional level in the Metropolitan City. This area was selected according to the Law 56/2014 and is based on the old boundaries of the Province of Naples, which was defined at the beginning of the 20th century. Urbanization in this region occurred in a very strong and chaotic way in the second half of the 18th century, transforming a rural reality in a metropolitan conurbation without a shared institutional vision (Russo, 2011; Formato, Fatigati, 2012; Amenta, Formato 2013; Formato 2015; Russomando, 2016).

The urbanization was encouraged by the industrialization process and by the realization of the infrastructures instigated by the 'Cassa per il Mezzogiorno' (this is a public bank for urban reconstruction that was financed with the funding of the Marshall Plan) after the Second World War, until the eighties and nineties. The result is a dense conurbation that developed around the old towns that were already existing in the Campania Plain, with many urban fringes, characterized by the coexistence of non–built fragments as well as discontinuous and low density built environments. Moreover, a large part of the urban expansion of the second half of the 20th century, especially the residential one, took place illegally outside of the areas of expansion identified in the urban plans, in the natural protected areas (in the National Park of the Vesuvius Volcano and in the Regional Park of Campi Flegrei) or in the vulnerable areas where there are conditions that create natural, hydraulic and landslide hazards. After the economic crisis, large productive areas are underused and abandoned. Moreover, there is a general phenomenon of filtering-down that is affecting the municipalities of the hinterland, and the peri-urban areas of the Metropolitan City of Naples. Some municipalities of the first belt of the metropolitan area, like Casoria and Portici, are suffering from the phenomenon of a shrinking population. In contrast, the large urban cores (Napoli, Salerno, and Caserta) are becoming very popular touristic locations and therefore an important process of gentrification, especially in the nicer central areas. The identified focus area for the REPAiR study is entirely localized inside the boundaries of the Metropolitan City, including the eastern neighbourhoods of the main city and other ten municipalities in the North–East direction. From a geographical point of view, the area could be described as a kind of flat wedge that is located in between Vesuvius and the hills of Naples facing towards the sea by the port of Naples and open towards the countryside of Caserta. The hydrographic system structures the entire study area: to the North, with the reclamation river of Regi Lagni that crosses the Campania Plain until the Litorale Domitio; to the South, there is the partial trace of the river basin of the former river Sebeto that is mainly covered in an artificial way. The main part of the hydrographic system is polluted because of both the bad functioning of the urban sewage systems, and the infiltration of pollutants into the groundwater that are present in the soils as a result of a previous deposit of hydrocarbons (http://www.arpacampania.it). Because of the presence of the Vesuvius Volcano, and the interfering hydrographic and settlements systems, some area of very high natural risk can be reported; especially the hydraulic one with a possibility of flooding and groundwater level rising in case of meteorological events.

The Focus Area is characterized by the presence of large infrastructure networks: the highways (A1 and A16) and other main roads (fast transit roads) (Asse Mediano, Asse di Supporto, and others), local and national railways, and the airport. Finally, in the last decade the high-speed railway line was realized as well as its new station: the Napoli – Afragola Station. All these structures are overlapped to the historical structure of the territory in a very fortuitous way, contributing to changing its former rural character into a peri-urban area.

The industrial areas are partially abandoned. Particularly, the whole oil district of East Naples is largely underused today and is characterized by the presence of very relevant soil pollution (in fact it is inserted in the Areas of National Interest for pollution - SIN).

Also, the industrial areas of the hinterland, realised from the State in the Municipality of Acerra, Caivano and Pomigliano, are in a condition of crisis because of some chemical industrial areas like the Montedison moving away. The area is also marked by the presence of relevant commercial areas along the strip of the so-called 'Strada degli Americani' in Casoria, and by the new high-speed train where the shopping mall Le Porte di Napol is localized, which is also in a great economic difficulty.

There are several plants for the waste treatment in the area; Located in the North of Acerra lays the only waste incinerator of the Campania Region. The condition of degradation of soils is not only dependent on the residues of the industrial activities, but also from the criminal practice of waste disposal by their illegal burning in the agricultural fields. Indeed, the entire territory is included in the SIN Terra dei Fuochi since 2013 (law. N. 136/2013).

There is the presence of many additional infrastructures (not only the main ones, but also the local ones, with many road networks in the agricultural fields) and a diffused urbanization that created many difficulties for rural production; indeed, they generated a high number of agricultural fields that are waiting for transformations. Very often the abandoned fields as well as the buffer zones of the large infrastructures are used for the illegal dumping of waste, especially construction and demolition waste.

The Wastescapes mapping of the Focus Area underlines the difference between the two sub-regions within the study area: the former industrial area to the South with the presence of the polluted areas and the abandoned industrial plants; the former rural areas to the North where there is abandonment and underused open spaces accompanied by degradation phenomena of the urban and social tissues. In general, many peripheral urban areas are typical of poor housing and urban suffering.

Inside the Focus Area a Sample Area of 3 square meters, by the high-train station of Afragola. It is a context that represents, all the general characteristics of the study area where the interests of institutional actors and other stakeholders are focused. Besides that, important programs regarding urban regeneration are interested in (with production of construction and demolition waste) and environmental regeneration; it is embedded in the realization of the industrial plant of composting (Municipality of Afragola).

Finally, a wide extension of the publicly owned soils could help the immediate development of 'demonstrative actions' for testing the Eco-Innovative Solutions, initiating in this way the more general actions of urban regeneration.

Natural Protected Areas

The Focus Area is inserted in between three important natural reserves: The National Park of the Vesuvius Volcano (South-East), the Regional Park of the Partenio (East), and the metropolitan park of the hills of Naples (West). Moreover, the entire network of the Regi Lagni Rivers is considered a protected landscape heritage for its historical value. All the historical centres and the archaeological traces of the Roman age are censored and protected.

The main public policies contained in the urban planning instruments of the Region and the Metropolitan City address the ecological reconnection of the large natural areas. These policies are targetted the edges of the Focus Area, through the use of corridors along the infrastructures and along the waterways. Moreover, the Metropolitan City provides for the establishment of a system of urban- rural parks near the new high-speed train station of Afragola.

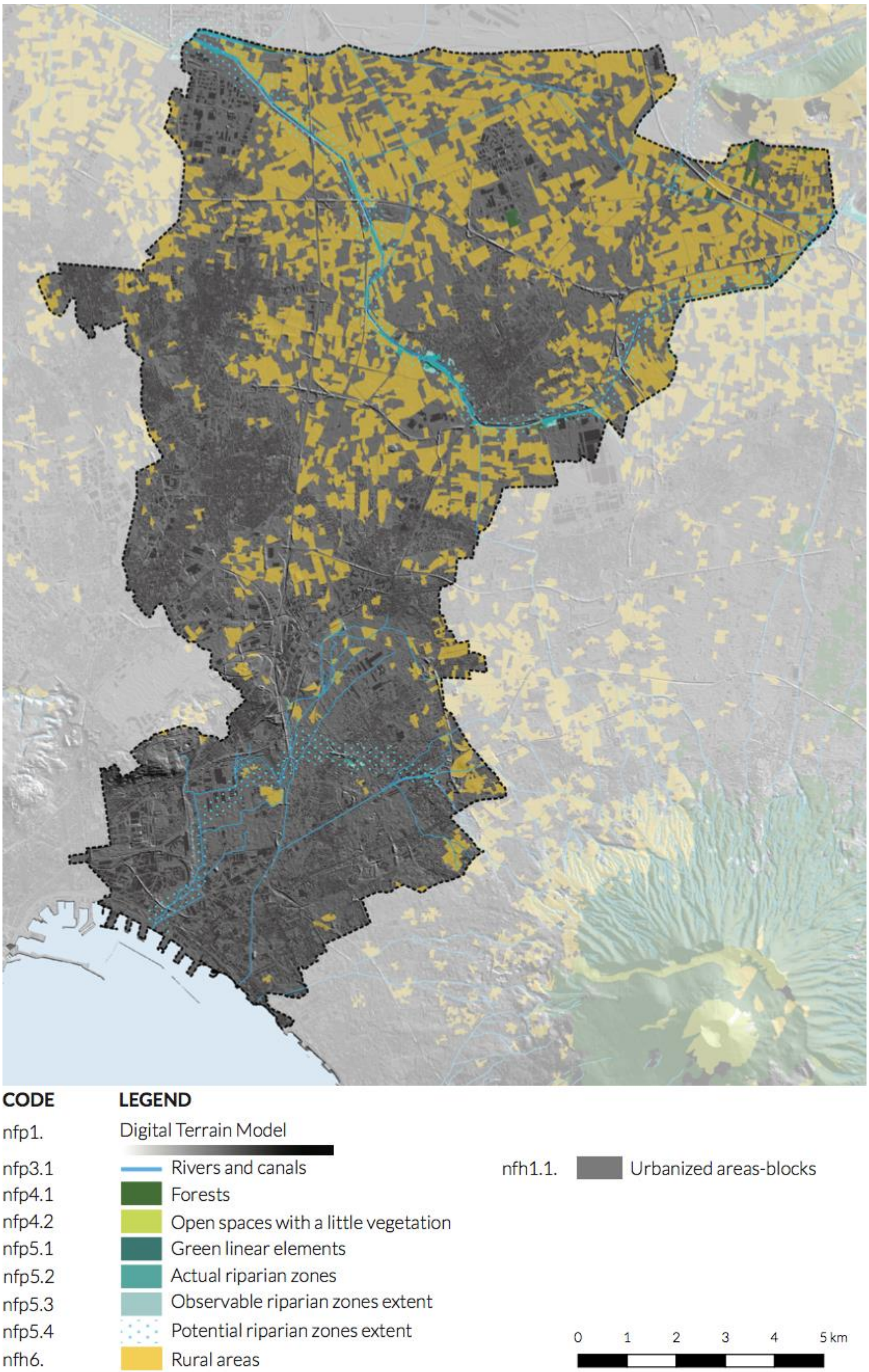

Figure 37: Physical morphology and hydrography. Source: UNINA, DIARC

3.6.2 Demography

Located in the southern part of Italy, with its capital Naples, the 13,670.0 square km territory of Campania with 5,850,850 inhabitants is the third most densely populated region of Italy, but the distribution of density is very uneven. Although the territory is largely rural and the urbanization is concentrated on the coastal area, the region was famously one of the earliest urbanised regions in Europe (Figure 38). Campania contains 4 provinces: Napoli, Caserta, Salerno, Benevento, and Avellino and the Metropolitan Area of Naples (ex province of Naples become metropolitan area with L. 56/2014) (Figure 39). The province of Naples has 2,642 inhabitants /sq. km (one of the highest density rates in Europe), in contrast, the rest of the provinces are well below this density. The difference is most measurable when compared with inland areas like Benevento (135,3/km2).

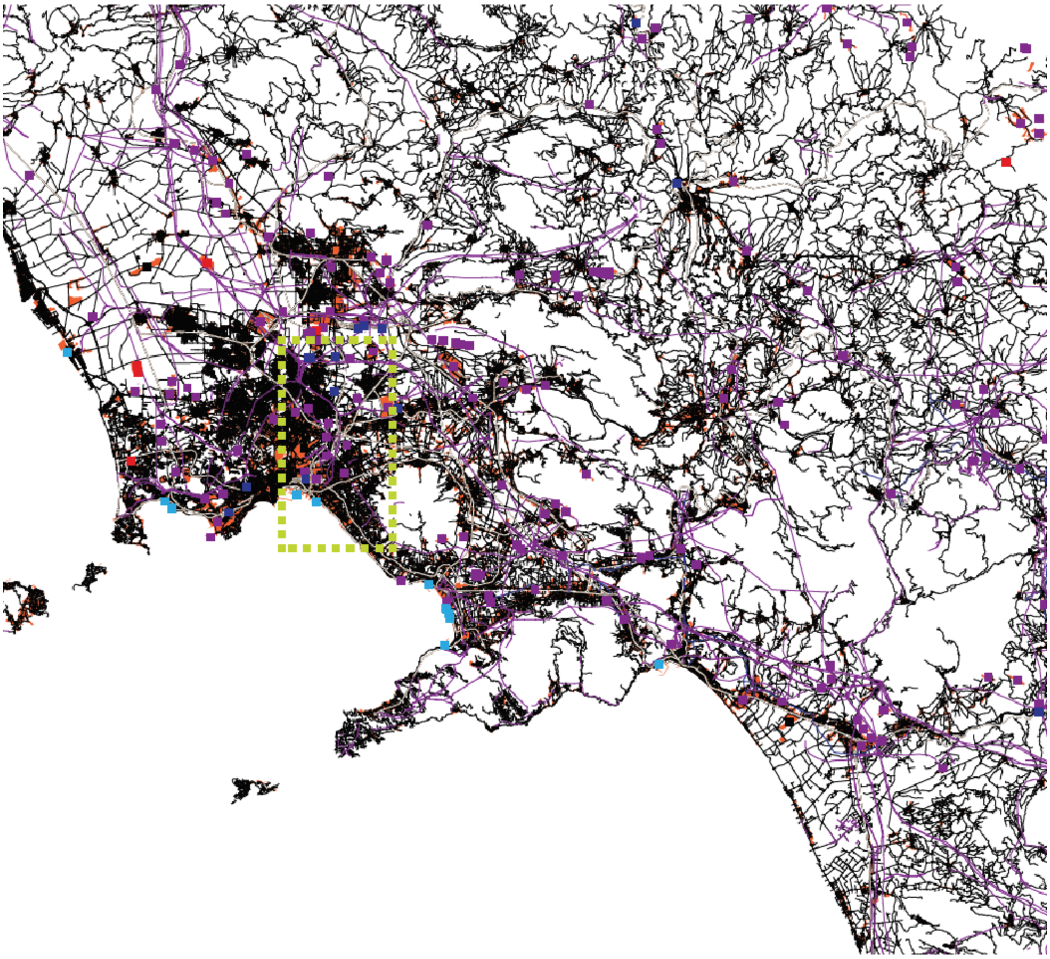

Figure 38: Urbanised areas of the case study area. Source: UNINA, DIARC

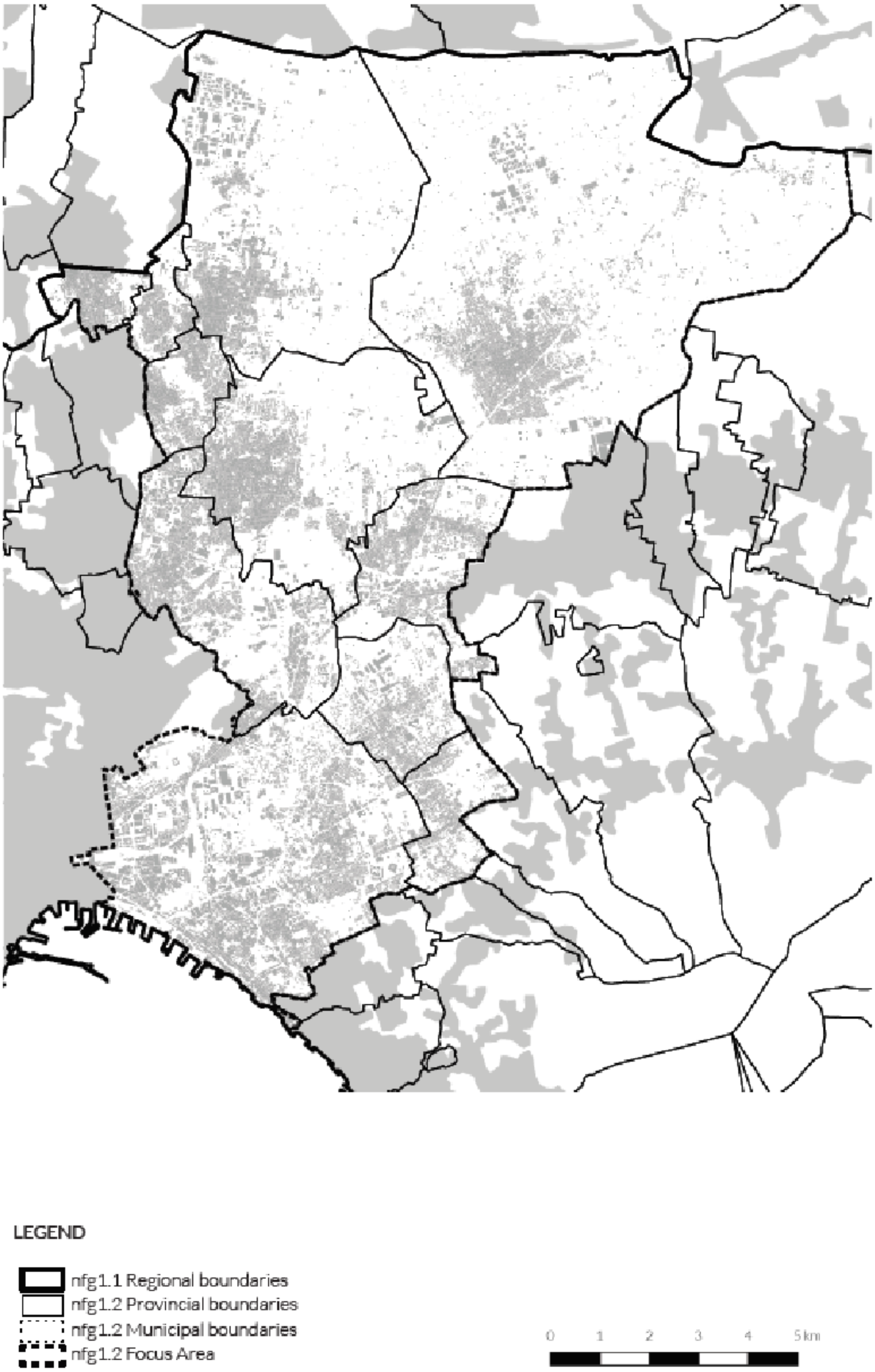

Figure 39: Administrative boundaries of the Italian case. Source: UNINA, DIARC

Concerning ISTAT data, in the beginning of 2016, the region counted 5,850,850 inhabitants (2,846,720 males and 3,004,130 females) from which 3,906.9 are in the economically active age. While in the past decades the population increase was typical, observing the statistics of the last three years, there was a slight decline. This is mostly due to the fact that the natural increase turned into natural decrease. (The number of live births in 2016 were 50,384, while number of deaths 53,044, causing -2660 lives natural change) and the volume of immigration is less intense (net migration was -7600 in the last year).

The old age dependency ratio is 27.2, and the ageing index is (121.6), which continually increased over the years. The proportion of people aged 65 or over is 18.2% out of the whole. The median age is highest in Benevento (45.3 years), and the lowest in Napoli (41.1).

The metropolitan region of Naples covers a 1,162 square kilometres area and has a population of 3,118,149 people (1,608,409 females and 1,509,740 males). In the last decade, the density decreased in parallel with population growth due to urban sprawl. Similar to the natural decrease being seen in the perspective of the whole country and in Campania, this is visible in Naples, where the natural change of population was -103 (based on EUROSTAT data). Population projections estimate that the Naples population will peak in 2020 and from then a gradual decline is anticipated.

3.6.3 Labour force

In the economically active population the employment rate is currently 55.7 %. It's an alarmingly high rate and reflects the disadvantaged economic position of the region. The share of long-term unemployment rate peaked in 2014 with 15%, and stood at 13.9% at the end of 2016. The rate of those young people (aged 15-25) that are neither employed nor in education or training is 28.2%. This is the third highest among the Italian regions after Insole and Sicily; again, this aggravates greater risk of poverty or social exclusion. This presents evidence of a mismatch between labour supply and demand.

As previously mentioned: the high rate of young people neither in work nor in education, contributes strongly to the lack of economic performance and to poverty 15.2% of the population aged 25-64 years has completed tertiary education, in the same age group: 39.9% has less than primary, primary, or lower secondary/upper secondary, post-secondary non-tertiary education attainment. Overall, the proportion of early school leavers is high (18.1%), this not only exceeds EU target but also the national rate (13.8%.)

As a percentage of total employment in Campania, high tech has a 2% share. The R&D expenditure in GDP is 1.3%. Campania has improved its innovation performance over the years. However, it remains a 'moderate performer' (Eurostat).

The Metropolitan area of Naples is the main employment centre in the region; it currently gives jobs for 955,800 people. The distribution of labour force does not share much of the GDP among sectors. The gross domestic product of Metropolitan region of Naples is 55,170 million Euros; with this, Naples is 4th among Italian metropolitan areas. The main pillars of the Neapolitan economy are the previously mentioned agri-food industry (operating mainly on small sized firms), construction and manufacturing (including luxurious products like Alfa Romeo, but shipbuilding, metal processing also), and above all, tourism.

3.6.4 Economy

As it was stated before, from Campania's total population, 3,906.9 of the residents are in the economically active age (67%). Narrowing this active population, among them currently 44.3% are unemployed. This is an alarmingly high rate and reflects the disadvantaged position of the region. Regional GDP per capita is the second lowest in the country (17,200 Euro), and within the region the province of Benevento and Caserta has the lowest (both provinces with 15,300 Euro of GDP/capita) followed by Avellino (16,300), Salerno (17,000) and Naples (17,800). The GDP of the region is 99,880 million euro. The average disposable income of private households is: 11,500.00 Euro (annually).

Campania's economy lags behind the national level in terms of development and productivity. The number of economic activities in Campania is low (51 enterprises per 1,000 inhabitants vs. 63.8 in Italy (Eurostat). EU territorial pacts require cooperation between all sectors, including third-sector associations. The task is to encourage measures that bring together industrial modernization and service creation. As far as models of cooperation are concerned, the regional and provincial administrations still lack to varying degrees the culture and capacity to innovate and change (Zeitlin & Trubek, 2003). The main pillars of region are the agro-food industry, the manufacturing of metal products, and tourism; this makes Naples a relatively better situation the rest of the region.

In the GDP composition, agriculture in Campania has a bigger slice (3.6) compared to the share of agriculture on national level . The region has 74,360 farms, with 509,000 ha utilized agricultural area (UAA). In the composition of UAA, arable lands are most dominant (49.9%), followed by permanent grassland (25.4%), permanent crops (24.1%), and kitchen gardens are in the minority (0.6%). The standard output from agricultural activity is 2,163,342,650 Euros, over two billion euros. Moreover, organic agriculture plays a strategic role in Campania. Organic farming is a production system that sustains the health of soils, ecosystems and people. It has positive effects on both the economy and environment. However, in recent years the Campania Region has faced serious problems of environmental pollution and food safety that has generated strong mistrust and insecurity among the public towards the quality of local agricultural food production, and undermined consumers' trust in the safety of local agri-food systems. In particular, this refers to the topic of food chains contamination (Annunziata & Vecchio, 2016).

Campania's economy strongly relies on its touristic attractiveness as well, and is managing to maintain multi-day tourism, which we can measure with the numbers of nights spent at touristic accommodations. Within Italy, Veneto is the leader as a touristic destination (63,257,174 nights spent), but Campania is responsible for a total of 18,855,907 nights, which also identifies the region as a significant host. Hence the contribution of the tourism and service sector to the GDP in Campania is significant.

3.6.5 Transportation

Campania has a relatively complex transport system comprised of multiple modes: a 1,095-km long rail network, which is fairly complex when compared with the other Italian regions (7th in the ranking of complexity), and a motorways network of 442 km with the density of 33 km/thousand square km. With the Port of Naples (one of the biggest in the Mediterranean Sea) the proper maritime transport (for both goods and for passengers) is insured. Maritime transport of freight was 23,590 tonnes in 2015 this highly contributed to the commerce of Naples. The International Airport of Naples (Aeroporto Internazionale di Napoli - NAP) operates and transports both goods and passengers. The Airport of Salerno is a modest regional airport. Air transport of freight in Campania was 8 thousand tonnes in 2015. Naples also acts as an important cargo terminal.

3.6.6 Development strategy and waste sensitivity towards circularity

One of the biggest problems in the region is the wasted landscape, which is wasted for several reasons. First, the industrial sector is still the leading sector of its kind in the south of Italy. However, since the start of the century, the industrial expansion has always been restricted to a number of privileged areas, particularly round Naples, Sarno and Salerno, giving rise to pollution and environmental problems associated with the heavy concentration of factories close to inhabited zones. Illegal toxic waste dump in Campania covers a huge area. Tons of waste have been dumped in agricultural areas and illegally burned (Figure 40).

Second, a considerable influence of the Camorra was on the transport and disposal of waste (Greyl et al. 2013:11), through both disguised (e.g. relabeling of hazardous and toxic waste to harmless urban or construction waste) and open illegal means (e.g. open fires, illegal landfills, construction site dumping). As recycling and other alternative means of waste management became more popular and the increased interest of reducing the control of organized criminal elements on waste management, several proposed political solutions were put into action (Pasotti, 2010).

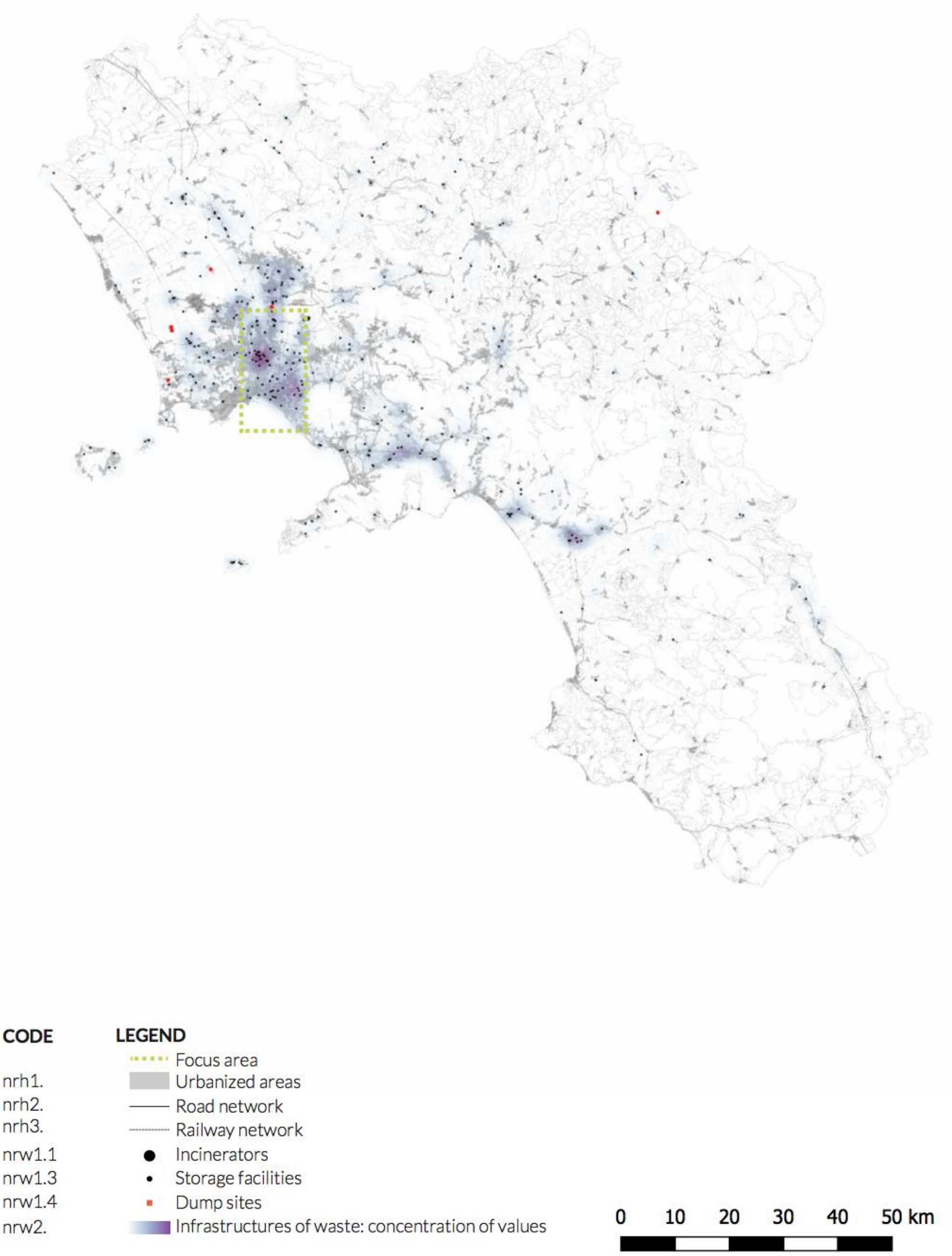

Figure 40: Waste geography in Campania. Source: UNINA, DIARC

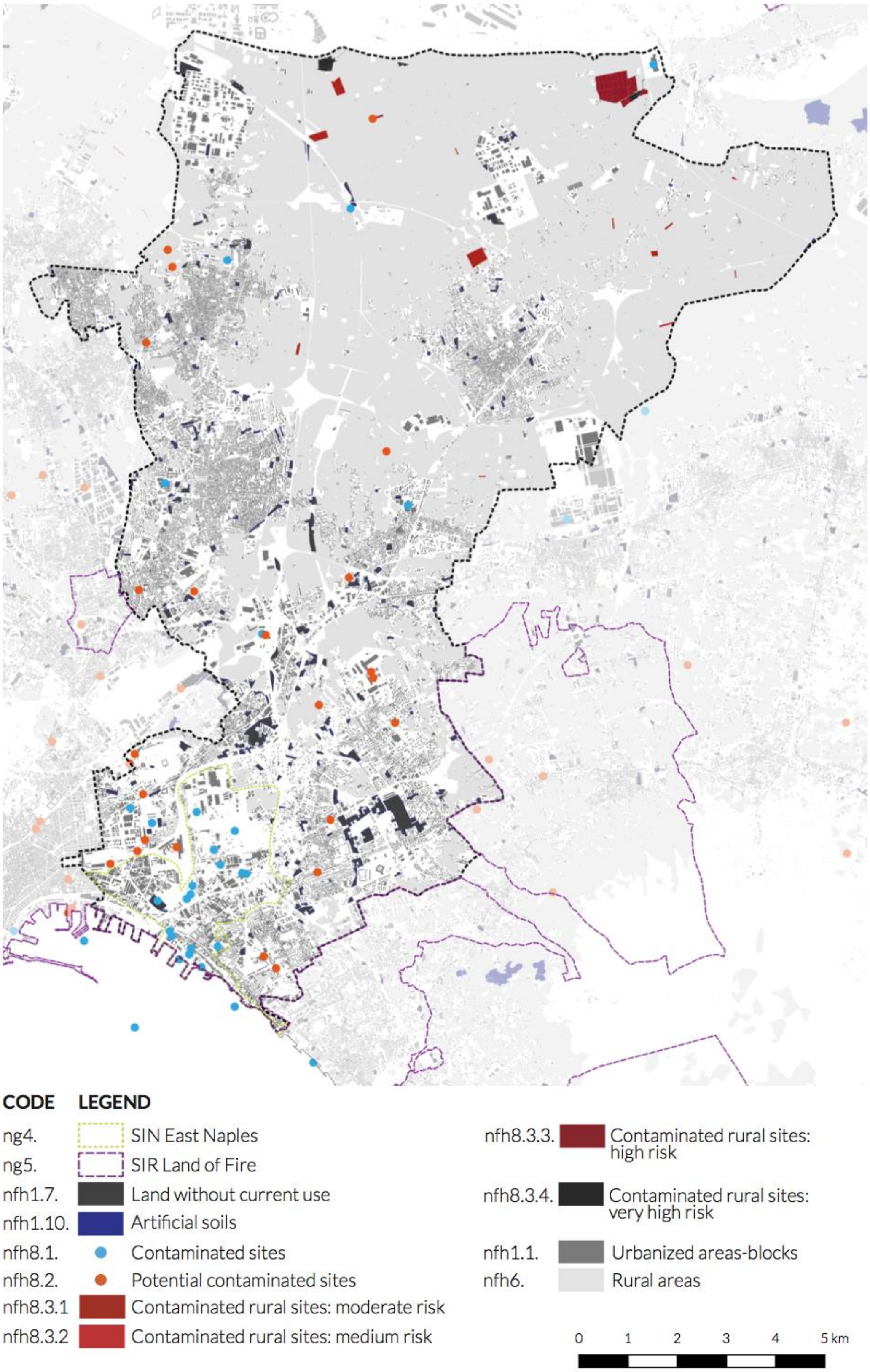

Figure 41: Land pollution in the focus area. Source: UNINA, DIARC

The Naples case is explored in regard to the waste management policy in the Campania region. This waste management policy is an ongoing complex process that went through emergencies in three decades, such as the “Land of Fire” disaster, and still present illegal interests (to deepen the knowledge of events, policies and governance structure read the chapter 4.2 Governance Background of D 6.1).

Since 2012, some sectoral plans for urban and special waste management were aimed to find solutions to solve the emergency period and with Regional Law no. 14 of 26. In May of 2016 the Regional Government tried to shift to a Circular Economy (CE) model based on integrated waste cycle; this is according to the Programming Documents 2014-2020 and the lines of address of European Commission.

It might be because of the ‘history of pollution’ that companies have higher waste/environmental sensitivity in Italy in Campania than in The Netherlands. In Campania, 32 companies out of the 929 Italian ones bear EMAS certification. 31 out of the 32 are small- and medium size enterprises (SME), and 4 of them are micro. Concerning their NACE code seven of the enterprises (21.88%) are dealing with waste collection or waste treatment, while another six are in metal industry. Most of the companies (56.25%) are from processing industry (mainly manufacturing products) and 37.5% of them are from the service sector. Only two dealt with mining and quarrying sector. Only 28.12% of these companies are located in Napoli.

Taking into account everyday peoples’ waste sensitivity, the region is not the leading in Italy (Figure 42). The reason could be that a denser urban structure, industrialisation and traffic can be found in the north part of the country.

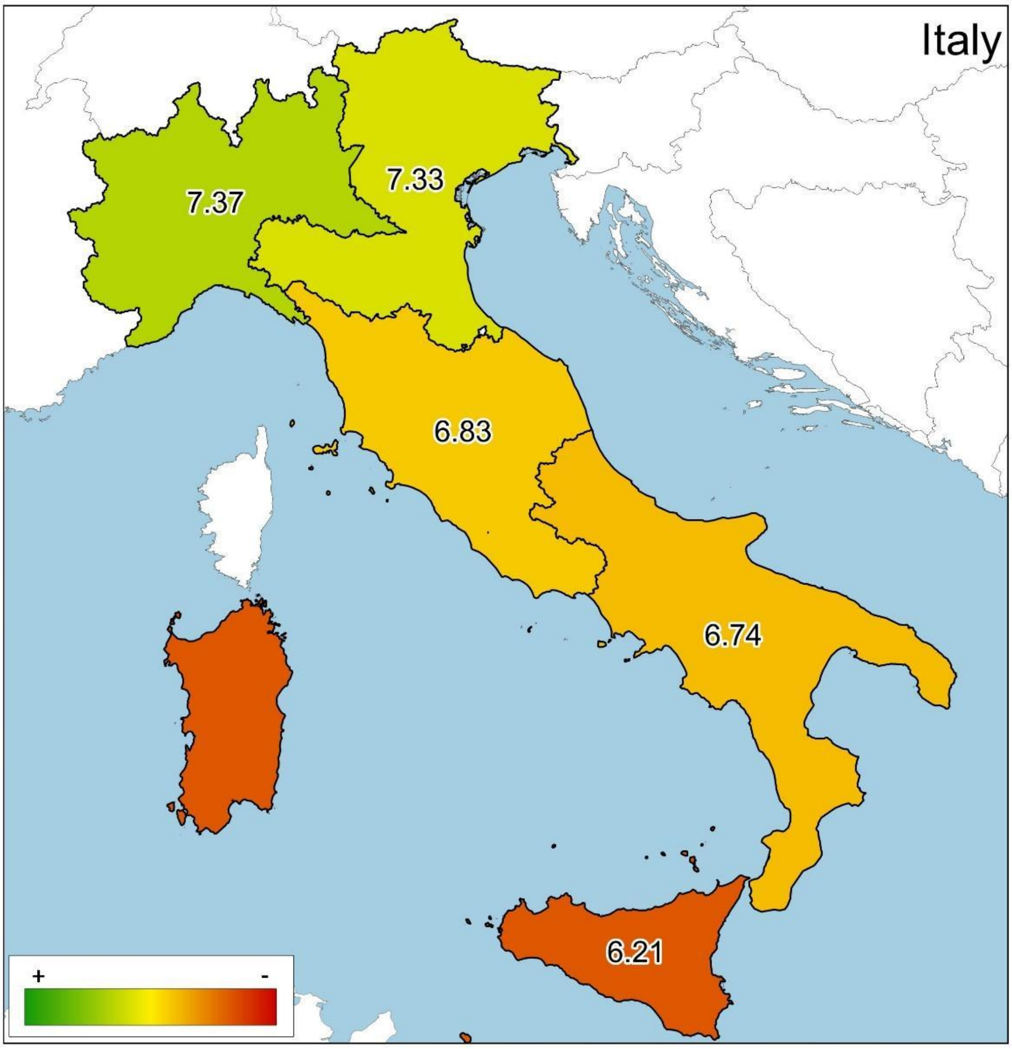

Figure 42: WCB index mean values in Italy. Source: Authors' elaboration based on data from Flash Eurobarometer 388)

Given the continuous waste crises and the need for improved governance and regional development, policy makers have tried to enhance the situation. The actual planning instruments are the Regional Plan for Management of Urban Waste (Piano Regionale di Gestione dei Rifiuti Urbani - PRGRU) which came into force in January of 2012 with the aim of defining management and plant system solutions to structurally solve the "waste emergency" period, and its subsequent updates (DGR n.381 of 08/15 and DGR n. 685 of 12/16); Regional Plan for Management of Special Waste, (Piano Regionale di Gestione dei Rifiuti Speciali - PRGRS) which came into force in May of 2011 and Regional Plan for Remediation of Polluted Water (Piano Regionale di Bonifica - PRB).

Particularly article numbers 2 and 3 of the RL 14/2016 refers to CE and measures to achieve it. It recognizes the validity of CE principles and specifies that the Campania Region will proceed the realization of a CE model with concrete actions and will provide support through reward criteria in awarding European, national, and regional resources; the scientific research for innovative design and production of reusable, repairable and recyclable goods and the research on materials used in productive cycle to minimize environmental effects of their production and management after the use for the reduction of raw material use. All these objectives are to be persecuted to offer durable and innovative products to consumers that can generate savings and improve the quality of life.

The law provides the substantial participation of municipalities, single and in association, dividing the Campania Region area in 7 OTA – Optimal Territorial Area – that represents the new territorial dimension. The Entity of Area manages each of this OTA. The OTA can be divided in several Sda– Sub district area. Even if the OTA's activation was in 2016 they are still no longer functioning due to the missing election of every entity of the Entity of Area.

Furthermore, the law entrusts the waste flow management process to the Campania Region and municipalities. This leaves to Metropolitan City of Naples, that also has the role of managing public services, the only role of leading the transition phase (Berruti e Palestino, 2017).

The increasing importance of waste management led the Campania Region to introduce the Osservatorio Regionale per la Gestione dei Rifiuti (ORGR) – Regional Observatory for Waste Management – within the RL 14/2016 with the aim of processing and monitoring statistic and cognitive data related to collection, management, transformation and use of waste, controlling the state of implementation of separate collection goals, and promoting knowledge awareness regarding produced waste. This ORGR will come back in the following chapter regarding the Material Flow Analysis.

Indeed, the waste management in Campania Region is in a complex transitory period in which different companies are in charge of collection and disposal. However, this will shift to only one company per OTA being in charge after the LR 14/16 completed application. The chosen focus area composed of 11 municipalities, related to 2 different OTA is:

- 9 municipalities from OTA 1 (Acerra, Afragola, Caivano, Cardito, Casalnuovo di Napoli, Casoria, Crispano, Frattaminore, Napoli), including Metropolitan City of Naples;

- 2 municipalities from OTA 3 (Cercola and Volla).

Construction & Demolition Waste is another crucial issue linked to the legal and illegal transformations of the territory and requires the need to control and monitor the construction process while also taking the requirement to intervene on the recovery of built heritage and landscape into account.
The concentration of built heritage is characterized by a high level of degradation that needs innovative interventions that are also requested by the construction companies that intend to activate innovative technical instruments to select the waste already in the construction phase.

3.7 Material Flow Analysis Naples case

The above-mentioned ORGR identifies the relevance of two main critical value chains for the CE transition: Organic residual streams (waste category: Organic Waste, OW) and the construction and demolition value chain (waste category: Construction & Demolition Waste, CDW).

In particular, Organic residual streams are a crucial issue as more than 80% of the organic fraction is collected in the Campania region and is treated outside the regional territory, as there is a shortage of composting plants (only one plant is active in the province of Salerno).

Although the Campania Region has implemented a series of measures to build new plants to meet the request of the European Union, the various municipalities are strongly resisting and it is difficult to get them accepted on the territory.

At the same time, Construction & Demolition Waste is another crucial issue linked to the legal and illegal transformations of the territory and requires the need to control and monitor the construction process as well as taking into account the need to intervene on the recovery of built heritage and landscape.

The concentration of built heritage is characterized by a high level of degradation that requires innovative interventions, and also requested by the construction companies that intend to activate innovative technical instruments to select the waste already in the construction phase.

In the interaction with the different stakeholders, both during the Interviews (WP6) and the PULL workshops in the co-exploration phase (WP5), the value chains relevance has been confirmed and integrates the technical information with the perceptions and the point of view of the different key players.

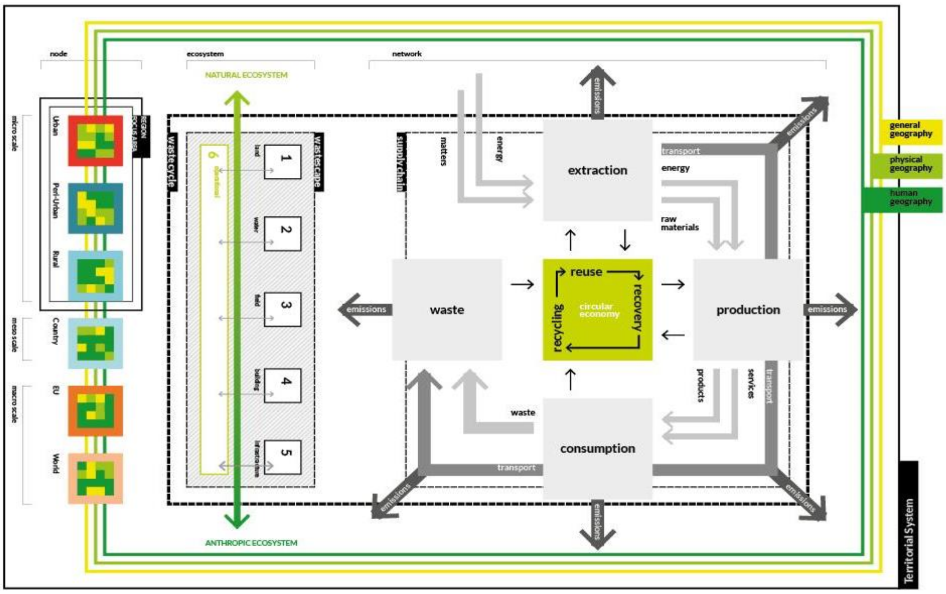

Figure 43: The waste supply chain in relation to the Wastescapes and Geographies (P. Inglese and S. Iodice elaboration)

Wastescapes are intended as negative externalities of the environmental, social and economic interactions that occur in urban ecosystems. For the territorial identification of Wastescapes, it is necessary to define a suitable spatial methodology of analysis that could be systematically replicable in the heterogeneous contexts of the different Focus Areas and Sample Area.

The flows of matters and energy that cross the territory and allow the activities of the supply chain to be carried out cause not only emissions and flows of waste but they also shape the territory in its physicality (Figure 44). There is, indeed, a strict link between territorial processes and Wastescapes determination that can be considered the spatial result of Urban Metabolism (Wolman, 1965) together with impacts at micro, meso and macro scale (see Deliverable 4.2).

Analysing the metabolism of a city makes it possible to understand the impacts of urban development (Mostafavi et al., 2014) by taking into consideration the flows of energy, water, nutrients and waste, and the materials that circulate within a city. To sustain its economic activities, the territory requires natural resources and energy and, at the same time, it is crisscrossed by various kinds of material flows (EEA, 2015).

Therefore, the metabolic activities of extraction, production, distribution, and consumption that define the supply chain and the activity of waste management affect the resources but are also simultaneously able to generate Land Use Functions (LUFs) and provide environmental, social and economic services as well. At the same time, they alter territorial performances by generating multidimensional impacts and in addition a particular form of spatial impact identified as Wastescape (cf. D3.1). The latter are portions of the territory that are at the end of their life cycle need to be regenerated so to give rise to new functions as well as to new services according to the definition of multifunctional landscape and landscape services (Costanza et al., 1997; MA, 2005; de Groot, 2006; Termorshuizen and Opdam, 2009; Verburg et al., 2009) (Fig. *42*).

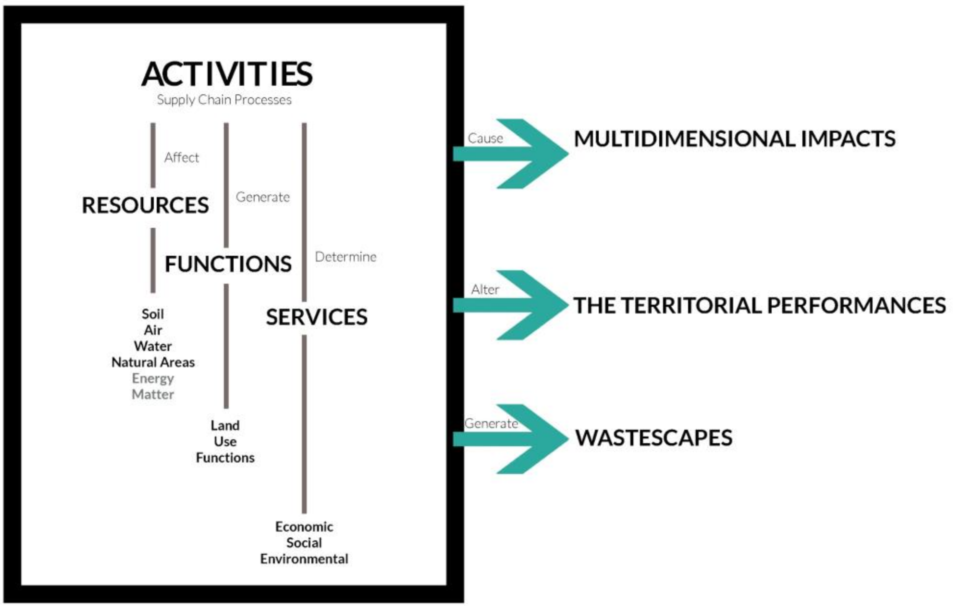

Figure 44: Supply chain processes in waste management (P. Inglese and S. Iodice, elaboration)

The general idea for the Wastescapes characterization is that of aggregating increasingly complex information up to the definition of performance indicators.

The starting point is the concept is that resources that feed the process power these metabolic activities (EEA, 2015) that then act on the territory and in the meantime generate environmental, social and economic performances.
The European Commission's Thematic Strategy on the Sustainable Use of Natural Resources (EC, 2005), states that European Economies depend on natural resources that can be defined as "anything that occurs in nature that can be used for economic production or consumption" (OECD, 2010) or also "for producing something else" (UNEP, 2011). According to EC (2005), natural resources that feed European economies are composed by:

– Raw materials, such as minerals, biomass and biological resources;
– Environmental media such as air, water and soil;
– Flow resources such as wind, geothermal, tidal and solar energy;
– Space (land area).

The life cycle of the supply chain processes and the available resources that allow interpreting the territory as a system of "use functions" (Loiseau, 2014; Torricelli and Gargari, 2015).

The system of interpretation for the Wastescapes characterization is formed by four main steps which follow each other cyclically: driver, pattern, process, effect (Fig. *45*).

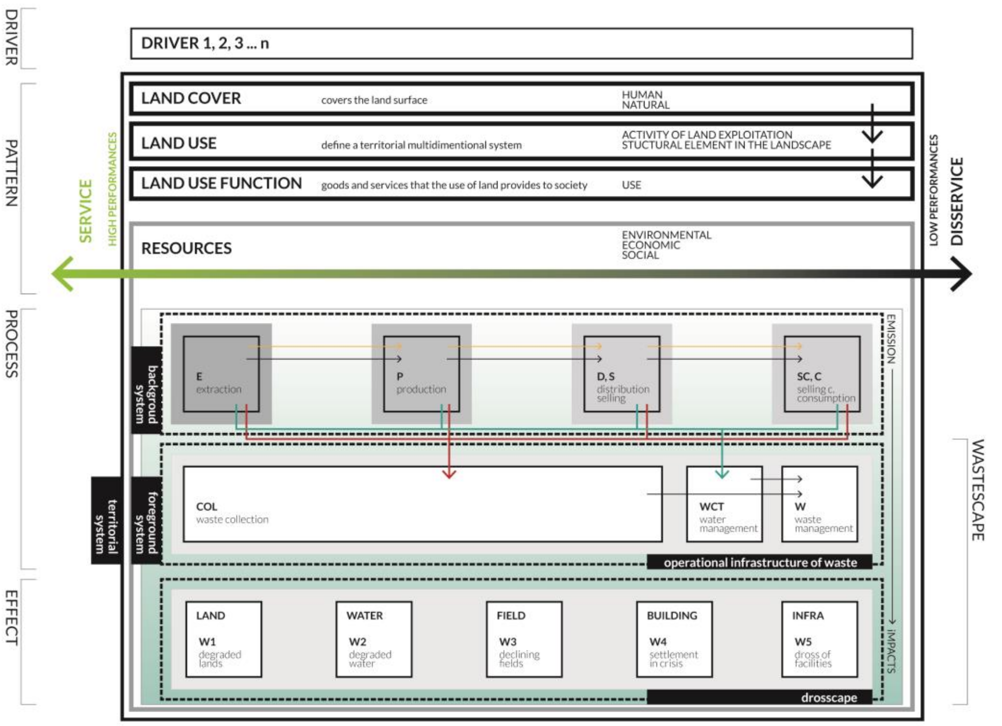

Figure 45: The system of interpretation for the Wastescapes characterization (P. Inglese and S. Iodice elaboration)

Driver(s) refer to causes of alteration of the territorial functioning and represent factors of change with influence on the environment, on economy and on society. As far as the **pattern** is concerned, once the Wastescape is selected to characterize, the first step is the selection of the appropriate geographies that allows defining the main features of the area under analysis from a physical and human perspective (see D3.1). The selection of the Wastescape to characterize has to be made at the beginning, as this choice will influence the subsequent methodology.

Secondly, Wastescapes are the results of the territorial processes and therefore they could be analysed according to every single activity of the supply chain. Once the activity is chosen, it is necessary to define the Land Cover that hosts this activity and the subsequent Land Use.

On the one hand, the first represents the observed (bio)physical cover of the earth's surface (Di Gregorio and Jansen, 2005), it can be human or natural, and it generates a certain number of sub-categories. The Corine Land Cover elaborated by Copernicus is the latest version and the main reference for the Land Cover (2012). On the other hand, Land Use refers to the human activities carried out on a certain Land Cover from a functional dimension (Torricelli, 2015) and the reference can be represented by the categories of Land Use proposed by European Environment Agency for the latest version of Urban Atlas (2012 as well). Land Use is a determining factor that influences the ability of ecosystems to provide services (EEA, 2015).

From a combination of the two informative layers, a system of Land Use Functions (LUFs) is developed according to the categories proposed by Pérez-Soba et al. (2008) to which the cycles of the activities of the supply chain and the resources that feed these activities refer. LUFs can be defined as the "goods and services that the use of land provides to human society, which are of economic, ecological and socio-cultural value and are likely to be affected by policy changes" (ESPON 2013, p. 12). Pérez-Soba et al. (2008) classify LUFs, that represent the social, environmental and economic issues of a territory as follows:

- Provision of work;
- Human health and recreation;
- Cultural and aesthetic values;
- Residential and non-land-based industry and services;
- Land-based production;
- Infrastructure;
- Provision of abiotic resources;
- Support and provision of biotic resources;
- Maintenance of ecosystem processes.

Each LUF can be analysed from an environmental, social or economic perspective according to the Wastescape they characterize. LUFs consideration allows completing the pattern definition.

The following step is the **process** that is related to the processes that happens in the territorial system; the activities of the supply chain that define the territorial processes are contained in the LUFs categories. The background system is related to the activities of extraction, production, distribution and consumption and each of them generates a certain amount of waste; the foreground system refers to the Waste Management activities that happen in the Focus Area or Region (cf. D4.2).

The collection is a transversal activity, followed by storage, transport and treatment of the collected amount. The territorial component of Waste Management activities can be associated with W6 "Operational Infrastructure of waste". Therefore, Waste Management can be interpreted as a hybrid component

that is halfway between an activity from a process dimension and a Wastescape from a pattern dimension; this depends on the purposes of the analysis.
These territorial processes determine an **effect** represented in the form of impacts at micro, meso and macro level (cf. D4.2) as well as the above-mentioned Wastescapes.
The final step of this chain is the identification of performance indicators (Loiseau et al., 2014), characterized by thresholds for a territorial benchmark. If these thresholds are exceeded, they act on the pattern through degradation processes and they generate the transition from services to disservices. While at the initial life cycle the performance is high and the pattern is in a healthy condition, able to provide goods and services through LUFs, as the territorial processes take place they generate drivers of change and the life cycle tends to run out until it flows into the Wastescapes at the end of the territorial life cycle.
It is provided with a first example of this iterative and cyclical process of characterization, taking in consideration W1 category represented by “degraded lands” and more in-depth the sub-category “polluted soil” in relation to the activity “waste treatment” and to the resource “soil”.

The geographies that describe the reference pattern and the reference activity, apart from the General Geography related to the boundaries, are:
- PG2 “land” and the topics PG2.2 “soil” and PG2.3 “land cover”;
- HG 3 “health” with the topics HG 3.3 “pollution” according to the sub-topic “soil contamination”, HG 3.4 “production and industrial facilities”;
- HG 6 “urban” with the topic HG 6.1 “land use”.

In order to complete the pattern description, it is necessary to establish the corresponding Land Cover and Land Use represented respectively by artificial surfaces and industrial use. From the combination of these to patterns, it is selected the examined LUF that falls in the category: “residential and non land-based industry and services” according to the activity “waste treatment” that defines the process to analyse.
At this point, each Wastescape category is caused by a specific degradation process; in this case it is related to soil. According to EC (2002), the soil degradation processes is represented by the following processes:
- Soil erosion;
- Soil contamination;
- Soil salinization;
- The decline in soil organic matter;
- Soil sealing;
- Floods and landslides;
- Soil compaction;
- Loss of soil biodiversity.

A combination of these processes defines the sub-categories W 1.1 and W 1.2.
Soil contamination in relation to a specific activity of waste management, such as a landfill, will be in particular a local one that “above certain levels entails multiple negative consequences for the food chain and thus for human health” (EC, 2002, p. 12).

Apart from the Contaminated Sites and Potentially Contaminated Sites that are already part of this Wastescape category, it is necessary to identify some performance indicators with a correspondent threshold that can be defined. For example, the emissions intensity of contaminants in soil that is due to Waste Management activities such as heavy metals. Where the intensity exceeds the defined threshold, there is a transition from a service provided by the soil to a disservice or also lack of service. It is definite that soil "loses its capacity to carry out its functions" (European Commission, 2002, p. 9) ending its life cycle until a process of regeneration has started. At this last step, the initial pattern, completely degraded, closes the chain of the entire methodology and waits for the start of new conditions that could allow a new life cycle to be performed.
For the applicability of the methodology among all the partners, a list of performance indicators with the relative source will be provided.

In particular, in regard to the the Organic Waste (OW) flow, the subcategory Food Waste (FW) was identified as a priority issue; with regard to the CDW flow, waste associated with landscape renovation is selected as a crucial point.
In regard to the process model for the AMS case, the focus was restricted to the FW case, taking into account time restrictions and some difficulties related to data collection and processing.
After completing the CDW case, we will proceed to the processing of the case study of FW.

3.7.1 MFA of Food waste

European policies are careful regarding food waste. It is relevant to consider the whole alimentary system from production to consumption including processes and trade. The EU is one of the bigger world producers of food in the world: its productivity per hectare has increased over the second half of 20th century, and has a great environmental impact.

Moreover, it is estimated that about one-third of food produced in the EU is not consumed and this waste concerns every part of the chain. This kind of waste is one of the issues to address in Roadmap to a Resource Efficient Europe. There are no estimates about the amount of food waste in each phase and no data available concerning food waste produced in agriculture and fishing. Every time food is wasted, resources such as land, water, energy and other production factors are lost as a consequence. Therefore, food waste reduction has direct benefits for the environment.

Indeed, the choice for food waste as a material scope is related to the waste hierarchy of the Campania Region correlated with Circular Economy principles.
The new regulation has as its minimum objectives for regional planning the pursuit of 65% of separated waste collection and, for each differentiated fraction, 70% of the material needs to be recovered. The goal is to achieve this by 2020 through actions aimed at:

- Ensuring economic incentives and rewarding measures on tariffs for municipalities with the best results in terms of waste reduction, separate collection and recycling;

- Favouring projects to reduce food waste;
- Promoting projects and actions aimed at reducing urban waste production and end-of-life reuse projects;
- Favouring the differentiated collection systems that guarantee maximum differentiation of waste for recycling purposes and the best quality of separately collected fractions, such as door-to-door home collections or equivalent systems;
- Incentivizing the application of the punctual tariff;
- Promoting the development of plants connected to re-use and recycling both for differentiated fractions and for residual waste;
- Promoting research on residual waste in order to modify the production of non-recyclable goods upstream and the management methods lacking in results;
- Adopting the level of reduction of Residual Urban Waste (RUW) as a criterion for assessing the effectiveness and efficiency of the policies implemented.

Considering the above purposes, the representation and process models are the first step in the REPAiR project to identify a decision support tool for Food Waste (FW).
The work done for the FW material scope in Naples case study will be elaborated according to the 6-steps structure proposed in D3.1, integrated with some additional steps related to new interpretations and reflections.

3.7.1.1 Step 1: Determination of material scope - results

Among the several categories of waste contemplated in REPAiR project, in Campania Region and Naples case study, Organic Waste (OW) is particularly relevant.

The choice related to OW matured on the base of the analysis of hard and soft data and takes into account the REPAiR definition of OW adapted from the European Commission (EC, 1998, 2016) and the EU Fusions project (Östergren et al., 2014).

Indeed, according to the FAO definition, FW is part of Food Loss and refers to discarding or alternative (non-food) use of safe and nutritious food for human consumption along all food supply chains (FAO, 2014). Measurement of FW is a key component of any reduction intervention. At the same time, in Italy, the L. n.166 of 19th of August 2016 “Provisions about donation and distribution of foodstuffs and pharmaceutical products for the social solidarity and for the limitation of waste” expresses awareness about this problem.

3.7.1.2 Step 2: Defining the material supply chain - results

In Italy, Food supply chain is composed of four sectors that represent the whole production process and reach about 1,1 trillion Euro of world interchange: agricultural products, that represent the 60% of the value of goods traded, food and beverage (34%), agricultural machinery and the ones for alimentary transformation, that affects for a residual of 6%.

In order to define the material supply chain for food and product preparation, according to the general framework of the REPAiR project, a set of NACE codes was identified to represent the FW chain and is subdivided into Groups that includes different activities of the Chain.

In Figure 46 it is illustrated the system diagram model of activities and flows that build the general system of the food value chain in the Campania Region area, where the different segments have been identified and explained.

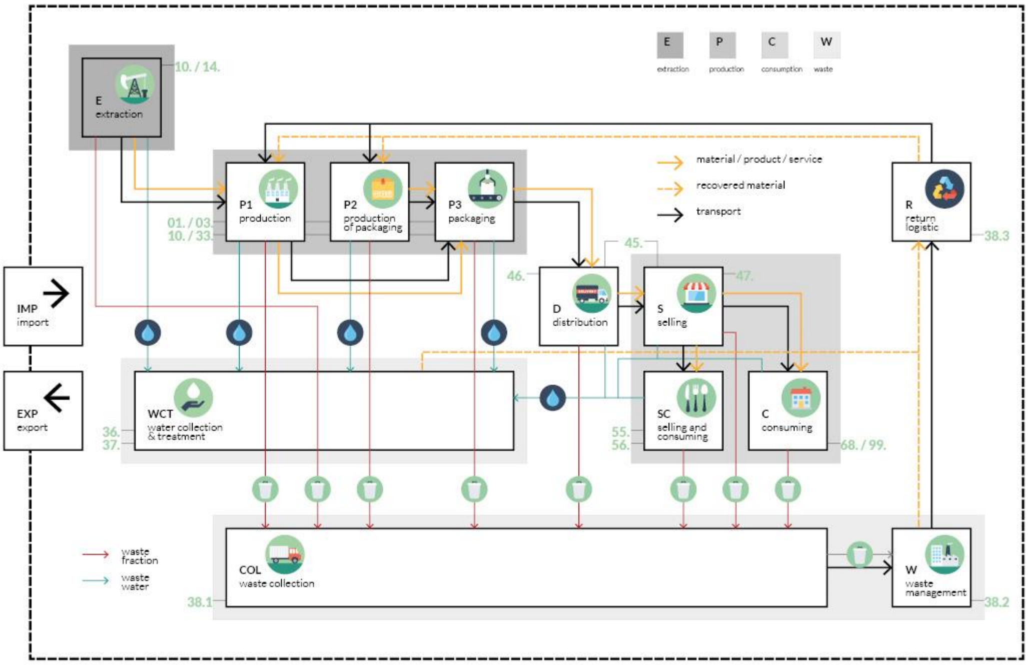

Figure 46: The general system diagram model of activities and flows that build the system of the food value chain in the Campania Region area (P. Inglese elaboration). Click here for a larger image

The selected NACE codes for the Activity Groups (AG), and the interrelations of the AG are displayed in the system diagram in Figure 47 below. The diagram also presents the activities and flows that build the system of the food value chain in the Campania Region area with the identification of related NACE categories.

The selected AG are:

P1: Primary Production - NACE codes Level 4 from Level 2: 01, 03
P2 – P3: Secondary Production - NACE codes Level 4 from Level 2: 10, 11, 12, 14, 15, 16
D - Distribution - NACE codes Level 4 from Level 2: 49, 50
S - Selling - NACE codes Level 4 from Level 2: 46, 47, 52, 68
SC – Selling and consuming - NACE codes Level 4 from Level 2: 50, 56, 81, 82, 86
C – Consuming - NACE codes Level 4 from Level 2: 30, 41, 42, 43
COL - Collection - NACE codes Level 4 from Level 2: 38
W - Waste Management - NACE codes Level 4 from Level 2: 38, 39

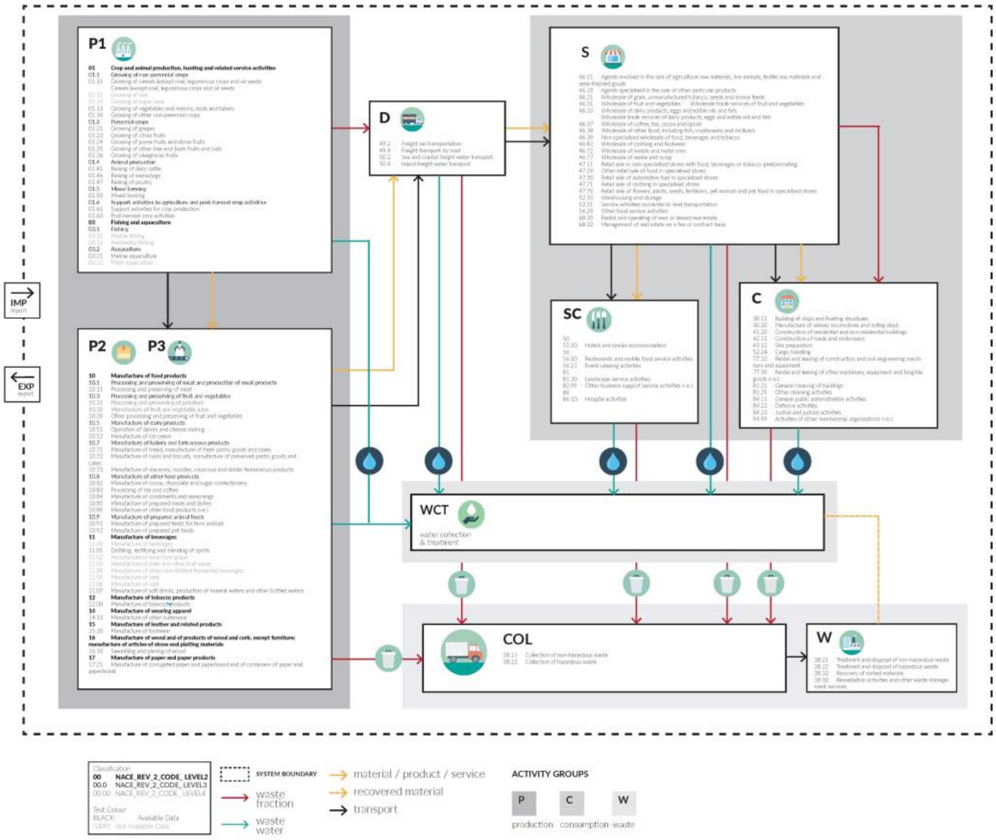

Figure 47: The system diagram of activities and flows that build the system of the food value chain in the Campania Region area with the identification of related NACE categories (P. Inglese and C. Mazzarella elaboration).

3.7.1.3 Step 3: Selection of geographical area & spatial scales - results

For the Naples case study, the Focus Area (FA) identifies 11 municipalities but their boundaries are not the only relevant issue for the MFA (Figure 48).

The FA constitutes a central core that is used to identify and analyse some issues and for collecting representative top-down and bottom-up data.

The geographical area has been defined by the boundaries of the 550 municipalities in the Campania Region. The administrative boundaries of the Campania Region coincide with the studied region, according to which the data is analysed for the different segments of the supply chain.

Figure 48 displays the different levels of boundaries and the cross-scale relations: Italy and its subdivision in 20 regions, the Campania Region and its subdivision in the 550 municipalities, and the Focus Area with the 11 municipalities.

Figure 48: Country area, Region area, Focus area (P. Inglese elaboration)

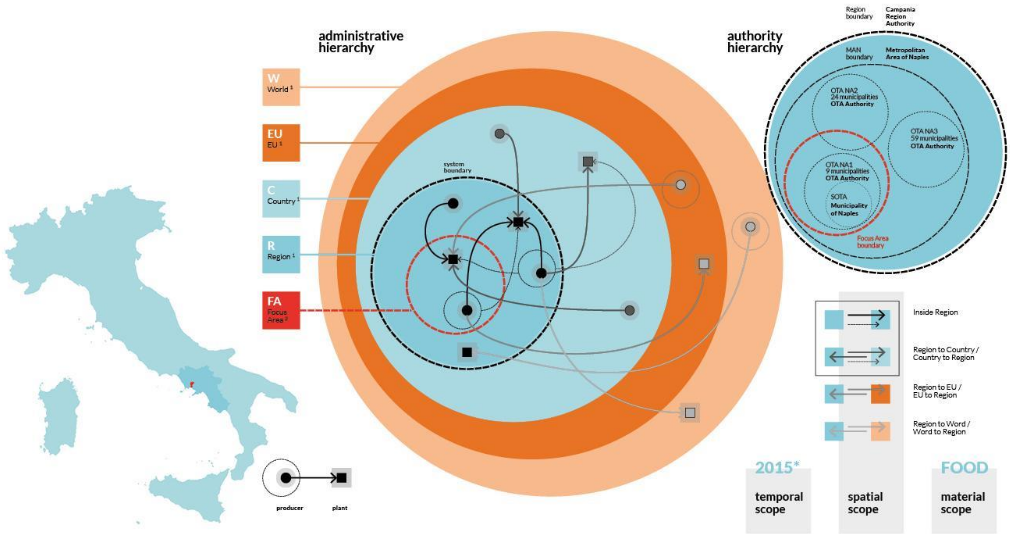

Figure 49: The geographical area, spatial scale and governance institutions (P. Inglese elaboration).

Figure 49 identifies the geographical area, spatial scale and governance institutions. In particular, the analogy between the region as an administrative border and the Campania Region as a competent authority for the governance of waste, which is explained by considering hierarchy of administration and the relations from producer to plant. Specific attention was reserved for the different interactions inside Region and those from Region to Country. The analysis shows that the flows also concern both EU and World Scale. We however do not have adequate information regarding them, therefor these flows are not considered in this analysis.

Table 16: Distribution of number of Municipalities per OTA and per demographic boxes of Municipalities (Year 2015; source ISPRA)

OTA	Naples (Municipality)	Municipalities > 50.000 Inh	Municipalities 20.000 - 50.000 Inh	Municipalities 5.000 - 20.000 Inh	Municipalities < 5.000 Inh	Total Municipalities/OTA
Avellino		1	1	15	96	113
Benevento		1		7	72	80
Caserta		2	9	45	48	104
NA 1	1	4	2	2		9
NA 2		3	9	10	2	24
NA 3		4	15	32	8	59
Salerno		4	10	38	109	161
	1	**19**	**46**	**149**	**335**	**550**

Table 16 provides the distribution of 550 Campania Municipalities in the 7 OTAs, subdivided by population size. Due note should be taken in respect to big differences between OTAs: for example, OTA NA1 is composed of 9 Municipalities with a population of 1,320,337 inhabitants, Salerno OTA has the biggest number of Municipalities (n. 161) with a population of 1,115,271 inhabitants.

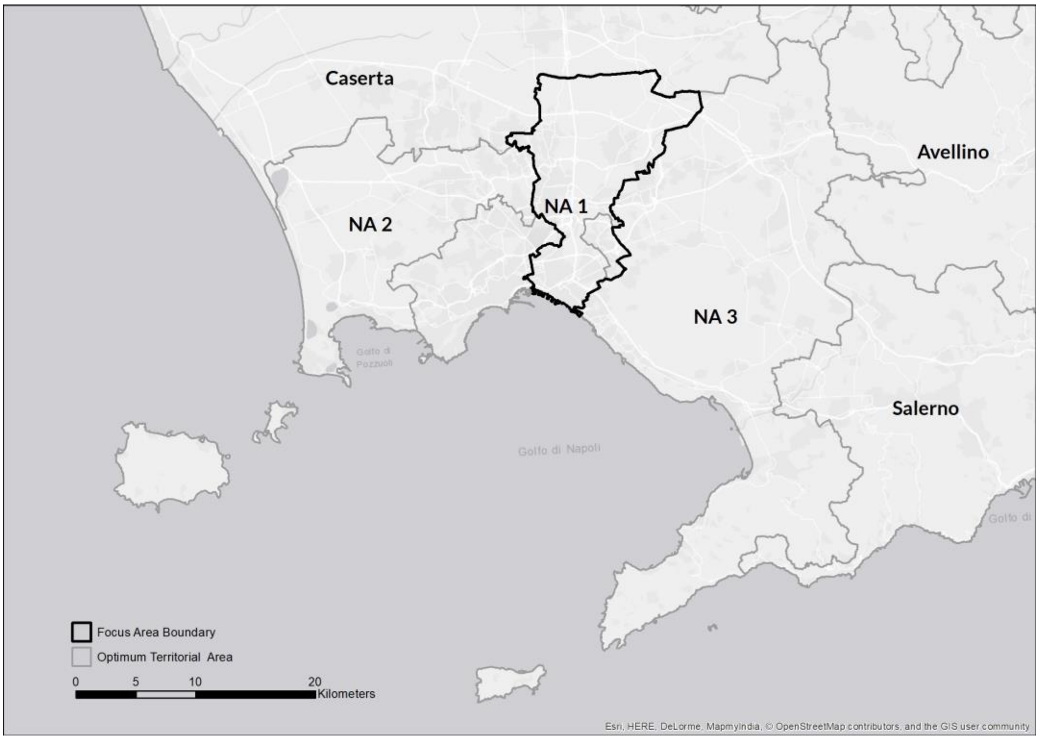

Figure 50: Relations among boundaries of Focus Area and Optimum Territorial Area (P. Inglese elaboration)

Figure 50 presents the FA in relation to the two different OTAs: OTA NA1 (Acerra, Afragola, Caivano, Cardito, Casalnuovo di Napoli, Casoria, Crispano, Frattaminore, Napoli), including the Metropolitan City of Naples, and OTA NA3 (Cercola and Volla).

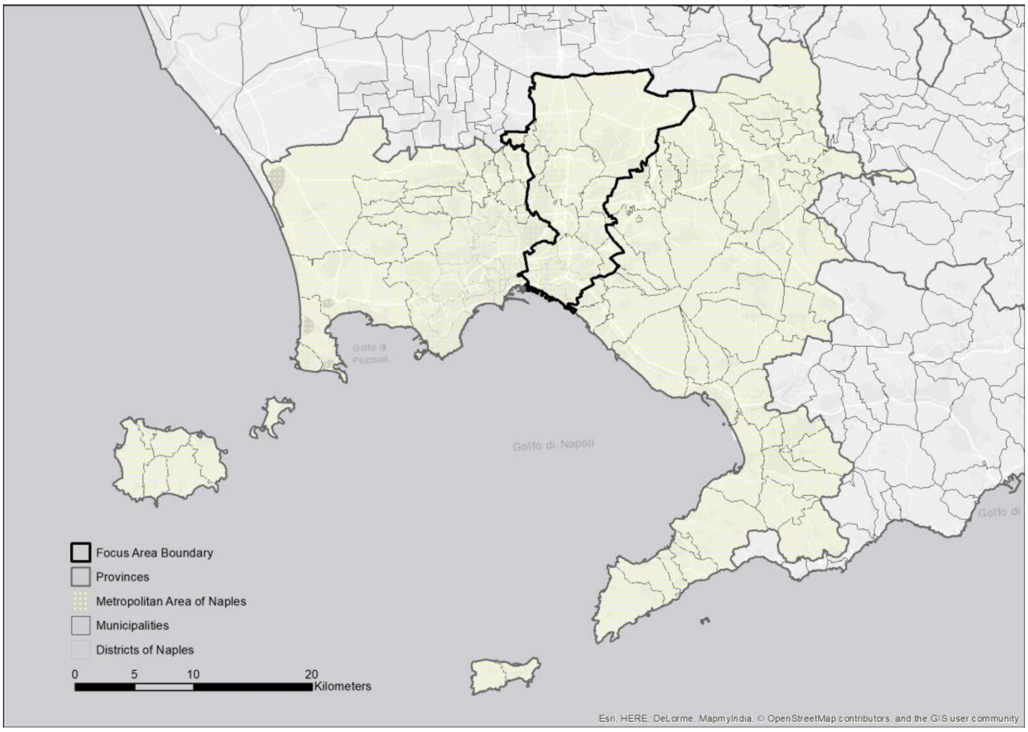

Figure 51: Relations among boundaries of Focus Area, Metropolitan Area of Naples, Municipalities and Districts of Naples (P. Inglese elaboration).

Figure 51 shows the relations among boundaries of the Focus Area, the Metropolitan Area of Naples and Municipalities and Districts of Naples. Administrative boundaries identify a clear conflict of competences between the various institutional bodies operating in the territory under study.

Figure 52: Municipalities of Focus Area related two OTA (P. Inglese elaboration)

Figure 52 shows the 11 municipalities and their belonging to the two OTAs (NA1 and NA3).

Figures 53 and 54 identify the main scales of information analysed for two levels of aggregation/disaggregation: the municipal boundaries for the aggregated information and the census area boundaries for the disaggregated information.

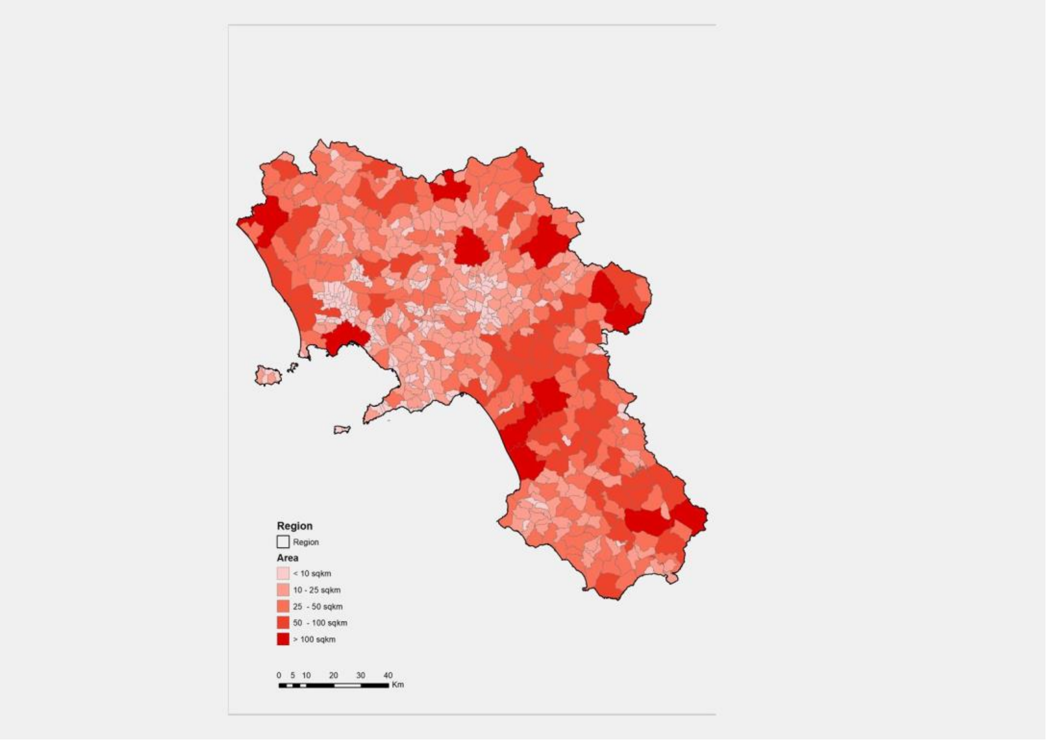

Figure 53: Region scale. Classes of Territorial Surface for the municipal boundaries (P. Inglese elaboration)

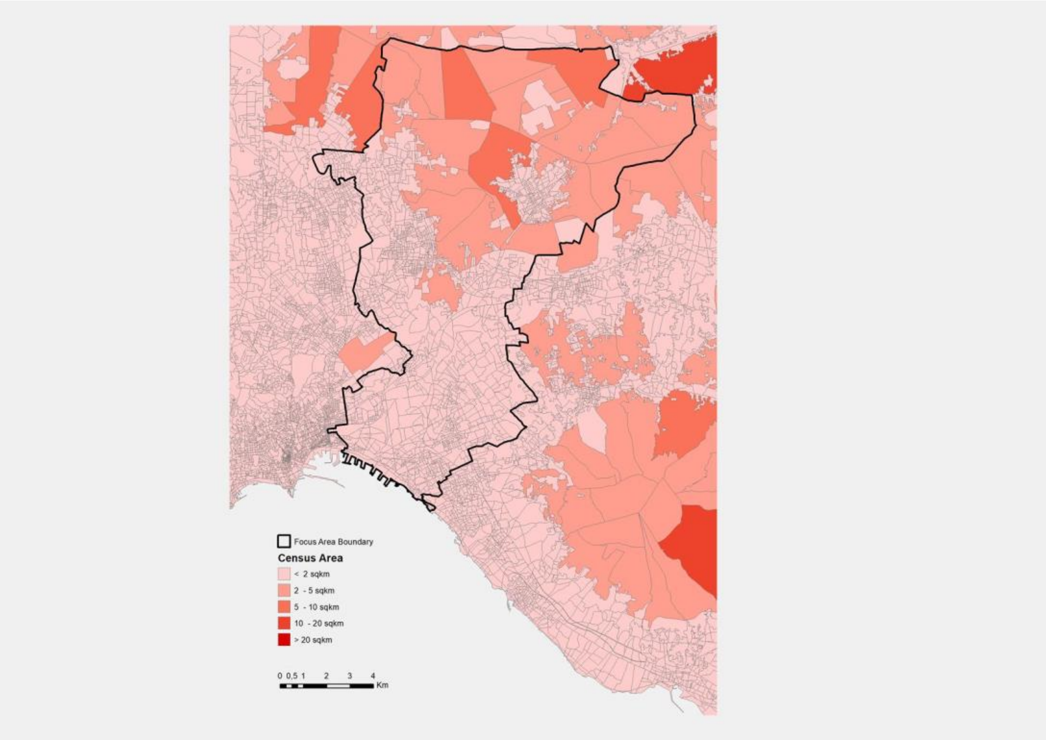

Figure 54: Focus Area scale. Classes of Territorial Surface for the census area (P. Inglese elaboration)

3.7.1.4 Step 4: Defining case specific supply chain - Preliminary results

The activities relevant to the FW chain were defined in step 2 and the geographical area was defined in step 3.
In step 4 the actors that generate FW are identifies and described. This will be completed separately for companies (Activity Groups P1-P2-P3, D, S, SC, WCT*, COL*, W* and RL*) and households (subgroup of C).

We can then compare the two different levels of information, one related to the Regional scale and the other to the FA scale, in order to return an informative framework useful for characterizing the two categories that generate waste.

Figures 55 and 56 show the comparison between the characteristics (in absolute value and in relation to the Territorial Surface) used to describe households (inhabitants, houses, households) and the characteristics used to describe companies (local units, and employees) at the two different scales.

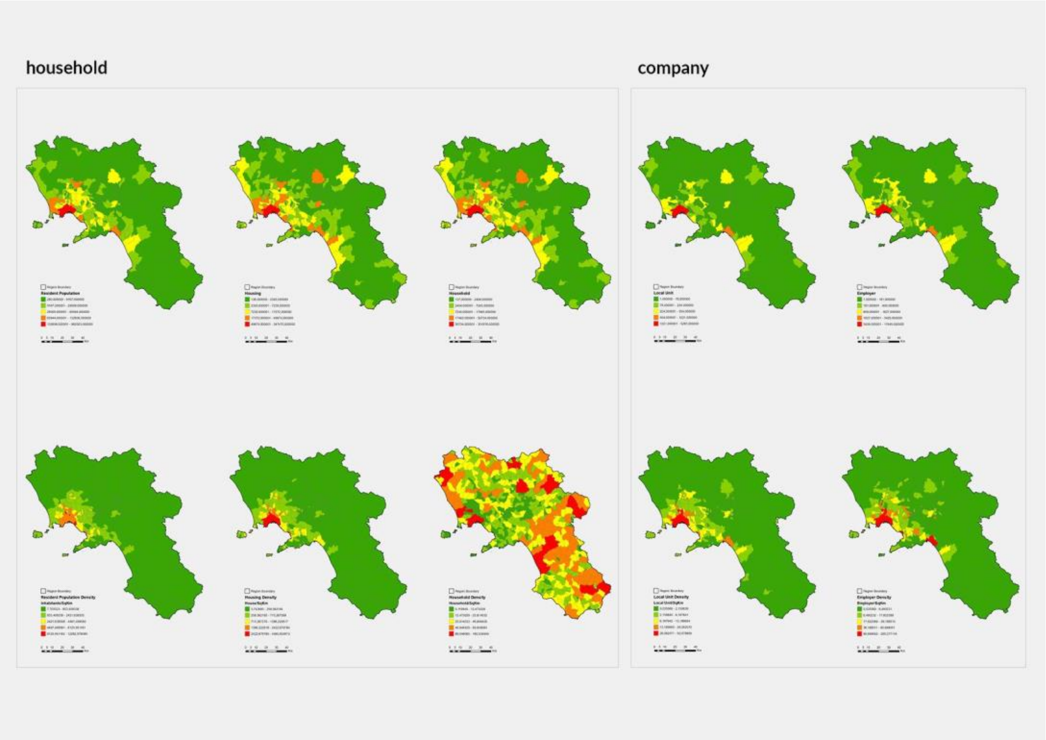

Figure 55: Characteristics at the Region scale (P. Inglese elaboration). Click here for larger image

The Region scale defines the grid of characteristics aggregated for municipality boundaries.

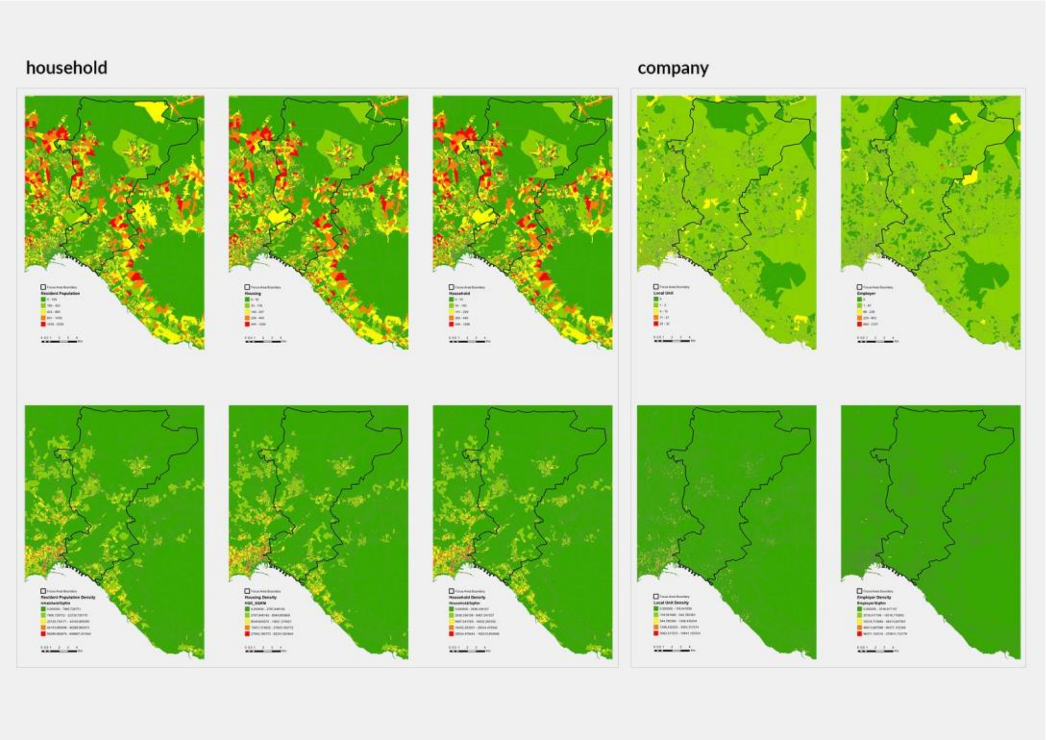

Figure 56: Characteristics at the FA scale (P. Inglese elaboration). Click here for a larger image

The FA scale defines the grid of characteristics disaggregated for the census section.

Companies in the FW chain

The Italian agri-food sector represents world excellence in terms of quality, safety, and the cutting edge in innovation technology, sustainability, biodiversity and respect of traditions.
In Italy, great territorial differences have led to the creation of a large number of small companies that are not able to compete with foreign markets and invest in the value of uniqueness of their products.
According to the dossier of Eurostat "Agriculture, forestry and fishery statistics" (2016), Italy is the second power in agriculture in EU with an annual turnover of more than 55 billion Euro in 2015 and according to the last general agricultural census, realised by ISTAT, 1,630,420 agricultural and livestock holdings were active.
Puglia is the Region with the highest number of agricultural holdings (more than 275 thousand), followed by Sicily (219 thousand), Calabria (138 thousand), Campania (137 thousand), and Veneto (121 thousand). In these Regions, it is concentrated the 54,6% of Italian agricultural holdings.

The Campania Regions productive fabric consists of 571,955 thousand registered companies, equal to 28.6% of the companies of Southern of Italy (1,998,441) and 9.4% of national territory (6,057,647); it is a productive system that, even with some significant internal differences, is composed by a lot of small and medium-sized companies that represents the backbone of the Regional economic system.

Table 17: Numbers of total registered companies in the provinces of Campania Region divided for economic activity sector. (Year 2015; Absolute values)

Province	Agriculture	Industry	Construction	Business	Other services	Not classified
Avellino	11,023	4,282	4,995	10,679	9,218	3,672
Benevento	11,418	2,598	3,556	7,206	6,817	3,126
Caserta	12,359	6,641	13,470	29,797	19,068	9,465
Napoli (MAN)	9,973	25,457	31,795	117,569	77,651	20,713
Salerno	17,364	10,371	13,524	36,786	31,383	9,979
Total	**62,137**	**49,349**	**67,340**	**202,037**	**144,137**	**46,955**

Source: Processing Institute Guglielmo Tagliacarne Foundation on Unioncamere – Infocamere data

For the selection of the NACE codes, the Orbis database was incomplete and not useful to perform a suitable analysis. Indeed, it has information related to only

265,653 of 571,955 thousand companies, and therefore the data used derive from National/Regional Database (cf. 3.2.1.4).
At first glance, the number of companies found for the FW chain in the Campania Region can be seen in Table 18. From this, we can establish that the identification of the activity group within the flow model was carried out by considering the information collected on a regional scale and by selecting all the actors that generate organic fraction as output. Therefore, the categories shown are those that actually generate a waste stream that can be traced through the collected data.

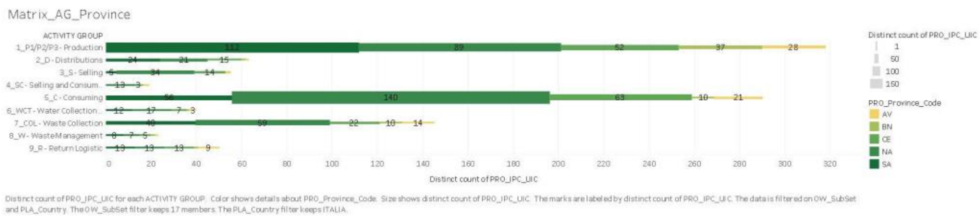

Figure 57: Number of companies for Activity Group for Province (P. Inglese elaboration). Click *here* *for a larger image*

Table 18: Detailed count of the company for Activity Group per NACE Code (P. Inglese elaboration).

Activity Groups_Actor Count

Producer Number 1 – 92

ACTIVITY GROUP	PRO_NACE_SE..	PRO_NACE..	NACE_DESCRIPTION	
Grand Total				680
1_P1/P2/P3 - Production	Total			317
	A	A-01.11	Growing of cereals (except rice), leguminous crops and oil seeds	3
		A-01.13	Growing of vegetables and melons, roots and tubers	11
		A-01.19	Growing of other non-perennial crops	2
		A-01.21	Growing of grapes	22
		A-01.23	Growing of citrus fruits	1
		A-01.25	Growing of other tree and bush fruits and nuts	1
		A-01.41	Raising of dairy cattle	7
		A-01.46	Raising of swine/pigs	1
		A-01.47	Raising of poultry	1
		A-01.50	Mixed farming	1
		A-01.61	Support activities for crop production	3
		A-01.63	Post-harvest crop activities	3
		A-03.21	Marine aquaculture	1
	C	C-10.11	Processing and preserving of meat	4
		C-10.13	Production of meat and poultry meat products	1
		C-10.20	Processing and preserving of fish, crustaceans and molluscs	5
		C-10.31	Processing and preserving of potatoes	1
		C-10.32	Manufacture of fruit and vegetable juice	1
		C-10.39	Other processing and preserving of fruit and vegetables	92
		C-10.41	Manufacture of oils and fats	4
		C-10.51	Operation of dairies and cheese making	42
		C-10.52	Manufacture of ice cream	2
		C-10.71	Manufacture of bread; manufacture of fresh pastry goods and cakes	6
		C-10.72	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	6
		C-10.73	Manufacture of macaroni, noodles, couscous and similar farinaceous products	7
		C-10.82	Manufacture of cocoa, chocolate and sugar confectionery	6
		C-10.83	Processing of tea and coffee	9
		C-10.84	Manufacture of condiments and seasonings	2
		C-10.85	Manufacture of prepared meals and dishes	3
		C-10.89	Manufacture of other food products n.e.c.	3
		C-10.91	Manufacture of prepared feeds for farm animals	1
		C-10.92	Manufacture of prepared pet foods	1
		C-11.01	Distilling, rectifying and blending of spirits	4
		C-11.02	Manufacture of wine from grape	10
		C-11.07	Manufacture of soft drinks; production of mineral waters and other bottled waters	4
		C-12.00	Manufacture of tobacco products	1
		C-14.13	Manufacture of other outerwear	2
		C-15.20	Manufacture of footwear	1
		C-17.12	Manufacture of paper and paperboard	1
		C-17.21	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	3
		C-17.23	Manufacture of paper stationery	1
		C-19.20	Manufacture of refined petroleum products	2
		C-21.10	Manufacture of basic pharmaceutical products	3
		C-21.20	Manufacture of pharmaceutical preparations	2
		C-22.11	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres	1
		C-22.22	Manufacture of plastic packing goods	1
		C-22.29	Manufacture of other plastic products	1
		C-23.61	Manufacture of concrete products for construction purposes	1
		C-23.63	Manufacture of ready-mixed concrete	1
		C-24.45	Other non-ferrous metal production	1
		C-25.11	Manufacture of metal structures and parts of structures	1
		C-25.50	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	1
		C-25.61	Treatment and coating of metals	2
		C-25.91	Manufacture of steel drums and similar containers	1
		C-25.92	Manufacture of light metal packaging	1
		C-26.11	Manufacture of electronic components	1
		C-27.11	Manufacture of electric motors, generators and transformers	2
		C-28.22	Manufacture of lifting and handling equipment	1
		C-28.29	Manufacture of other general-purpose machinery n.e.c.	1
		C-29.32	Manufacture of other parts and accessories for motor vehicles	1
		C-30.11	Building of ships and floating structures	1
		C-30.20	Manufacture of railway locomotives and rolling stock	2
		C-30.30	Manufacture of air and spacecraft and related machinery	3
		C-33.12	Repair of machinery	1
		C-33.16	Repair and maintenance of aircraft and spacecraft	1
		C-33.17	Repair and maintenance of other transport equipment	2
		C-33.20	Installation of industrial machinery and equipment	2
2_D - Distributions	Total			50
	G	G-46.11	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods	1
		G-46.21	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds	3
		G-46.24	Wholesale of hides, skins and leather	1
		G-46.31	Wholesale of fruit and vegetables	11
		G-46.33	Wholesale of dairy products, eggs and edible oils and fats	1
		G-46.34	Wholesale of beverages	1
		G-46.35	Wholesale of tobacco products	1
		G-46.37	Wholesale of coffee, tea, cocoa and spices	5
		G-46.38	Wholesale of other food, including fish, crustaceans and molluscs	8
		G-46.39	Non-specialised wholesale of food, beverages and tobacco	3
		G-46.42	Wholesale of clothing and footwear	2
		G-46.44	Wholesale of china and glassware and cleaning materials	1
		G-46.46	Wholesale of pharmaceutical goods	8
		G-46.71	Wholesale of solid, liquid and gaseous fuels and related products	1

Producer Number broken down by ACTIVITY GROUP, PRO_NACE_SECTIONS, PRO_NACE_S_4 and NACE_DESCRIPTION. Color shows Producer Number. The marks are labeled by Producer Number. The data is filtered on OW_SubSet and PRO_OnlyTransport. The OW_SubSet filter keeps 17 members. The PRO_OnlyTransport filter keeps 0.

Table 19: Detailed count of the company for Activity Group per NACE Code (P. Inglese elaboration).

Activity Groups_Actor Count

Producer Number: 1 – 92

ACTIVITY GROUP	PRO_NACE_SE..	PRO_NACE..	NACE_DESCRIPTION	
2_D - Distributions	G	G-46.72	Wholesale of metals and metal ores	1
		G-46.90	Non-specialised wholesale trade	2
3_S - Selling	Total			55
	G	G-47.11	Retail sale in non-specialised stores with food, beverages or tobacco predominating	2
		G-47.22	Retail sale of meat and meat products in specialised stores	3
		G-47.29	Other retail sale of food in specialised stores	2
		G-47.30	Retail sale of automotive fuel in specialised stores	1
		G-47.52	Retail sale of hardware, paints and glass in specialised stores	1
		G-47.71	Retail sale of clothing in specialised stores	1
		G-47.73	Dispensing chemist in specialised stores	43
		G-47.76	Retail sale of flowers, plants, seeds, fertilisers, pet animals and pet food in specialised stores	1
		G-47.99	Other retail sale not in stores, stalls or markets	1
4_SC - Selling and Consuming	Total			19
	G	G-55.10	Hotels and similar accommodation	4
		G-56.10	Restaurants and mobile food service activities	10
		G-56.21	Event catering activities	1
		G-56.29	Other food service activities	3
		G-56.30	Beverage serving activities	1
5_C - Consuming	Total			163
	C	C-35.11	Production of electricity	1
	E	E-39.00	Remediation activities and other waste management services	2
	F	F-41.20	Construction of residential and non-residential buildings	19
		F-42.11	Construction of roads and motorways	1
		F-42.12	Construction of railways and underground railways	1
		F-42.21	Construction of utility projects for fluids	4
		F-42.91	Construction of water projects	1
		F-42.99	Construction of other civil engineering projects n.e.c.	4
		F-43.13	Test drilling and boring	1
		F-43.21	Electrical installation	1
		F-43.22	Plumbing, heat and air-conditioning installation	2
		F-43.29	Other construction installation	5
	G	G-45.20	Maintenance and repair of motor vehicles	2
		G-49.10	Passenger rail transport, interurban	2
		G-49.31	Urban and suburban passenger land transport	1
		G-49.41	Freight transport by road	15
		G-50.10	Sea and coastal passenger water transport	1
		G-52.10	Warehousing and storage	7
		G-52.21	Service activities incidental to land transportation	4
		G-52.22	Service activities incidental to water transportation	2
		G-52.23	Service activities incidental to air transportation	1
		G-52.24	Cargo handling	1
		G-52.29	Other transportation support activities	2
	K	K-68.20	Rental and operating of own or leased real estate	2
		K-68.32	Management of real estate on a fee or contract basis	1
	M	M-70.22	Business and other management consultancy activities	1
		M-71.20	Technical testing and analysis	1
		M-72.19	Other research and experimental development on natural sciences and engineering	2
		M-74.90	Other professional, scientific and technical activities n.e.c.	1
		M-75.00	Veterinary activities	1
	N	N-81.21	General cleaning of buildings	7
		N-81.22	Other building and industrial cleaning activities	3
		N-81.29	Other cleaning activities	1
		N-81.30	Landscape service activities	10
		N-82.92	Packaging activities	1
		N-82.99	Other business support service activities n.e.c.	5
		N-84.11	General public administration activities	18
		N-84.22	Defence activities	4
		N-84.23	Justice and judicial activities	1
		N-85.42	Tertiary education	2
		N-86.10	Hospital activities	2
		N-88.10	Social work activities without accommodation for the elderly and disabled	1
		N-94.11	Activities of business and employers membership organisations	1
		N-94.99	Activities of other membership organisations n.e.c.	3
		N-95.12	Repair of communication equipment	1
		N-96.03	Funeral and related activities	2
		N-96.09	Other personal service activities n.e.c.	11
		N-99.00	Activities of extraterritorial organisations and bodies	1
6_WCT - Water Collection and Treatment	Total			7
	E	E-37.00	Sewerage	7
7_COL - Waste Collection	Total			28
	E	E-38.11	Collection of non-hazardous waste	24
		E-38.12	Collection of hazardous waste	4
8_W - Waste Management	Total			14
	E	E-38.21	Treatment and disposal of non-hazardous waste	9
		E-38.22	Treatment and disposal of hazardous waste	5
9_R - Return Logistic	Total			27
	E	E-38.32	Recovery of sorted materials	27

Producer Number broken down by ACTIVITY GROUP, PRO_NACE_SECTIONS, PRO_NACE_S_4 and NACE_DESCRIPTION. Color shows Producer Number. The marks are labeled by Producer Number. The data is filtered on OW_SubSet and PRO_OnlyTransport. The OW_SubSet filter keeps 17 members. The PRO_OnlyTransport filter keeps 0.

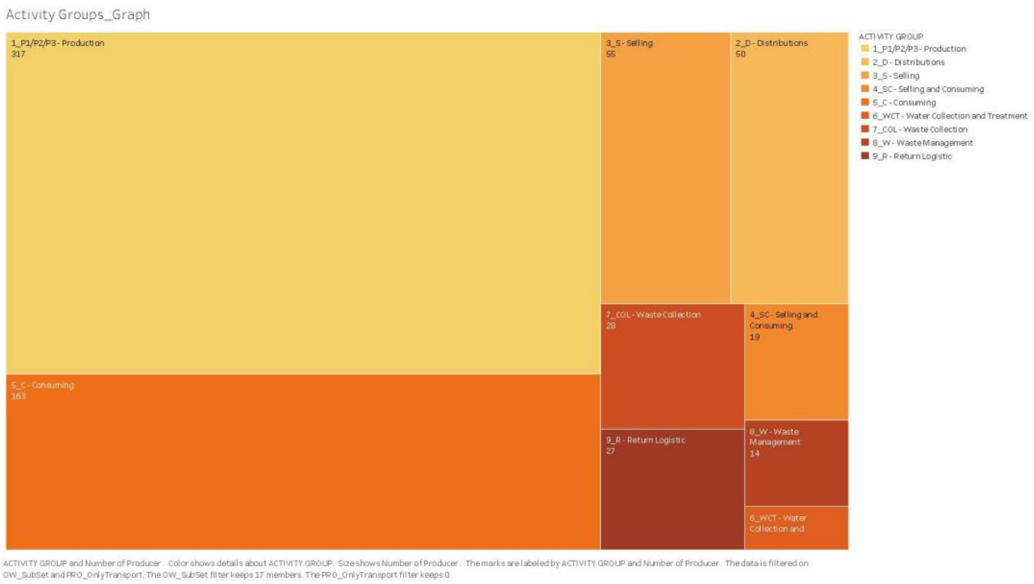

Figure 58: Count of the company for Activity Group (P. Inglese elaboration).

Food waste from Households

Although households produce a significant part of FW, consumption in households isn't identified through NACE codes. Therefore, the data implemented is related to: number of families, number of housing, number of inhabitants included in census sections. Data is derived from National Institute of Statistic (ISTAT), the main Italian corporate body of research, and is related to the census of 2011.

Table 20: In Campania Region, in 2011 the total resident population reaches 5,766,810 inhabitants. In the Metropolitan City of Naples, in the same year, live 3,054,956 inhabitants

Province	Inhabitants	House	Household
Avellino	429,157	161,330	165,689
Benevento	284,900	108,431	112,061
Caserta	904,921	319,176	325,887
Napoli (MAN)	3,054,956	1,041,100	1,053,267
Salerno	1,092,876	396,119	403,522
Total	**5,766,810**	**2,026,156**	**2,060,426**

It is relevant to observe that in Campania Region, in 2011 the total resident population reaches 5,766,810 inhabitants. In the same year in the Metropolitan City of Naples, lived 3,054,956 inhabitants.

3.7.1.5 Step 5: Activity-based mass flow modelling

Waste is firstly collected considering the source it comes from. It is, therefore, distinguished in urban, better known as Municipal Solid Waste (MSW), coming from household and similar activities* and Special Waste (SW) coming from industrial, handcrafted, commercial and service industry activities.

A further criterion, used in order to classify waste, concerns its dangerousness. Special waste can, indeed, be divided in hazardous and non-hazardous. Urban Waste as well can contain a hazardous component related to the presence of polluting and toxic substances (Figure 59).

Furthermore, the content of MSW is formed by the quantity coming from household as well as the one coming from activities that produce a typology of waste assimilated by amount and by quality to the household one. Therefore, households represent a subset of the actors that produce MSW.

	Urban	Special
Non-Hazardous	→ Household → Comparable to municipal waste in quality and quantity → From street sweeping or of all kind, that remain in public space → From green areas, as gardens and parks and from cemeteries	→ From agricultural and agro-industrial activities → From construction, demolition and excava-tion → From industrial processing, artisanal manu-facture, commercial and service activities → From recovering and disposal activities and from mechanical selection activities of municipal solid waste → From health activities → Machines and equipment that are deteriora-ted and obsolete, motor vehicles, trailers and similars down and them parts
Hazardous	→ Waste that, in spite of household origin, contain polluting and toxic substances and, therefore, need to be disposed in special plants (batteries, lead-acid accumulators; expired medicines, contaminated packaging, tv, monitors, refrigerators, air-conditioning and lamps; mineral olis; etc.)	→ Waste generated by pructive activities that contains an high percentage of pollutants inside and that need to be treated to get innocuous before dismantling. For this purpouse are planned specific collection arrengment, storage, transport and final disposal (waste from petrolchemical and farmaceutical productions; metallurgi-cal waste, sludges from clean-up activities; etc.)

Figure 59: Classification of Waste for origin and type (source: D.Lgs. 152/2006) (P. Inglese elaboration)

Urban waste management is regulated from public authority and is based on a network of public, public-private or private managers of the service, each of them is completely responsible for management of several phases of collection, transport and waste management including the phases of waste recovery and disposal at plant.

Municipal Solid Waste and Regional Municipal Waste Managment Plan (Piano Regionale di Gestione dei Rifiuti Urbani, PRGRU)

Municipal Solid Waste (MSW) is a kind of waste produced in activities of consumption and selling, consumption by Household (HH) and Similar to household (SHH) activities. PRGRU plan provides that this waste should be separated from Sorted Collection (SC) to recover: Organic Waste (OW), Paper and Paperboard Waste (PPW), Plastic Waste (PW), Glass Waste (GW), Metal Waste (MW), Wood Waste (WW), Electrical and Electronic Equipment Waste (EEEW).

OW recovering in Biological Treatment Plants produces Secondary Raw Organic material (such as compost) and energy (biogas), but not recoverable Liquid Effluent. All other sorted materials that go through specific Sorted Treatment Plants let Secondary Raw Inorganic Material be Recycled and Reused. Residual Solid Waste (RSW) that is treated with Mechanical-Biological Treatment (MBT), in addition to Dry Fraction that is sent to Incinerator to produce energy, produces Wet and Ferrous Fractions that could be recovered as Secondary Raw Material.

According the Regional Plan, Hazardous Waste, produced in HH and SHH activities, must be treated in plants with chemical-physical operations and then disposed of in landfills.

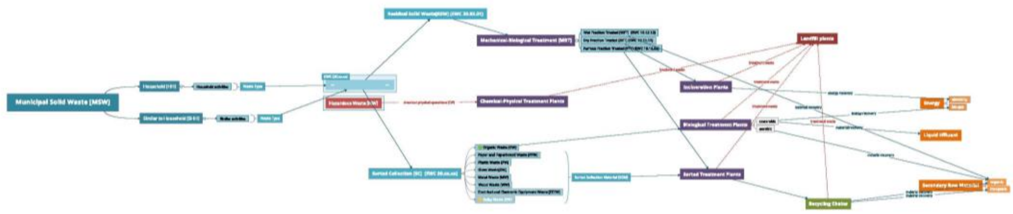

Figure 60: Municipal Solid Waste scheme (P. Inglese elaboration). Click here for a larger image

Special waste and Regional Special Waste Managment Plan (Piano di Gestione Regionale dei Rifiuti Speciali, PRGRS)

Waste produced by companies and activities are categorized as Special.

According to Special Waste Management Plan (PRGRS), SW is composed of products from Agriculture and Agro-Industry, Construction and Demolition, Industry, Commerce and Services. All these activities produce Hazardous Waste; HW of MSW must be treated with chemical-physical operations and then disposed of in landfills. SW classified by EWC 02 must be treated in Biological Treatment Plants to Recover Energy (biogas) and Secondary Raw Material.

CDW (EWC 17 code) that is treated by Sorted Treatment Plants produces secondary raw inorganic material. Waste from industry, commerce and services (EWC 20) produces different types of waste whose organic and inorganic material has to be recovered through Biological Treatment Plants and Sorted Treatment Plants, while RSW is intended to Incineration Plant.

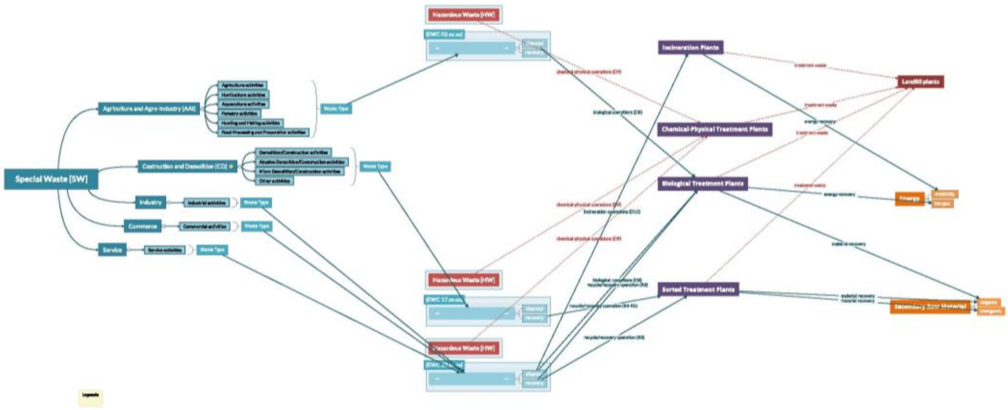

Figure 61: Special Waste scheme (P. Inglese elaboration). Click here for a larger image

MSW is classified with EWC code 20 (household waste and similar commercial, industrial and institutional wastes) including separately collected wastes'. This implies that if households generate a waste type and commercial, industrial and institutional companies also generate the same waste type, this waste will be allocated to the same code.

For example, when a household generates kitchen waste or when a canteen belonging to an office or manufacturing activity generates kitchen waste and the waste is separately collected this waste has the same code according to the European List of Waste (Biodegradable kitchen and canteen waste - 20 01 08).

It will also have the same code if the generated kitchen waste is not separately collected but is a part of the mixed municipal waste bin (code 20 03 01).

Furthermore, there is a portion of producers that are not obliged to draw up the MUD, such as small businesses, and there are also temporary users like tourists, whose waste flows cannot be traced.

However, if a company generates waste as a result of processing meat and other foods, this waste is not similar in its nature to household waste and it will be allocated a code belonging to chapter 2 of the LoW (Wastes from agriculture, horticulture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing) (Eurostat – Unit E2 – Environmental statistics and accounts; sustainable development, Guidance on municipal waste data collection, May 2017).

ANNEX I – Eurostat/OECD Definition of municipal waste

Wording from the Definition-Section of the Joint Questionnaire

Municipal waste includes household waste and similar waste.

It also includes:

- bulky waste (e.g. white goods, old furniture, mattresses), and
- yard waste, leaves, grass clippings, street sweepings, the content of litter containers, and market cleansing waste,

if managed as waste.

It includes waste originating from:

- households,
- commerce and trade, small businesses, office buildings and institutions (schools, hospitals, government buildings).

It also includes:

- waste from selected municipal services i.e. waste from park and garden maintenance, waste from street cleaning services (street sweepings, the content of litter containers, market cleansing waste),

if managed as waste.

It includes waste from these sources collected:

- door-to-door trough traditional collection (mixed household waste), and
- fractions collected separately for recovery operations (through door-to-door collection and/or through voluntary deposits).

For the purpose of this questionnaire municipal waste refers to waste defined as above, collected by or on behalf of municipalities.

The definition also includes waste from the same sources and similar in nature and composition which:

- are collected directly by the private sector (business or private non-profit institutions) not on behalf of municipalities (mainly separate collection for recovery purposes),
- originate from rural areas not served by a regular waste service, even if they are disposed by the generator.

The definition excludes:

- waste from municipal sewage network and treatment,
- municipal construction and demolition waste.

Figure 62: Classification of Waste for origin and type (source: Eurostat – Unit E2 – Environmental statistics and accounts; sustainable development, Guidance on municipal waste data collection, May 2017)

On the basis of the aforementioned waste classification, urban waste and assimilated ones (MSW) are managed by the Municipality, whereas for all other types of waste, the producer (or the holder) have to ensure waste management on his own initiative and at its own expense according to the priority laid down by the article n. 188, comma 2, D.L. 15/2006.

Data gathering

In Italy data on waste is held by Waste Cadastre of Superior Institute for the Environmental Protection and Research (ISPRA) – National Centre for waste cycle.

The Waste Registry manages databases related to the amount of MSW and SW produced in Italy. It has the fundamental role of ensuring the full and constantly updated knowledge framework of data related to the production and management of waste on a national scale. The framework is necessary to perform monitoring activities, planning, and environmental control operated by competent authorities.

Data acquired by ISPRA, thanks to regional sections of Registry and all the public bodies that own this kind of information are processed and published annually (article 189 (6) Legislative Decree n. 152/2006).

On the basis of the existing legislation in Campania, Figure 63 shows informative flows of waste production and management data and relatives monitoring systems.

Mainly, it can be observed that Campania Municipalities are the only ones in Italy that have to produce four communications to four different data collection systems (ORR – MUD – SISTRI and ANCI Database – CONAI): the result is a large quantity of information in systems not interconnected and not comparable to each other.

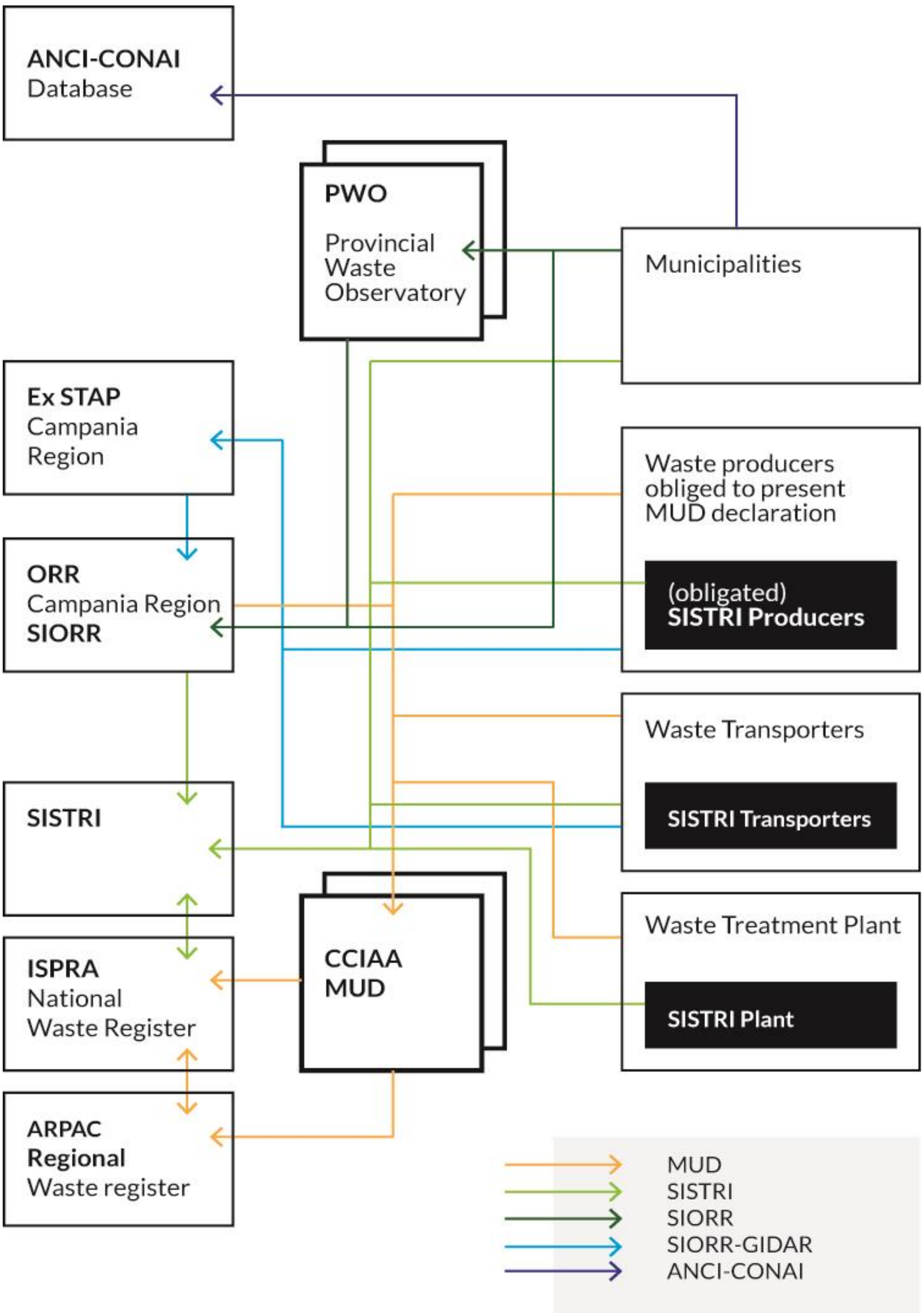

Figure 63: Diagram of informative flows related to waste production and management data and related to Campania monitoring systems (source: PRGRU) (P. Inglese and C. Mazzarella elaboration)

In Figure 63, in blocks are identified:
- Data producers:
  a) Municipalities and MSW producers;
  b) Waste producers with disclosure requirement Sistri or MUD;
  c) Waste transporters, with the specifics of those with Sistri disclosure requirement;
  d) Waste managers, with the specifics of those with Sistri disclosure requirement.

-Entities or relevant bodies monitoring waste management data with an indication of relatives monitoring systems:
  a) Regional Waste Observatory (Osservatorio Regionale Rifiuti ORR - SIORR);
  b) Provincial Waste Observatory (Osservatori Provinciali Rifiuti OPR);
  c) Ex STAP of Campania Region (GIDAR);
  d) National division of waste register (ISPTRA – Telematic register);
  e) The regional division of waste register (ARPAC – Waste register);
  f) SISTRI (Ministry of Environment);
  g) Database ANCI-CONAI.

In Campania Region, the detailed information related to waste is organized in two databases managed by two different regional bodies.

The Regional Waste Registry (RWR) handled by the Regional Environmental Protection Agency (ARPAC – Regional Agency for Enviromental Protection in Campania) collects in one database all data related to waste production and management. The Information System of Regional Waste Observatory (ISRWO), which is handled by Campania Region Authority - General Management for Integrated cycle of water and waste and Evaluation and Environmental Permit, improves and controls the traceability system of urban and hazardous waste and analyzes the trend of their production.

These two regional bodies process all the information on waste flows on the basis of two logistic documents. The RWR manages the information taken from the Unique Model of Environmental Statement (MUD), that identifies a series of statements annually submitted by waste plants, transporters and producers to Chamber of Commerce. The ISRWO instead manages the information derived from Waste Identification Form (FIR), a document joint to waste transport that is made by an authorized transporter and owns all the information related to the type of waste, producer, transporter and receiver.

Both databases provide information on the whole life cycle by classifying waste on the basis of EWC code (in Italian CER) but they differ in the monitored informative contest. The ISWRO owns the information related to production, transport and treatment of waste in urban areas excluding all the companies obliged to submit the MUD (companies with more than 10 employees or companies that produce special waste). The RWR owns the information related to production, transport and treatment of waste from companies.

The following three steps in the chain will present the data availability and gathering approach: 1) generation, 2) collection and 3) treatment. The following section will cover for the households (contained in C - Consuming) and companies (contained in P1-P2-P3 – Production, D-Distribution, S-Selling and SC- Selling and Consuming + WCT-Water Collect and Treatment, COL-Waste Collection, W-Waste Management, RL-Return Logistics).

Household waste flow data

Municipal waste management in Europe has become more and more complex in the last decade. This complexity is due in some extent to the introduction of additional facilities for pre-treatment of waste; mainly mechanical biological treatment and sorting for recovery. In addition, there are legal requirements for increasing the recovery of certain waste streams, resulting also in increasing cross-boundary transports of waste for recovery. Depending on national waste management and waste data collection systems, the approaches for MSW data collection establishes in the Member States vary to a large extent thus hampering data comparability across countries.

Focusing on the aspect of the similarity between MSW produced by household and MSW produced by other activities, Eurostat offered an option on how the scope of MSW could be expressed in terms of European classifications. This option is based on the principle that the scope of MSW includes household waste and similar waste types generated by sources other than households, regardless of whether municipalities or private actors are responsible for the collection. Recent experiences demonstrate that a relevant number of countries include amounts of mixed municipal waste from all NACE activities in the municipal waste data (see annexe 1).

Furthermore, one can argue that the overall target is to reduce the unsorted, mixed MSW regardless of the origin. If this should be done, it is consistent to cover the separately collected fractions from all origins as well. Therefore, the starting point for the waste types to be included are the waste codes listed in chapter 20 of the European List of Waste (LoW) with some additions from sub-chapter 15 01)

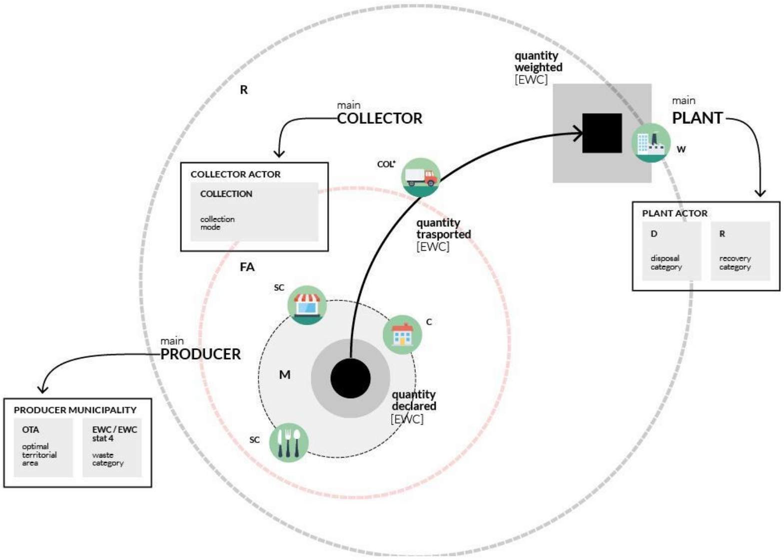

Figure 64: Household waste flow data in Campania (P. Inglese elaboration).

To elaborate household and similar activities data, it has been chosen to develop published data by ISPRA on the website of National Waste Register (from MUD), along with considering the data elaborated by ORR that is related to the difficulty of a specific comparison between the two sources.

1) Generation at the households

ISRWO produces data monthly for the municipal level per MSW type coded according to EWC code. Waste categories that contain FW have been selected in section 20 of EWC following codes:

Food preparation and product waste

EWC Code	Description
20 01 08	Biodegradable kitchen and canteen waste

Green waste

EWC Code	Description
20 02 01	Biodegradable waste

Mixed and general waste

EWC Code	Description
20 01 99	Other fractions not otherwise specified
20 03 01	Mixed municipal waste

20 03 02	Waste from markets
20 03 03	Street-cleaning residues
20 03 99	Municipal wastes not otherwise specified

From the aggregation of EWC codes, it has been identified that biodegradable OW (kitchens and mess hall, green and more organic), home composting and Residual Solid Waste (RSW) of separate collection on the municipal level. Each one of these categories has been derived from a quantity of waste produced per Municipality.

Output data that consists of households and all similar activities that produce OW and do not separate the quantity produced by a household from activities under 10 employees like receptive and food service activities (activities with more than 10 employees are due to present MUD declaration).

Data has been normalized by dividing waste flow per resident population. This normalising factor is applied to the number of inhabitants split by cadastral sections to obtain information more unbundled in the spatial dimension.

There are several conversion factors found to calculate the amount of food waste found in the OW and RSW streams.

In the case of OW, this conversion factor can vary amongst municipalities, since municipalities with more urbanized area produce less garden waste.

The conversion factor can be inferred from the relationship between the EWC codes that classifies the type of OW per municipality.

As far as RSW is concerned, the conversion factor may vary among municipalities, but in general data can be estimated on the basis of the product analysis performed at the MBT plants.

Conversion factors are found in the Regional urban waste management plan drawn up by the Campania Region Authority.

2) Collection of the household waste

Municipalities are responsible for the collection of the household waste and to delegate this task to private companies. The waste collection partners are contract-based and are therefore not permanent partners.

For the model, it was necessary to find out which private collection company is currently contracted by the Municipalities in the Region.

Annual data published by ISRWO contain detailed information on Municipal base, where contract-based companies and waste collection modes are identified per EWC code.

From data analysis, it has been noted that some municipalities have different companies that collect municipal waste, according to different collecting modes.

On Campania territory, there are several waste collection methods of MSW:

- Collection center;
- Door to door;
- Equipped mobile vehicle;
- On request;
- On road.

Figure 65 identifies the number of activities present per each OTA allocated to waste collection mode and highlights for each method the number of municipalities adopting it.

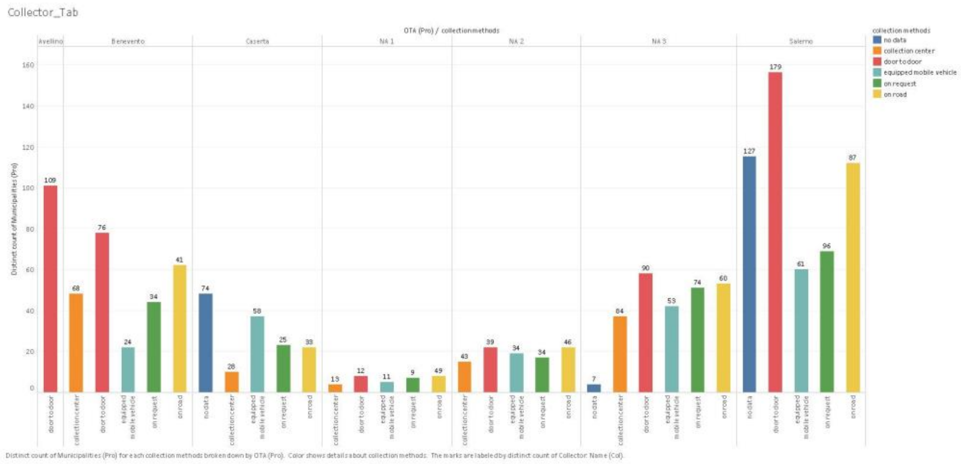

Figure 65: Diagram of Municipal Waste collection companies in Campania per method (P. Inglese elaboration).

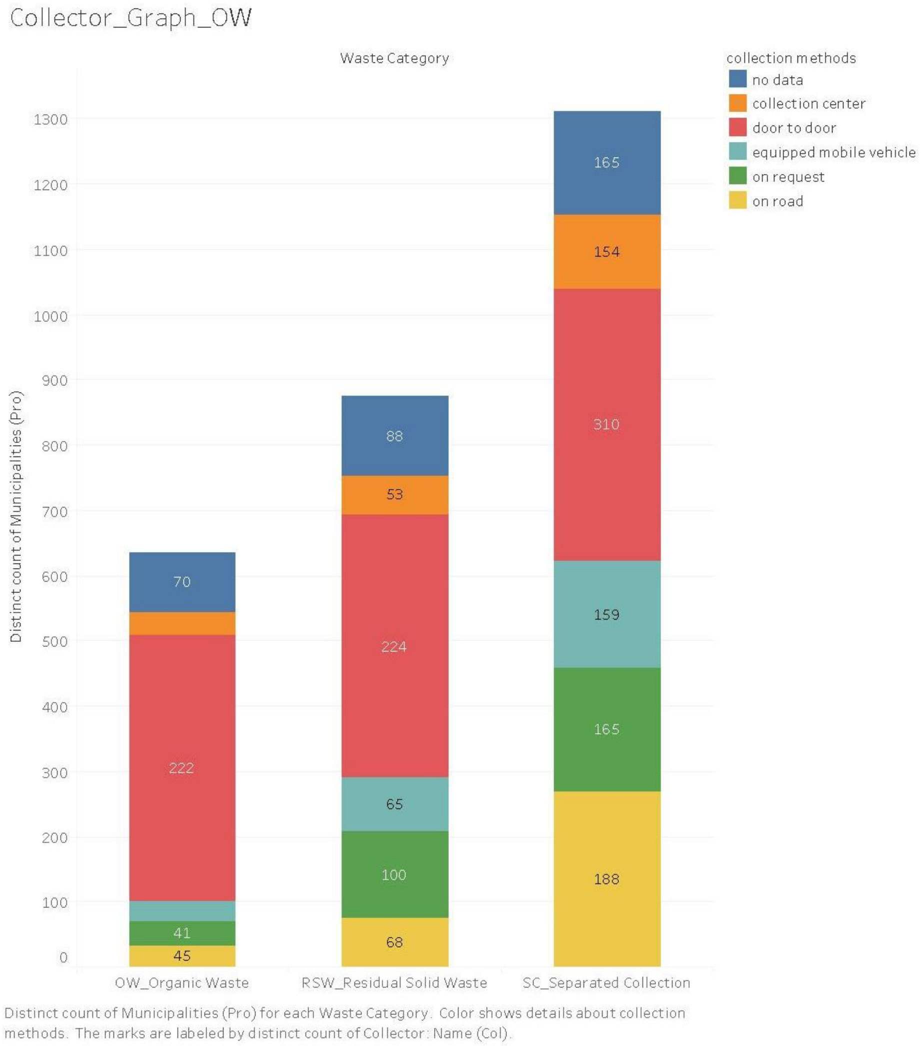

Figure 66: Diagram of Municipal Waste collection companies in Campania per waste type and collecting method (P. Inglese elaboration).

Collector_Tab

Distinct count of Collec..
1

OTA (Pro)	Municipalities (Pro)	Collector: Name (Col)	collection methods: no data	collection center	door to door	equipped mobile vehic..	on request	on road
NA 1	Acerra	DONA CON AMORE SOCIE..		+				+
		ECOLIT TRASPORTI S.R.L.						+
		ECOLOGIA FALZARANO S...		+	+		+	+
	Afragola	AMBIENTE SOLIDALE SOC..						+
		CONSORZIO GEMA			+	+		+
		RITRA S.R.L.						+
		SI.ECO S.P.A.			+	+		+
	Caivano	BUTTOL S.R.L.			+	+	+	+
		CETEX GROUP S.R.L.						+
		DELTA CHIMICA S.R.L.			+	+		
		ECOCE S.R.L.						+
		ECOMED S.R.L.			+	+	+	+
		EDILCAVA SANTA MARIA ..						+
		EUROFRIP S.R.L.						+
		F.LLI ESPOSITO SAS DI ES..						+
		L.E.M. LINEA ECOLOGICA ..				+		
		MAYA S.R.L.				+		
	Cardito	AMBIENTE S.P.A. (ERA A..					+	
		C.I.T.E. - CONSORZIO STA..			+		+	
		DONA CON AMORE SOCIE..						+
		F.LLI ESPOSITO SAS DI ES..						+
		L.E.M. LINEA ECOLOGICA ..						+
		PEZZAMIFICIO G.& B. DI C..						+
	Casalnuovo di Napoli	COMUNE DI CASALNUOVO..			+			
		ECOLIT TRASPORTI S.R.L.		+				
		ECOLOGIA FALZARANO S...			+	+	+	+
		EDILCAVA SANTA MARIA ..						+
		F.LLI ESPOSITO SAS DI ES..						+
	Casoria	CASORIA AMBIENTE S.P.A.			+	+	+	+
		CHIAROTEX SAS DI CHIAR..				+		
		F.LLI ESPOSITO SAS DI ES..				+		
		L.E.M. LINEA ECOLOGICA ..				+		
	Crispano	CONSORZIO STABILE GOS..		+	+		+	+
		CRI.LI. SERVICE S.R.L.		+				
		ECOMED S.R.L.		+	+			
		IMPRESUD S.R.L.						+
		PAPA S.R.L.		+				
		RENT LINE S.R.L.		+	+			+
		RITRA S.R.L.		+				
		ROMANO ARMANDO SRL					+	
		SERVICE GROUP S.R.L.		+				
		TRASPORTI SAN MARINO ..		+				
	Frattaminore	AMBIENTE S.P.A. (ERA A..		+				
		CONSORZIO STABILE GOS..		+	+		+	
		L.E.M. LINEA ECOLOGICA ..				+		
		PEZZAMIFICIO G.& B. DI C..			+			
		RENT LINE S.R.L.		+	+		+	
		TRANSECO SRL		+				
	Napoli	A.M.TECNOLOGY S.R.L.						+
		AMBIENTE SOLIDALE SOC..						+
		ARCOBALENO - COOPERA..						+
		ASIA NAPOLI S.P.A.						+
		BOCCIA S.R.L.						+
		CLEAN AVENUE SRL						+
		DE.FI.AM. S.R.L.						+
		DI GENNARO SPA						+
		ECO.GEA. SRL						+
		ECOLIT TRASPORTI S.R.L.						+
		ECOLOGICA SUD S.R.L.						+
		ECOLOGICA SUD SERVIZI ..						+
		ECOLOGICAL SYSTEMS S...						+
		ECOMED S.R.L.						+
		ECOROMA SRL						+
		ECOSUMMA S.R.L.						+
		EDILCAVA SANTA MARIA ..						+
		EKA S.R.L. - SERVIZI E TRA..						+
		ERRECOLOGIA S.R.L.						+
		F.LLI ESPOSITO SAS DI ES..						+
		FRATELLI OREFICE VILLAN..						+
		GO TRUCK S.R.L.						+
		GPN S.R.L.						+
		L.E.M. LINEA ECOLOGICA ..						+
		L'IGIENE URBANA SRL						+
		LRS TRASPORTI S.R.L.						+
		NEW ECOLOGY S.R.L.						+
		PAPA S.R.L.						+
		PROGEST S.P.A.						+
		PROJECO S.R.L.						+
		REC PROGRAM S.R.L. (ER..						+
		RITRA S.R.L.						+
		SERVICE GROUP S.R.L.						+
		T.D. S.R.L.						+
		T.L.Z. S.R.L.						+
		TRASPORTI SAN MARINO ..						+
NA 3	Cercola	AMBIENTE SOLIDALE SOC..						+
		CITTA' DI LEONIA COOPER..					+	
		CLEAN AVENUE SRL		+				
		ECOLIT TRASPORTI S.R.L.		+				
		ECOLOGICAL SYSTEMS S...		+				
		ECOMED S.R.L.		+				
		ERRECOLOGIA S.R.L.		+				
		GPN S.R.L.		+	+	+	+	+
		RITRA S.R.L.		+				
		SERVICE GROUP S.R.L.		+				
		TRASPORTI SAN MARINO ..		+				
	Volla	LANGELLA MARIO S.R.L.	+		+	+	+	+
		LAVORGNA S.R.L.			+			
		PACIELLO ALBA			+			

Distinct count of Collector: Name (Col) (color) broken down by collection methods vs. OTA (Pro), Municipalities (Pro) and Collector: Name (Col). The data is filtered on FA_Municipalities, which keeps 11 members.

Figure 67: Identification of waste collecting method per collecting company for Focus Area Municipalities (ARPAC 2015) (P. Inglese elaboration).

3) Treatment of the household waste

When the private collectors for the Campania Region municipalities are known, it is necessary to find out to which waste treatment plant the household waste gets delivered.

ISRWO identifies destination plants for each quantity of produced waste per EWC code. For each plant, the waste treatment type is also identified.

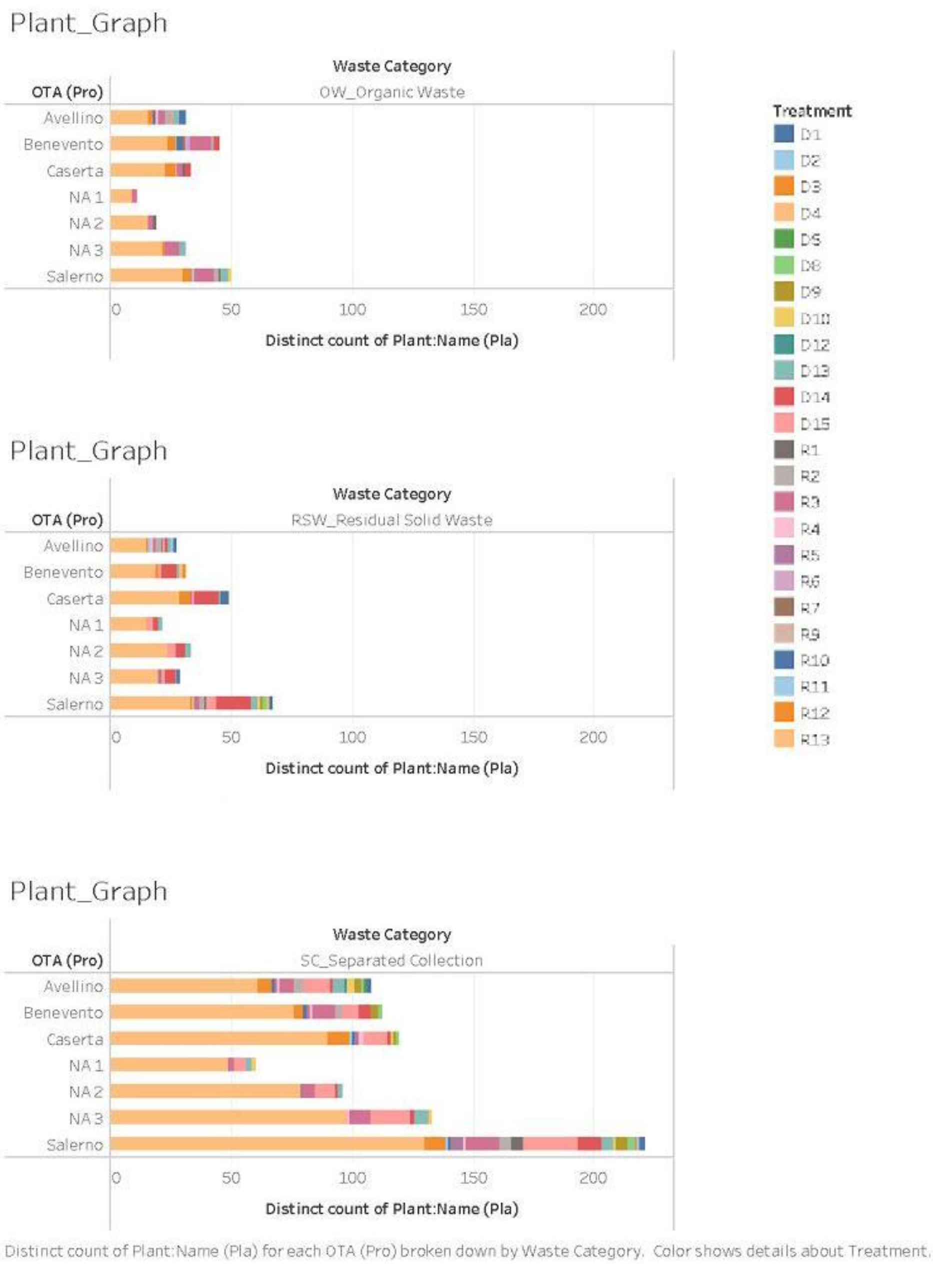

Figure 68: Treatment type per waste category in each OTA (P. Inglese elaboration).

Plant_Tab

			Waste Category		
OTA (Pro)	Municipalities (Pro)	Plant:Name (Pla)	OW_Organic Waste	RSW_Residual Solid Waste	SC_Separated Collection
NA 1	Acerra	A2A AMBIENTE SPA EX EC..		D14 D15	
		AMBIENTE S.P.A. (ERA A..			D15 R13
		CHIAROTEX SAS DI CHIAR..			R13
		ECO ENERGY S.R.L.			R13
		ECOLOGIA ITALIANA S.R.L.	R13	R13	
		ITAL AMBIENTE SRL		R13	R13
		MI.SO. S.R.L.			R13
		S.E.I.F. SRL			R13
		S.R.I. S.R.L.			R13
	Afragola	A2A AMBIENTE SPA EX EC..		D13 D14 D15	
		AMBIENTE S.P.A. (ERA A..			R13
		AMBIENTE SOLIDALE SOC..			R13
		DELTA CHIMICA S.R.L.			R13
		ECO TRANSIDER SRL		R13	
		HELIOS S.R.L.	R13	R13	R13
		HGE AMBIENTE SRL (EX I...	R13		R13
		RI. PLASTIC S.P.A. (ERA RI..			R13
		TESSINO S.R.L.			R13
	Caivano	A2A AMBIENTE SPA EX EC..		D14 D15	
		C.E.A. CONSORZIO ENERG..	R13		
		CETEX GROUP S.R.L.			R3 R13
		DELTA CHIMICA S.R.L.			R13
		DI GENNARO SPA		R13	R13
		ECO AMBIENTE SRL			D15
		EDIL CAVA SANTA MARIA ..			R13
		EUROFRIP S.R.L.			R13
		F.LLI ESPOSITO SAS DI ES..			R13
		GE.S.I.A. S.P.A.	R13	R13	
		ITAL AMBIENTE SRL	R13	R13	
		L.E.M. LINEA ECOLOGICA ..			R13
		RI. PLASTIC S.P.A. (ERA RI..			R13
		SERVICE GROUP S.R.L.			R13
	Cardito	A2A AMBIENTE SPA EX EC..		D14	
		AMBIENTE S.P.A. (ERA A..		R13	D15 R13
		DI GENNARO SPA		R13	R13
		DONA CON AMORE SOCIE..			R13
		F.LLI BALSAMO SRL	R13		
		F.LLI ESPOSITO SAS DI ES..			R3 R13
		ITAL AMBIENTE SRL		R13	R13
		L.E.M. LINEA ECOLOGICA ..			R13
		PEZZAMIFICIO G.&B. DI C..			R13
	Casalnuovo di Napoli	A2A AMBIENTE SPA EX EC..		D14 D15	
		AMBIENTE S.P.A. (ERA A..			D15 R13
		ECO AMBIENTE SRL	R13		
		ECO ENERGY S.R.L.		R13	R13
		ECOLOGIA ITALIANA S.R.L.	R13	R13	R13
		EDIL CAVA SANTA MARIA ..			R13
		F.LLI ESPOSITO SAS DI ES..			R3 R13
		ITAL AMBIENTE SRL		R13	D13 R13
		LANGELLA MARIO S.R.L.		R13	
		MI.SO. S.R.L.			R13
		PROGEST S.P.A.			D15 R13
		SERVICE GROUP S.R.L.			D13 R13
	Casoria	A2A AMBIENTE SPA EX EC..		D14	
		AMBIENTE S.P.A. (ERA A..		R13	R13
		C.E.A. CONSORZIO ENERG..	R13		
		CHIAROTEX SAS DI CHIAR..			R13
		ECOCART SRL			R13

Treatment broken down by Waste Category vs. OTA (Pro), Municipalities (Pro) and Plant:Name (Pla). The data is filtered on FA_Municipalities, which keeps 11 members.

Plant_Tab

			Waste Category		
OTA (Pro)	Municipalities (Pro)	Plant:Name (Pla)	OW_Organic Waste	RSW_Residual Solid Waste	SC_Separated Collection
NA 1	Casoria	ECOLOGIA ITALIANA S.R.L.	R13		
		F.LLI ESPOSITO SAS DI ES..			R13
		ITAL AMBIENTE SRL	R13	R13	R13
		L.E.M. LINEA ECOLOGICA ..			R13
		LANGELLA MARIO S.R.L.			R13
	Crispano	A2A AMBIENTE SPA EX EC..		D14 D15	
		ECOCART SRL		R13	R13
		ECOLOGIA IAVAZZI SRL (E..			R13
		IMPRESUD S.R.L.	R13	R13	R13
		PROGEST S.P.A.			D13 R13
		PROTEG S.P.A.			R13
		RAECYCLE S.C.P.A.			R13
		RI. PLASTIC S.P.A. (ERA RI..			R13
		ROMANO ARMANDO SRL			R13
		SERVICE GROUP S.R.L.			R13
	Frattaminore	AMBIENTE S.P.A. (ERA A..		R13	D15 R13
		CICCIOTTO CARTOFER S.R..			R13
		DI GENNARO SPA			R13
		ECOLOGIA ITALIANA S.R.L.	R13		R13
		HELIOS S.R.L.	R13		
		L.E.M. LINEA ECOLOGICA ..			R13
		PEZZAMIFICIO G.& B. DI C..			R13
		PROTEZIONI AMBIENTALI ..			R13
		SAPNA SISTEMA AMBIEN..		D14	
	Napoli	A2A AMBIENTE SPA EX EC..		D14	
		AMBIENTE SOLIDALE SOC..			R13
		AN.CA. PLASTICA S.R.L.			R13
		ASIA NAPOLI S.P.A.		D15 R13	R13
		BIO. CON. S.P.A.			R13
		DANECO S.P.A.	R3		
		DE.FI.AM. S.R.L.		R13	D15
		DEL. ECO. S.R.L.			R13
		DI GENNARO SPA		R13	R13
		ECOLOGIA ITALIANA S.R.L.			R13
		ECOLOGICA SUD S.R.L.			D15 R13
		ECOSUMMA S.R.L.			R13
		EDIL CAVA SANTA MARIA ..		R13	R13
		EUROFRIP S.R.L.			R13
		EUROVETRO MERIDIONAL..			R13
		F.LLI ESPOSITO SAS DI ES..			R13
		HELIOS S.R.L.	R13		R13
		ITAL AMBIENTE SRL			R13
		ITALGLASS S.R.L.			R13
		L.E.M. LINEA ECOLOGICA ..			R13
		LANGELLA MARIO S.R.L.			R13
		MI.SO. S.R.L.			R13
		PROGEST S.P.A.		D15	D15 R13
		PROTEG S.P.A.			R13
		REC PROGRAM S.R.L. (ER..			R13
		REC. PNEUS S.R.L.			R13
		RI. PLASTIC S.P.A. (ERA RI..			R13
		RI.PLAST S.A.S. DI MENZI..			R13
		RICICLA S.R.L.			R13
		S.E.S.A. S.P.A.	R3		
		S.R.I. S.R.L.			R13
		SAPNA SISTEMA AMBIEN..		D14	
		SECONDIGLIANO RECUPE..		R13	R13
		SERVICE GROUP S.R.L.			R13

Treatment broken down by Waste Category vs. OTA (Pro), Municipalities (Pro) and Plant:Name (Pla). The data is filtered on FA_Municipalities, which keeps 11 members.

Plant_Tab

			Waste Category		
OTA (Pro)	Municipalities (Pro)	Plant:Name (Pla)	OW_Organic Waste	RSW_Residual Solid Waste	SC_Separated Collection
NA 1	Napoli	SINEKO S.R.L.			R13
		SOGEMONT S.R.L.			R13
		T. ECO TRINCONE ECOLOG..			R13
		TESSINO S.R.L.			R13
		TORTORA VITTORIO S.R.L.			D10
NA 3	Cercola	A2A AMBIENTE SPA EX EC..		D14	
		AMBIENTE S.P.A. (ERA A..			D15 R13
		AMBIENTE SOLIDALE SOC..			R13
		BIO. CON. S.P.A.			R13
		CITTA' DI LEONIA COOPER..			R13
		DEL. ECO. S.R.L.			R13
		LANGELLA MARIO S.R.L.	R13	R13	R13
		MI.SO. S.R.L.			R13
		RI. PLASTIC S.P.A. (ERA RI..			R13
		S.E.A. S.R.L.			R13
		SELE AMBIENTE SRL	R13		
		SERVICE GROUP S.R.L.			R13
		SOGEMONT S.R.L.			R13
		TESSINO S.R.L.			R13
	Volla	ECO TRANSIDER SRL	R13		
		ECOLOGIA ITALIANA S.R.L.	R13		
		LANGELLA MARIO S.R.L.	R13	R13	D15 R13
		SAPNA SISTEMA AMBIEN..		D14	

Treatment broken down by Waste Category vs. OTA (Pro), Municipalities (Pro) and Plant:Name (Pla). The data is filtered on FA_Municipalities, which keeps 11 members.

Figure 69: Plants and treatments carried out according the waste type, per municipality in each OTA (P. Inglese elaboration).

Company waste flow data

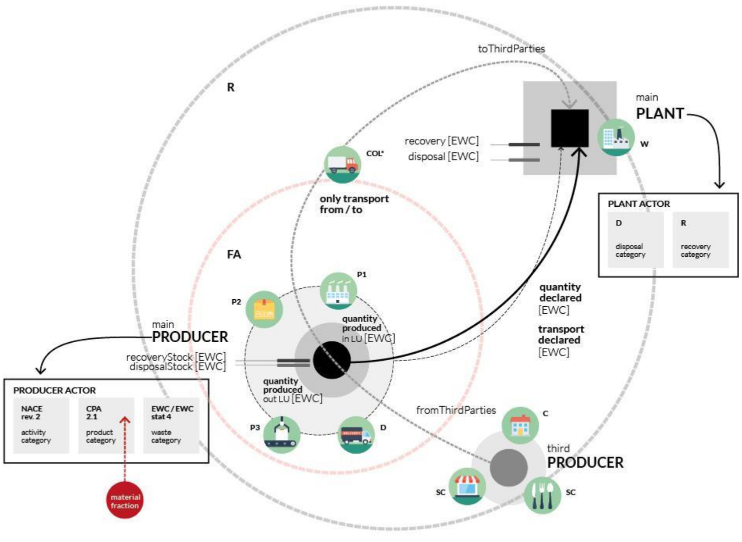

Figure 70: Diagram of special waste flow in Campania (P. Inglese elaboration).

Regional production of SW has been quantified by taking into account the information contained in MUD database that is related to annual reporting elaborated under the sectoral legislation. In order to process data companies, it opts to employ data processing worked out by Regional Section of waste cadastral of ARPAC (MUD source).

Information derived from MUD database has been integrated with quantity esteemed by ISPRA.
Some production sectors, under the existing legislation, has proven to be completely or partially exempted from the reporting obligation. With the cases identified here, it was necessary to resort to the assessment procedure. Particularly, with the meaning of comma 3 of article 189 of Legislative Decree n.152/2006, only corporations and enterprises that produce hazardous waste and the ones that produce non-hazardous waste, referring to in the article 184, comma 3, point c), d) e g) of the above-mentioned decree with a number of employers that exceeds ten are required to present annual reporting.
Therefore, it seems clear that for sectors completely exempted from the reporting obligation and for the sectors characterized by high presence of small enterprises, elaboration of MUD database can't provide complete information about non-hazardous waste production.
With regard to local units with a number of operators less than ten, comparing information about operators contained in MUD database with ones deduced from ISTAT data base related to different production sector (e.g. textile industry), it is noted, generally, a coverage ratio of MUD to below 10%.

1) Generation of company waste

In 2015, the regional production of SW stands at over 7 million tonnes, i.e. 5.3% of total national amount of production.
The 95.2% (almost 6.7 million tonnes) consists of non-hazardous waste and the remaining 4,8% (340,000 tonnes) of hazardous waste.
Main categories of waste produced consist of Construction and Demolition Waste (CDW) (43.3% of total Regional production) and waste resulting from waste treatment and waste water (38.1%) respectively belonging to chapter 17 and 19 of European List of Waste laid down in Decision 2000/532/CE.
RWR and ISPRA yearly process data by SW type coded according to the EWC code. SW type containing FW have been selected in section 02.20 of following codes:

Food preparation and product waste

EWC Code	Description
02 01 01	Sludges from washing and cleaning
02 01 02	Animal-tissue waste
02 01 03	Plant-tissue waste
02 01 99	Wastes not otherwise specified
02 02 01	Sludges from washing and cleaning
02 02 02	Animal-tissue waste
02 02 03	Materials unsuitable for consumption or processing
02 02 99	Wastes not otherwise specified
02 03 01	Sludges from washing, cleaning, peeling, centrifuging and separation
02 03 04	Materials unsuitable for consumption or processing

02 03 99	Wastes not otherwise specified
02 04 99	Wastes not otherwise specified
02 05 01	Materials unsuitable for consumption or processing
02 05 99	Wastes not otherwise specified
02 06 01	Materials unsuitable for consumption or processing
02 07 01	Wastes from washing, cleaning and mechanical reduction of raw materials
02 07 04	Materials unsuitable for consumption or processing
02 07 05	Sludges from on-site effluent treatment
04 01 01	Fleshings and lime split wastes
04 01 02	Liming waste
04 02 10	Organic matter from natural products (for example grease, wax)
20 01 08	Biodegradable kitchen and canteen waste
20 01 25	Edible oil and fat
20 01 26*	Oil and fat other than those mentioned in 20 01 25

Green waste

EWC Code	Description
02 01 07	Wastes from forestry
20 02 01	Biodegradable waste

Slurry and manure

EWC Code	Description
02 01 06	Animal faeces, urine and manure (including spoiled straw), effluent, collected separately and treated off-site

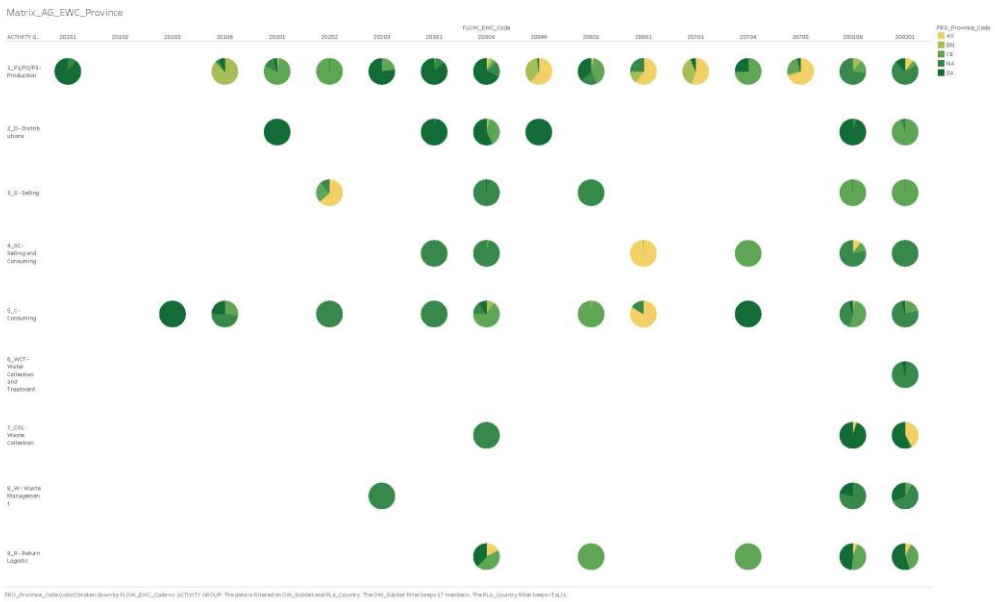

Figure 71: Special waste diagram in Campania per EWC code and Province (P. Inglese elaboration). Click here for a larger image

2) Collection of company waste

The service for the collection, transport and transfer of SW to waste management plants, as opposed to urban waste, may be carried out in the free trade. Companies may choose to have recourse to the operator that best fits their economic needs.

3) Treatment of company waste

Unfortunately, in Italy, the plan building network dedicated to managing this kind of waste is not sufficient to adequately treat the quantity of waste produced. For this reason, SW even today is largely disposed of in a landfill without the possibility to apply any treatment with less environmental impact. Inadequate plant building often entails transporting waste far from the place of actual production, in many cases abroad, where there are (especially in Central and Northen Europe) suitable waste management plants; moving outside the territory the related economic activities, that could be a potential source of income and employment. This happens without counting black market involvement, handled by organised crime, in the transportation of waste in landfill sites, able to offer to companies disposal prices lower than prices offered in legal treatment supply chain without any environmental and health protection; as a consequence, this threatens irreparably the quality of life and the natural heritage of large areas of Italy.

In 2015, special waste management in Campania affected about 5.2 million tonnes of waste, of which 4.9 million are non-hazardous ones amount equal to 94.4% of the total and 293,000 are hazardous ones, equal to 5.6% of the total.
Recovery of matter (from R2 to R12) is the prevalent kind of management applied to about 3.9 million tonnes, consisting of 74.2% of the total managed.

In this field, the recovery of inorganic materials (R5) allows recovering 71.5% of the total.

Instead, waste used as a source of energy (R1) turns out to be residual and almost equal to 270,00 tonnes (0.5% of the total managed).

On the whole, about 780,000 tonnes of SW (14.9% of the total managed) are destined to disposal operations): about 762,000 tonnes undergoes other disposal operations (D8, D9, D13, D14) such as physical/chemical treatments, biological treatments, preliminary reprocessing (14.6% of the total managed); a little less than 16,000 tonnes (0.3% of the total managed) are destined for incineration.

It is pointed out that the amount of SW sent to landfills is nothing because there are no active landfills for SW on the territory in the year considered.

The placement in reserve at year-end (R13) before destining to recovery operations amounts to approximately 552,000 tonnes (10% of the total managed), the storage (D15) before the disposal concerns almost 23,000 tonnes (0.4%).

Finally, it should be noted that exported SW amounts to approximately 65 million tonnes, of which only about 5,700 tonnes are hazardous waste whereas the imported ones are almost 7,600 tonnes, of which 551 tonnes consist of hazardous waste

Material flow analysis of the food waste chain

As the system diagram of food waste shows, two subsystems can be identified:

- food waste from consumption in households and similar activities (related to MSW)
- food waste along the value chain from primary production to waste management with consumption outside of the households and assimilated activities, but located in Campania Region (related to SW). The MFA for the two subsystems will be presented separately as different methods for data collection and modelling were applied.

The Model for the Household and assimilated activity related Food Waste Chain

The focus of this analysis was on understanding:

- Who wastes food (i.e. the demographic groups that waste the most food);
- Which food is wasted;
- When and why food is wasted;
- What can be done about food waste.

For the purposes of this study, we broke food waste down into three categories:

1. Avoidable food waste (food items that could have been eaten/consumed/used if they had not been allowed to go off or go past their use-by date);

2. Possibly avoidable food waste (food items that could be eaten/used but individuals choose not to - e.g. bread crusts, meat rinds/fat, soft fruit skins and some vegetable peelings);

3. Unavoidable food waste (food items that could not be eaten - tea bags, fruit seeds, some vegetable peelings and meat bones).

Since detailed data is not available to allow an AS-MFA to be performed based on spatially more precise spatial data than the municipal level, and given the lack of a division by neighbourhoods for all municipalities of the region, a model for determining the amount of food waste by census section should be developed.

The model combines data from the ISPRA and ISRWO, which accounts for waste collected as OW and RSW per municipality.

An analysis conducted by ARPAC has investigated the merceological composition of RSW based on documents redacted from MBT plants.

A summary is reported in the Table 21 below where, for some MBT, it is indicated that the media between merceological analysis done on residual solid waste was accepted for the year 2015.

Table 21: Merceological composition of residual municipal waste RSW for each MBT (year 2015, source: PRGRU)

MBT	bulky	organic and green	paper and cardboard	glass	plastic	Wood	metal	dangerous urban waste	textile	electrical and electronic equipment	Inert	other
Avellino	0.0%	35.5%	25.5%	0.0%	11.4%	0.0%	7.7%	0.0%	4.3%	0.0%	0.0%	15.6%
S.M.C.V. (CE)	0.0%	17.5%	21.2%	1.7%	23.6%	0.9%	3.1%	0.4%	14.0%	0.0%	1.3%	16.4%
Giugliano	0.0%	23.4%	18.1%	2.3%	25.0%	1.5%	3.1%	0.4%	6.8%	0.0%	1.5%	18.0%
Tufino	0.0%	17.8%	18.0%	1.5%	21.7%	1.7%	3.3%	0.2%	15.2%	0.0%	0.8%	19.7%
Battipaglia	0.0%	12.1%	17.2%	4.3%	29.6%	0.4%	3.2%	1.9%	12.0%	0.0%	0.3%	19.0%
Regione	**0.0%**	**17.7%**	**18.6%**	**2.4%**	**25.0%**	**1.1%**	**3.2%**	**0.7%**	**12.0%**	**0.0%**	**1.0%**	**18.3%**

Merceological sampling data shows that, theoretically, RSW quantity produced in Campania Region, which amounts to 1,350,000 tonnes in 2015, may be reduced about 80%. Applying the obtained percentages to production values of 2015, it is estimated that 233 tonnes/year of OW, was inferred from RSW.

In order to be able to apply spatially differentiated eco-innovative solutions, we choose the census sections as a smallest spatial unit for the food consumption in households and similar activities.

The above-described data allows for the production of separate models:

1. Food waste from OW (FW_{ow})
2. Food waste from RSW (FW_{rsw})

The respective waste fraction is calculated according to the following formula:

1. $FW_{(wt,cs)} = PP_{(wt,m)} * Inh_{cs,m}$
2. $FW_{(wt,cs)} = (PP_{(wt,m)} * Inh_{cs,m}) * F_{(wt)}$

Where $FW_{(wt,cs)}$ stands for the amount of food waste from waste type (wt),OW or RSW, in census sections (cs) in tonnes per year.

$PP_{(wt,m)}$ is the collected waste type OW or RSW, in t per person in municipality m;

$Inh_{(cs,m)}$ is the nr of inhabitants in census section cs in the municipality m.

$F_{(wt)}$ is a factor representing the mean percentage of food waste fraction. F has a different value also for the type of food waste as well as collection method, which is shown in Table 21.

FW from waste collected as RSW

The 5.8 million inhabitants of the Campania Region produce 1,321,296 tonnes of RSW per year. Of this waste collected as RSW 233,445 tonnes can be assumed to be OW using the model described above. How the production of this waste is distributed across the municipalities is demonstrated with the following maps.

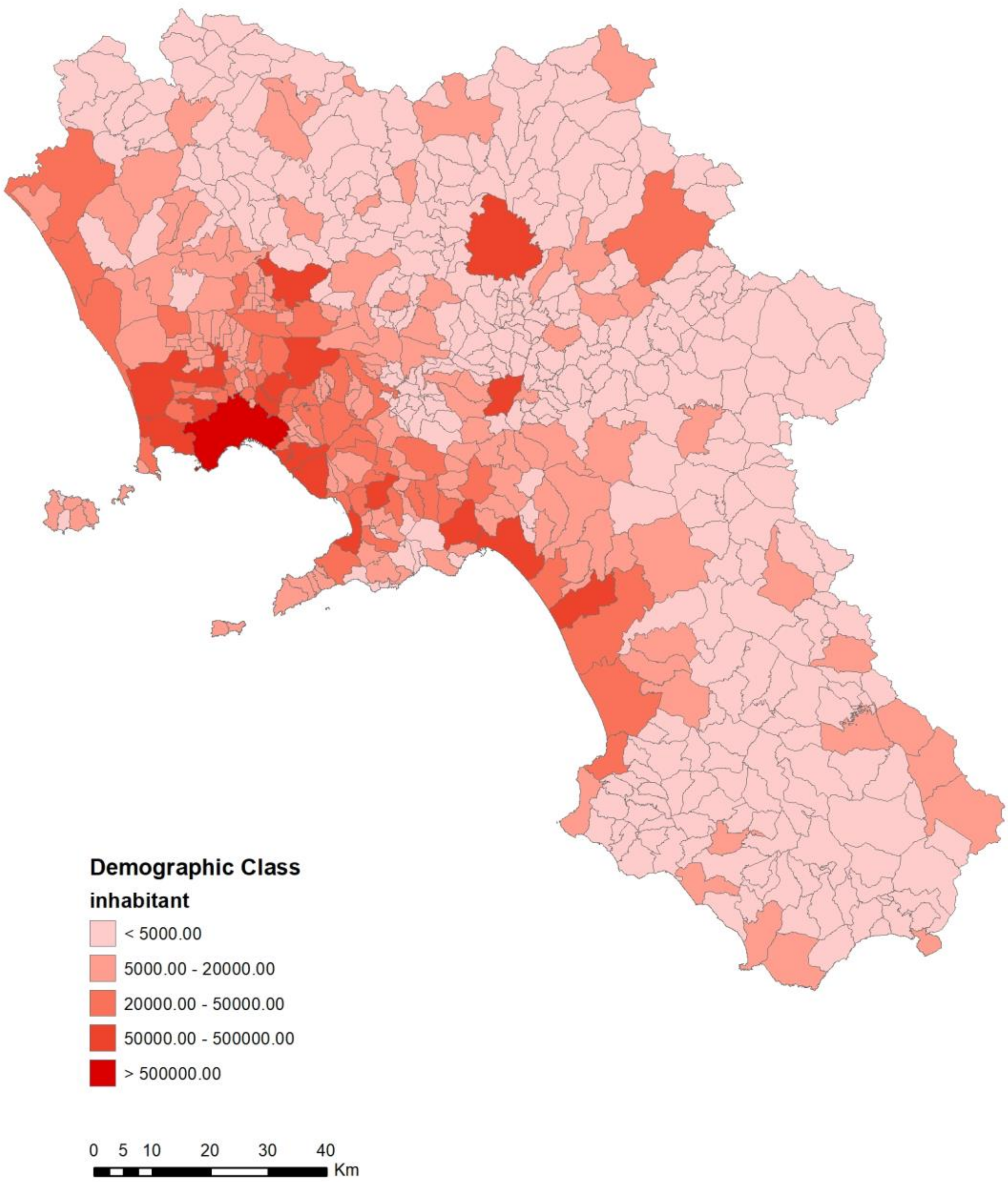

Figure 72: Demographic Class by municipalities in the Campania Region (Data source: ISTAT 2015) (P. Inglese elaboration).

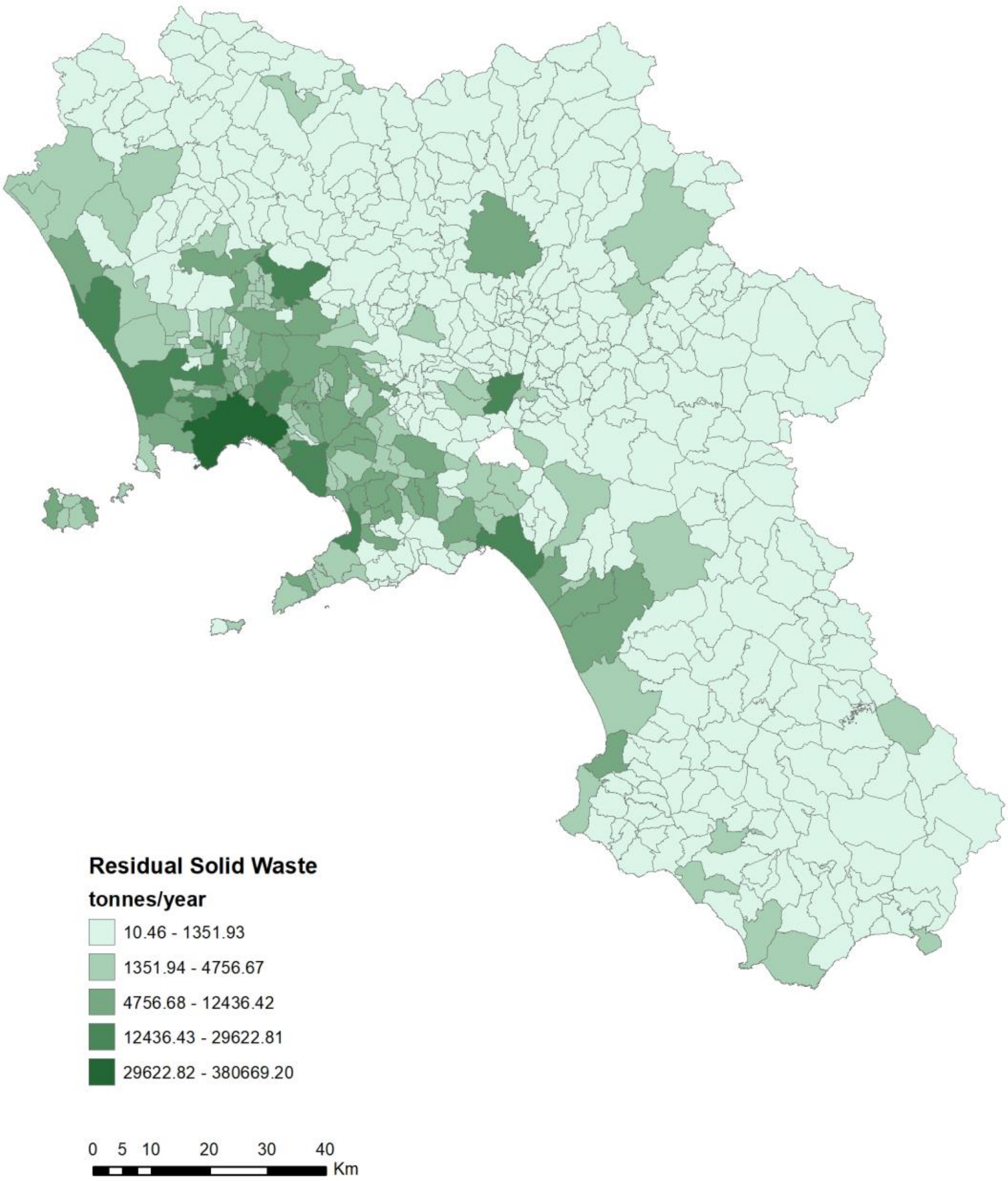

Figure 73: Residual Solid Waste collected per person per year for each municipality in the Campania Region (Data source: ISPRA 2015) (P. Inglese elaboration)

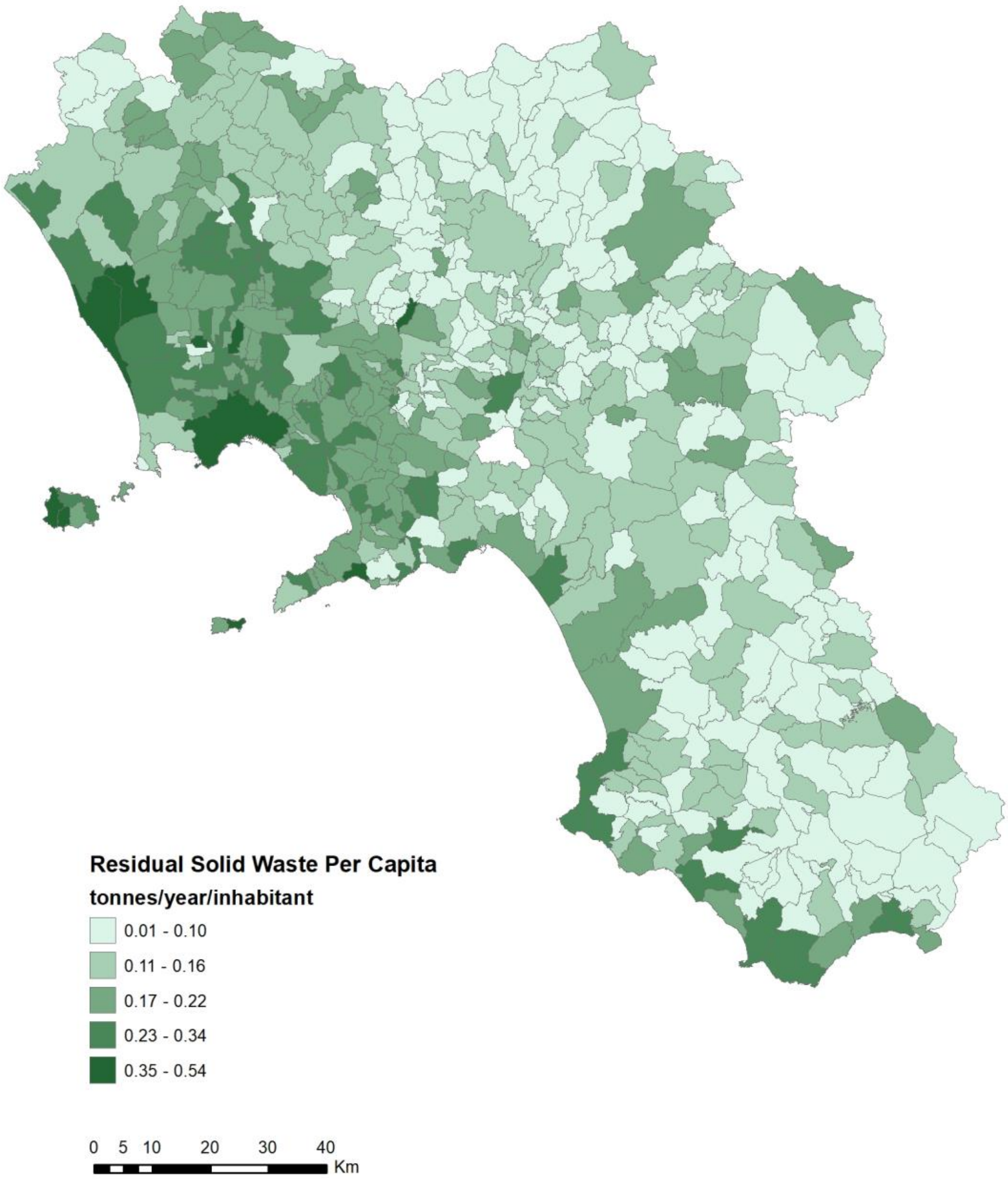

Figure 74: Residual Solid Waste collected per person per year for each municipality in the Campania Region. (Data source: ISPRA 2015) (P. Inglese elaboration)

Depending on the municipality, the household waste can also contain waste from small companies that therefore have their waste collected with the household waste when their waste production is under a certain limit (as is mentioned in the data collection process).

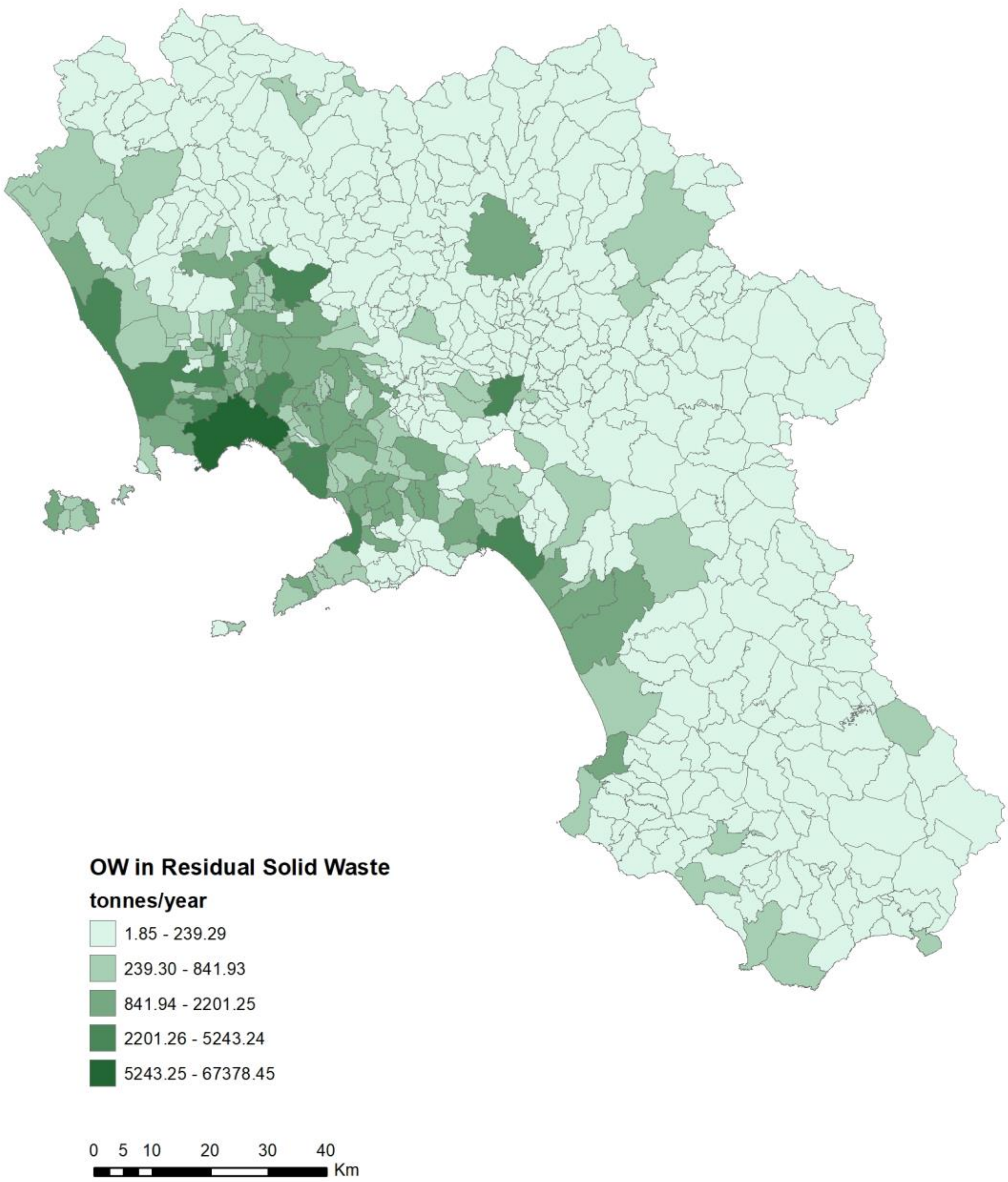

Figure 75: OW in Residual Solid Waste collected per year for each municipality in the Campania Region. (Data source: ISPRA 2015) (P. Inglese elaboration)

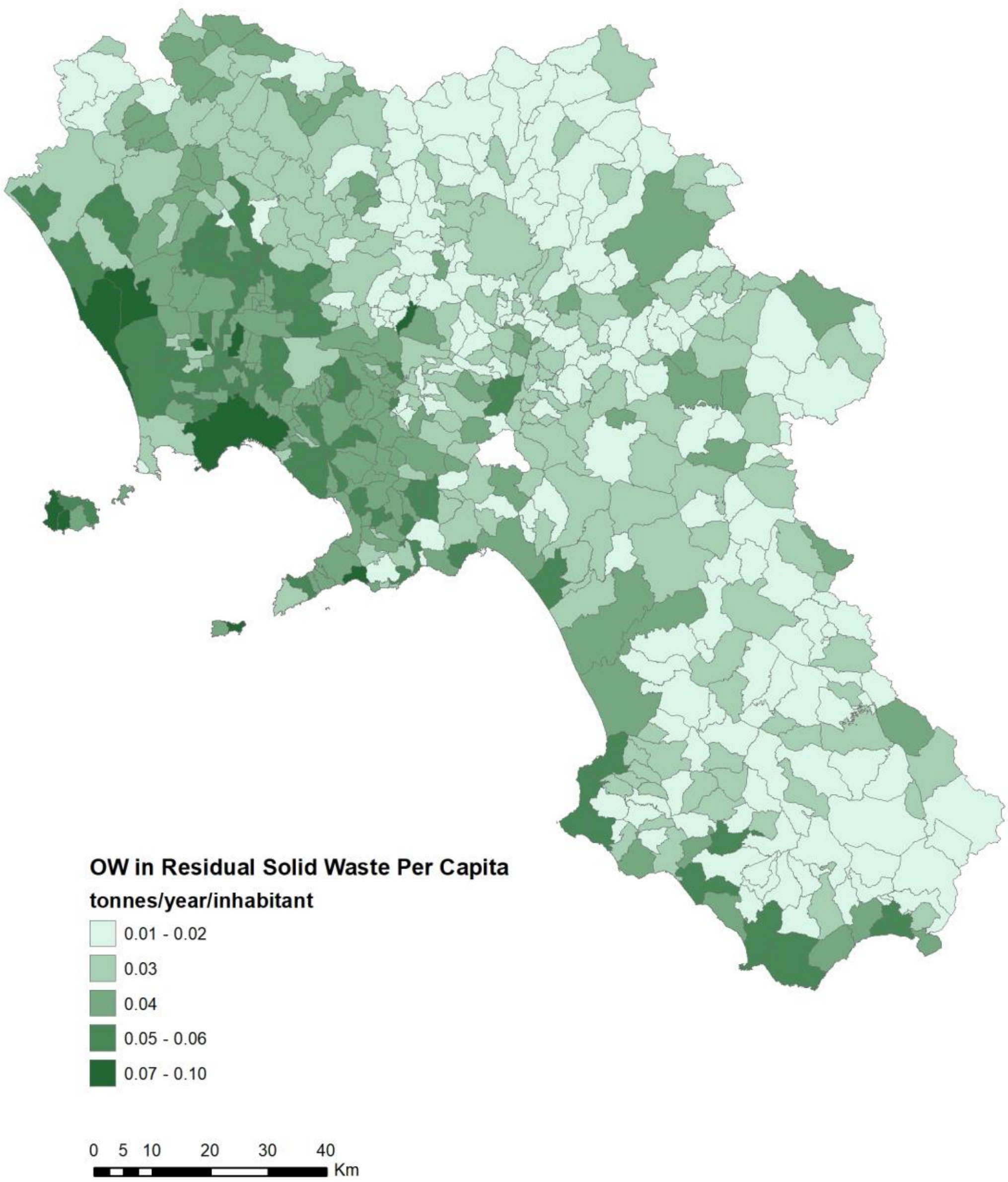

Figure 76: OW in Residual Solid Waste collected per person per year for each municipality in the Campania Region (Data source: ISPRA 2015) (P. Inglese elaboration)

FW from waste collected as OW

The 5.8 million inhabitants in the Campania Region produce 684,514 tonnes of organic household waste per year (OW). How the production of this waste is distributed across the municipalities is demonstrated with the following maps.

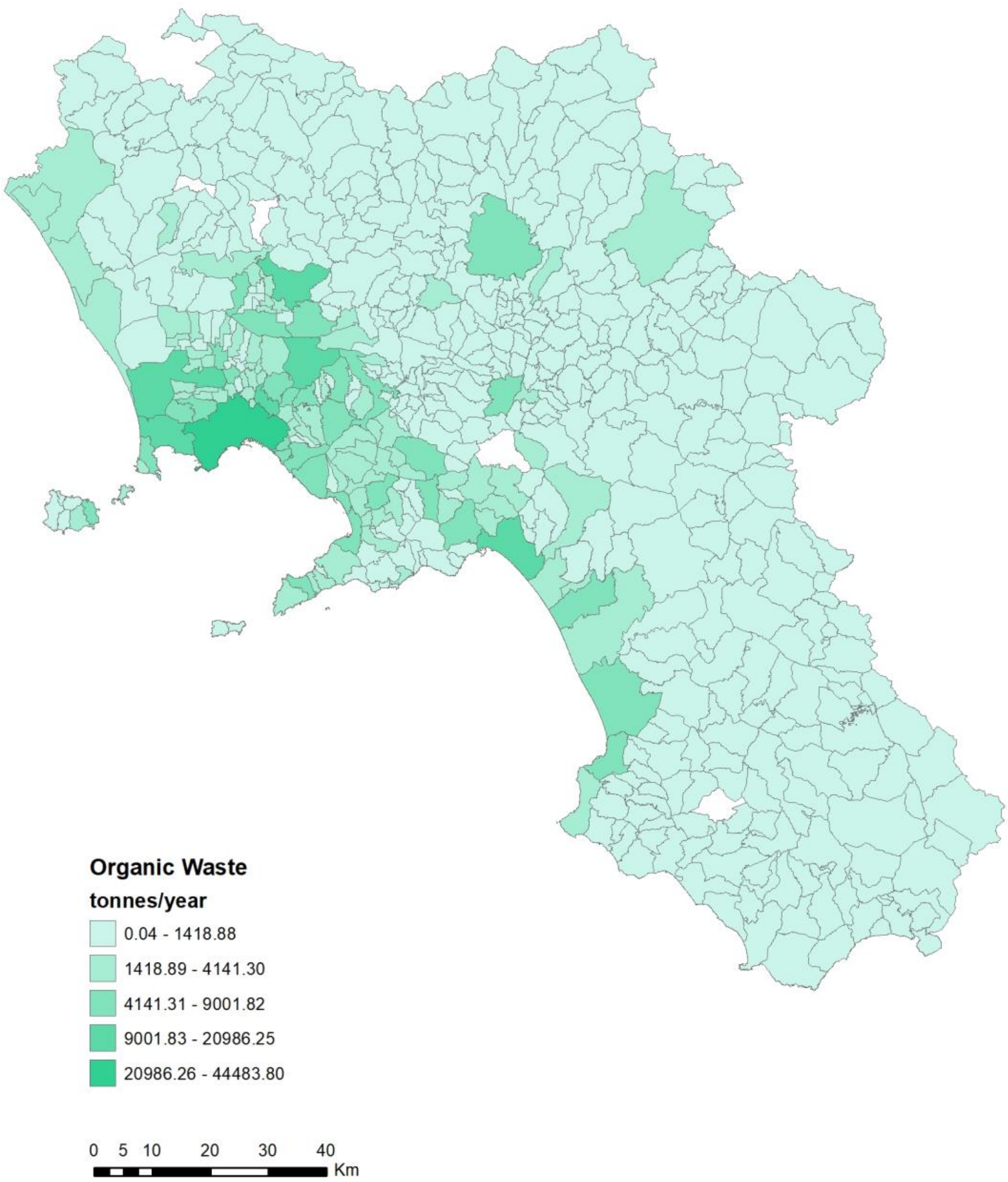

Figure 77: Organic waste collected per year for each municipality in the Campania Region (Data source: ISPRA 2015) (P. Inglese elaboration)

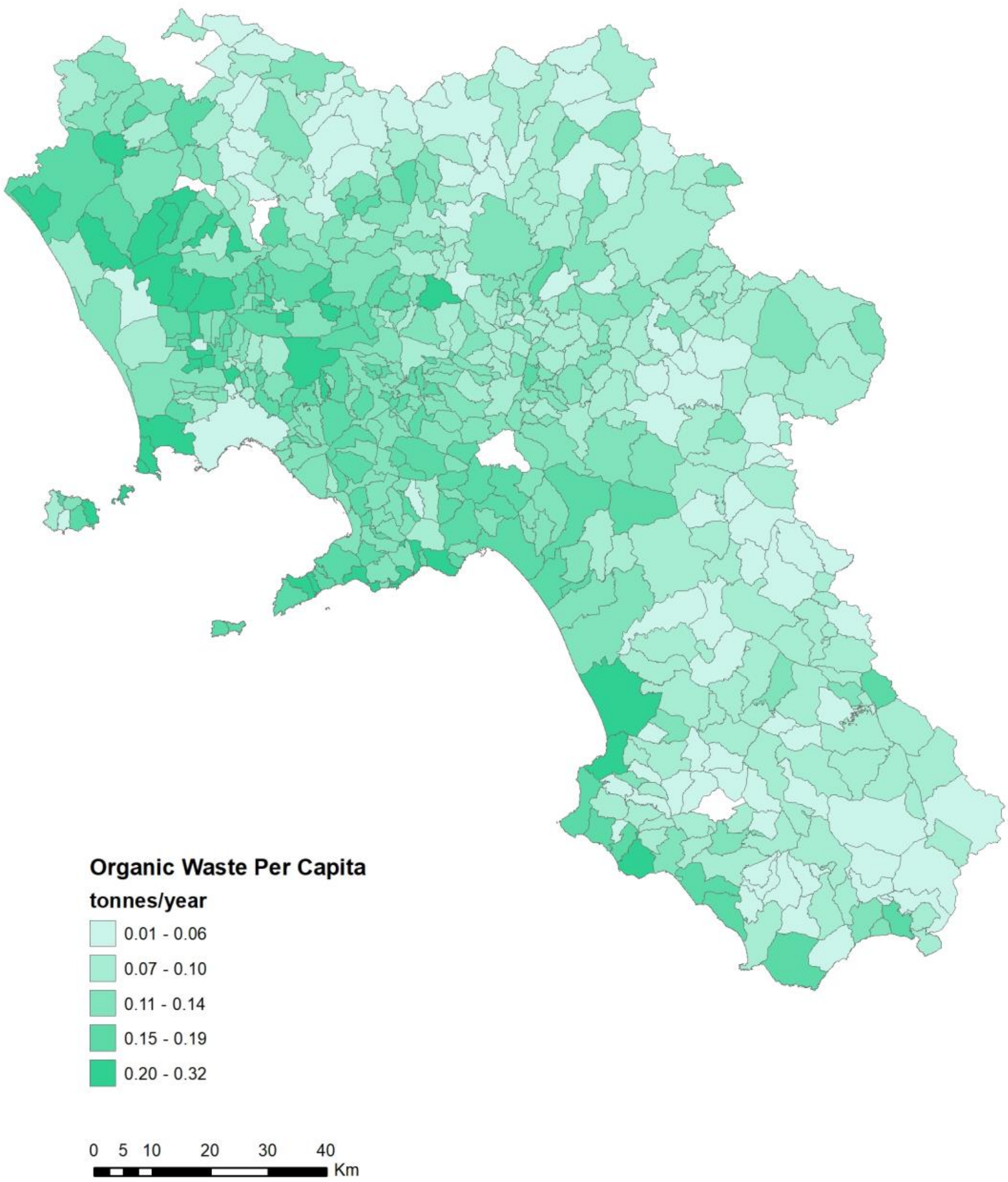

Figure 78: Organic waste collected per year per capita for each municipality in the Campania Region (Data source: ISPRA 2015) (P. Inglese elaboration)

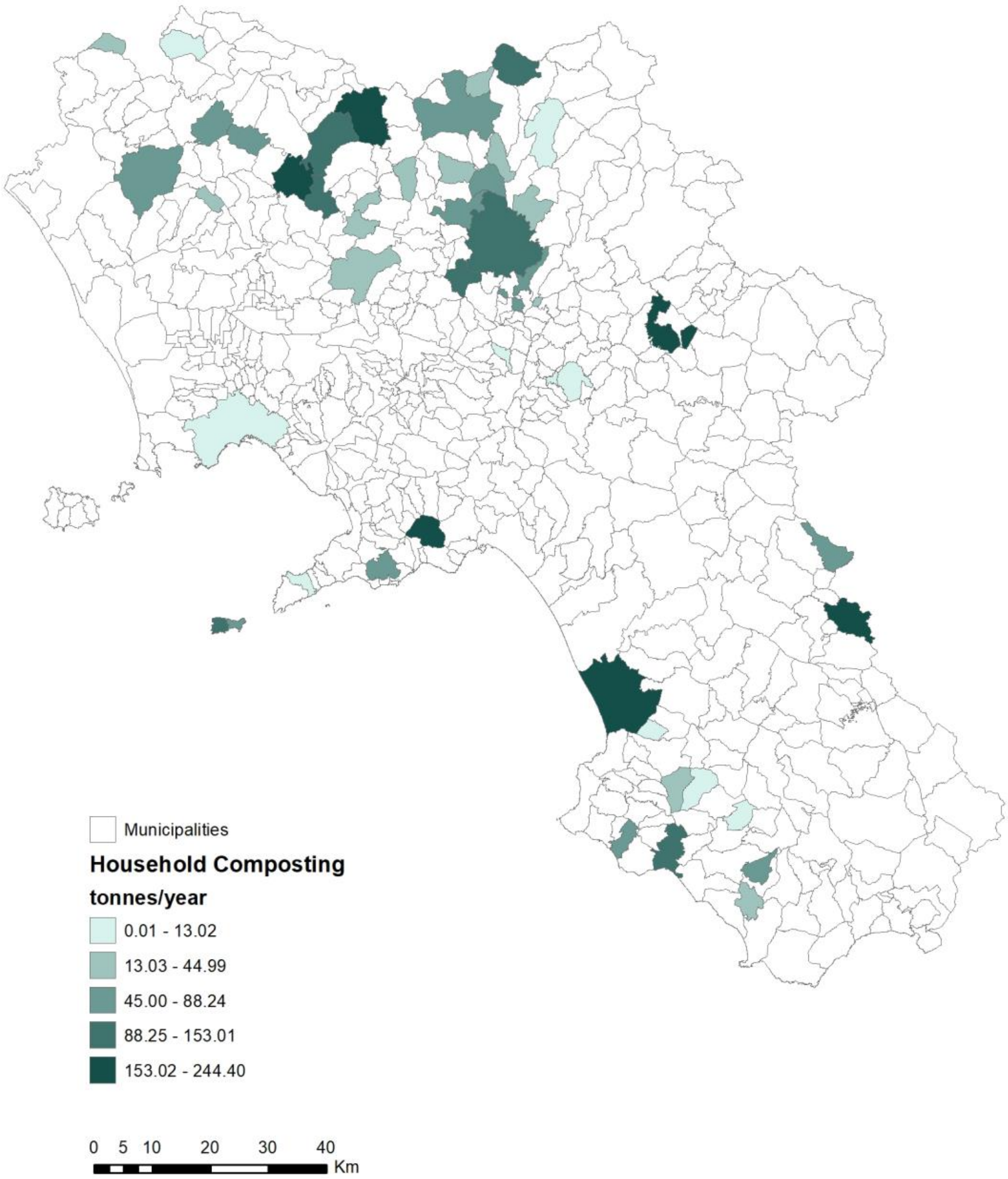

Figure 79: Household composting collected per year for each municipality in the Campania Region (Data source: ISPRA 2015) (P. Inglese elaboration)

In total, there are 24,323 census sections in the Region and applying the above formula allows for modelling the amounts of FW per census section. The following maps present the results for the Campania Region. The table with all data sources is available in the annex. The following maps always show both the total amount of a specific waste type per census section per year as well as in kg per person per year.

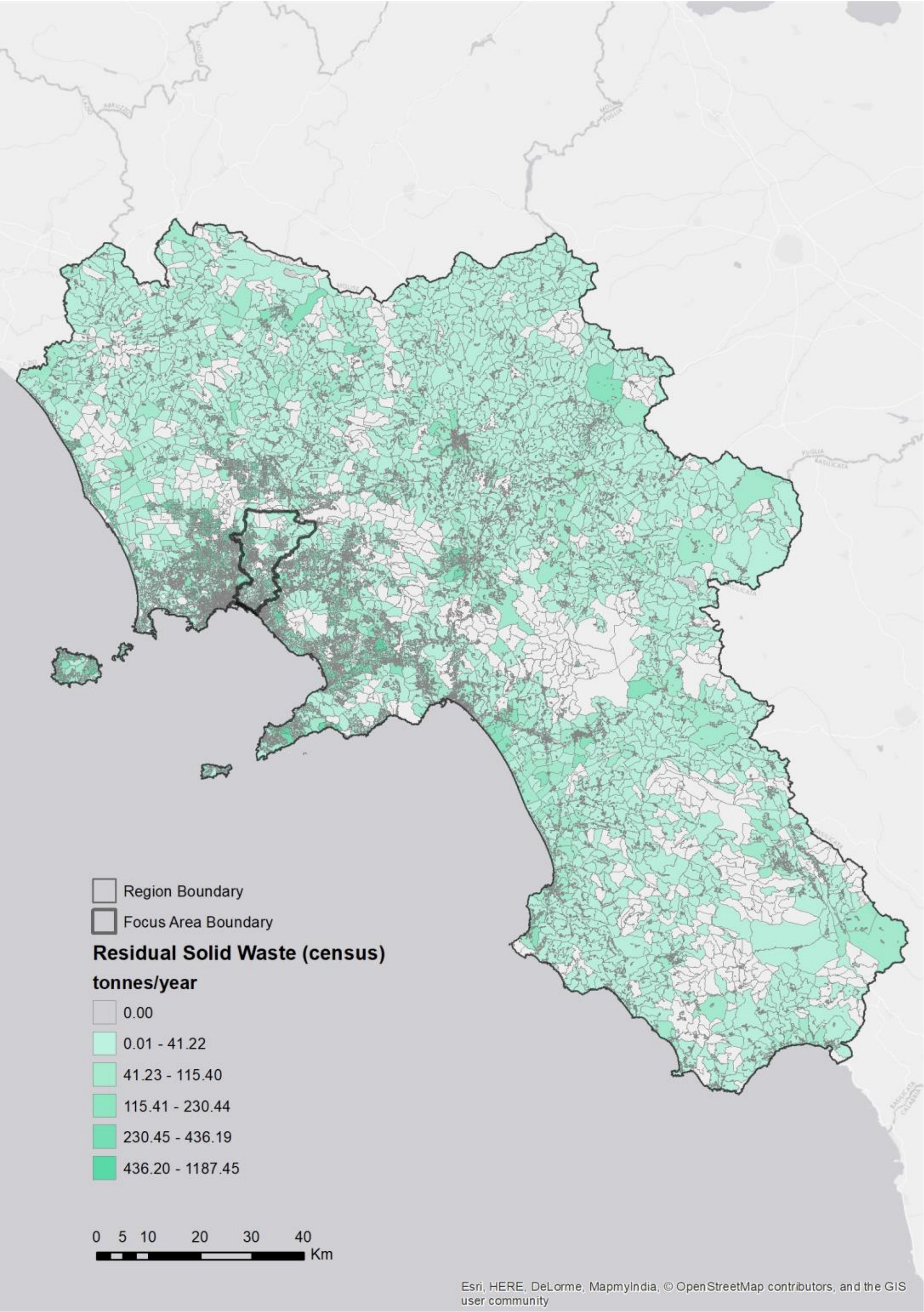

Figure 80: Residual Solid Waste collected per year for each census unit in the Campania Region scale (Data source: ISPRA 2015) (P. Inglese elaboration)

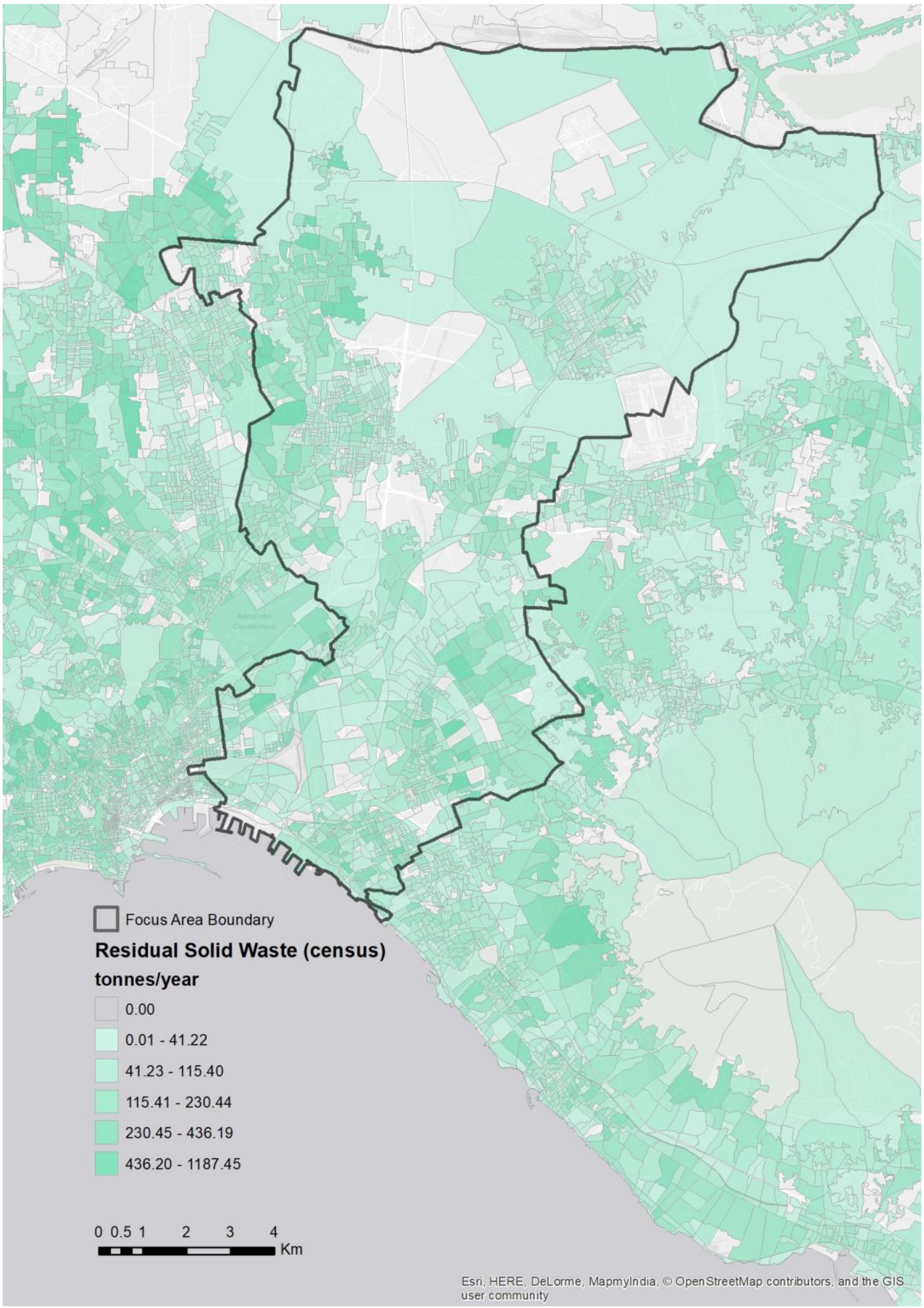

Figure 81: Residual Solid Waste collected per year for each census unit in the Focus Area scale (Data source: ISPRA 2015) (P. Inglese elaboration)

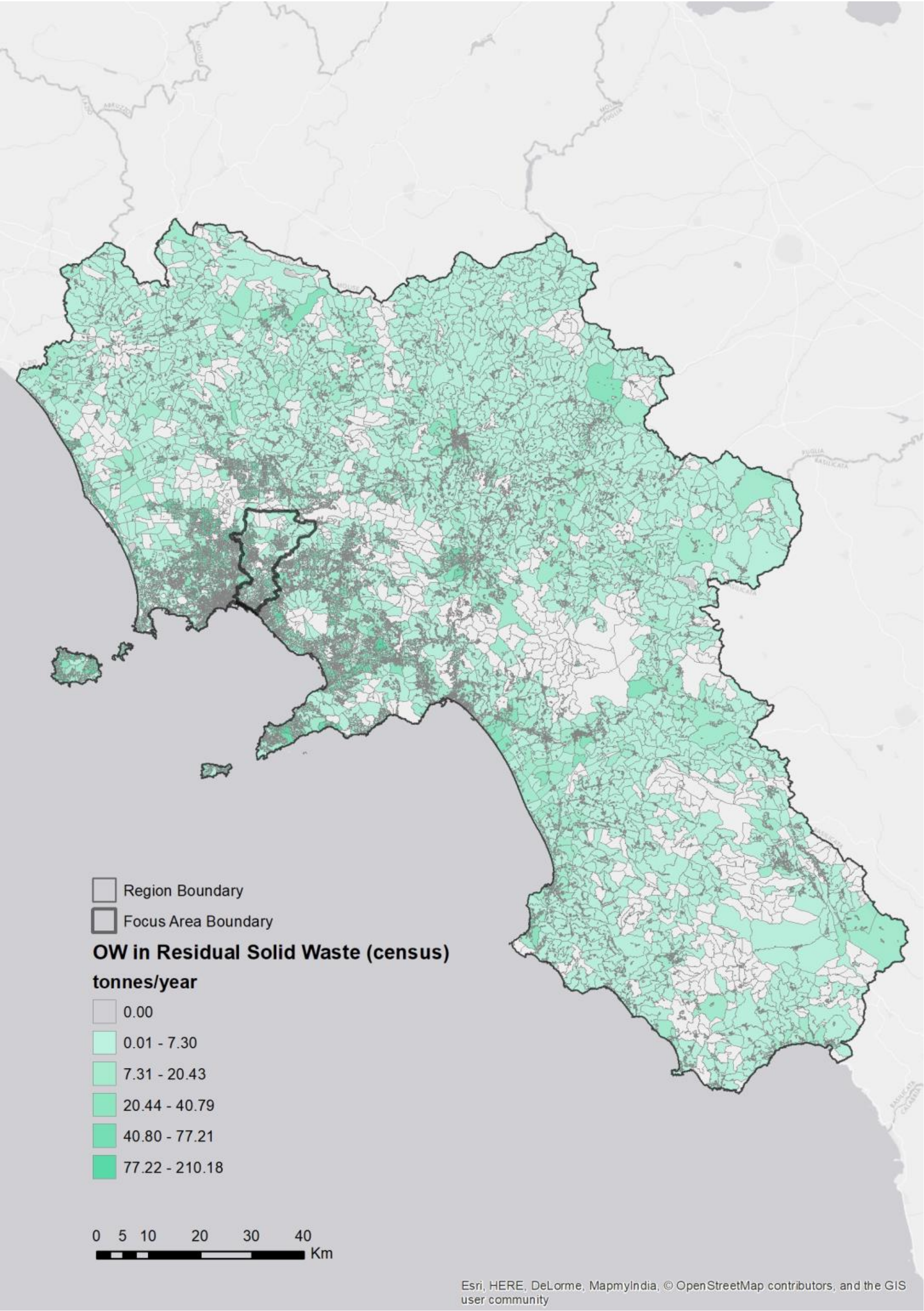

Figure 82: OW in Residual Solid Waste collected per year for each census unit in the Campania Region scale (Data source: ISPRA 2015) (P. Inglese elaboration)

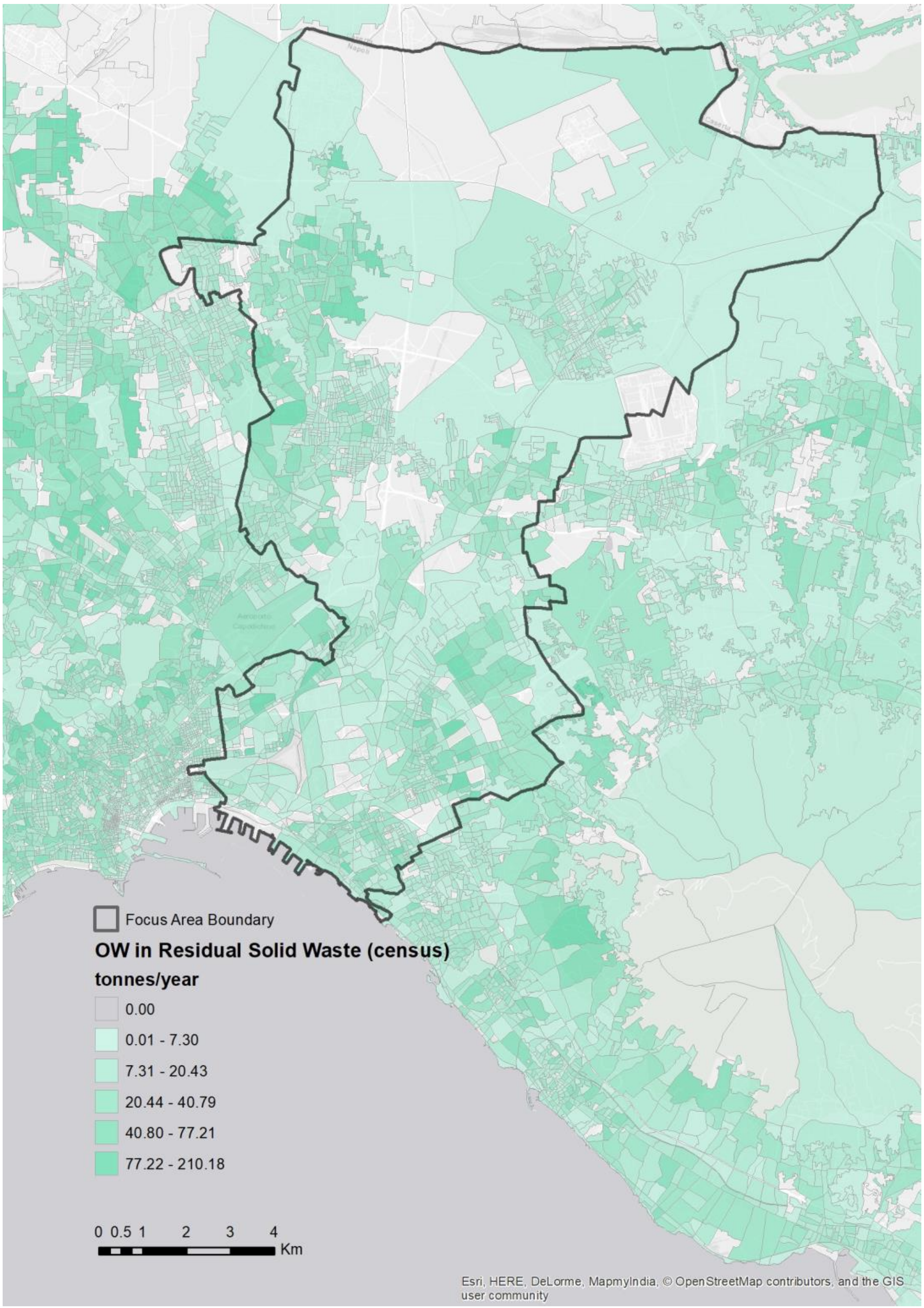

Figure 83: OW in Residual Solid Waste collected per year for each census unit in the Focus Area scale (Data source: ISPRA 2015) (P. Inglese elaboration)

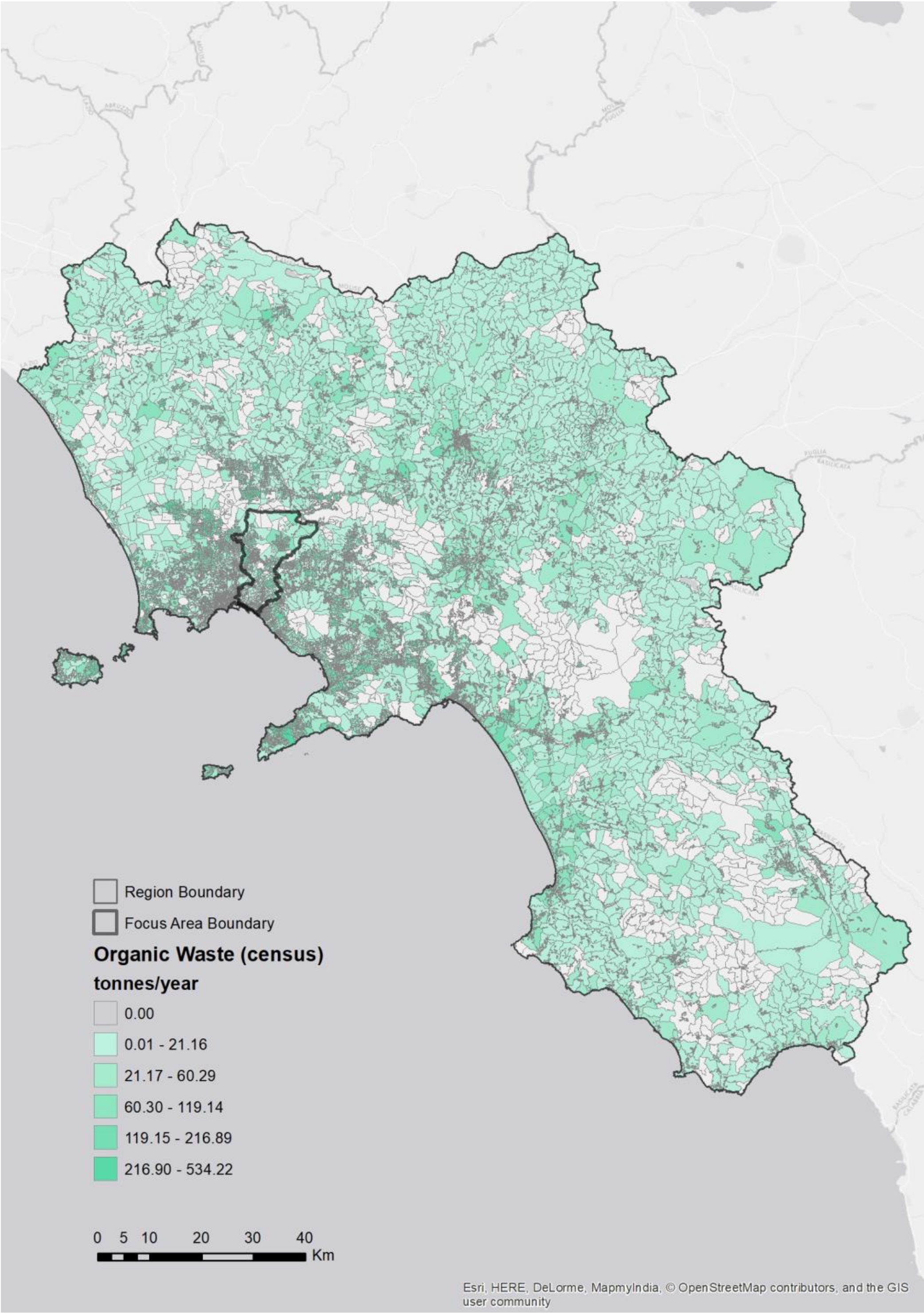

Figure 84: OW collected per year for each census unit in the Campania Region scale (Data source: ISPRA 2015) (P. Inglese elaboration)

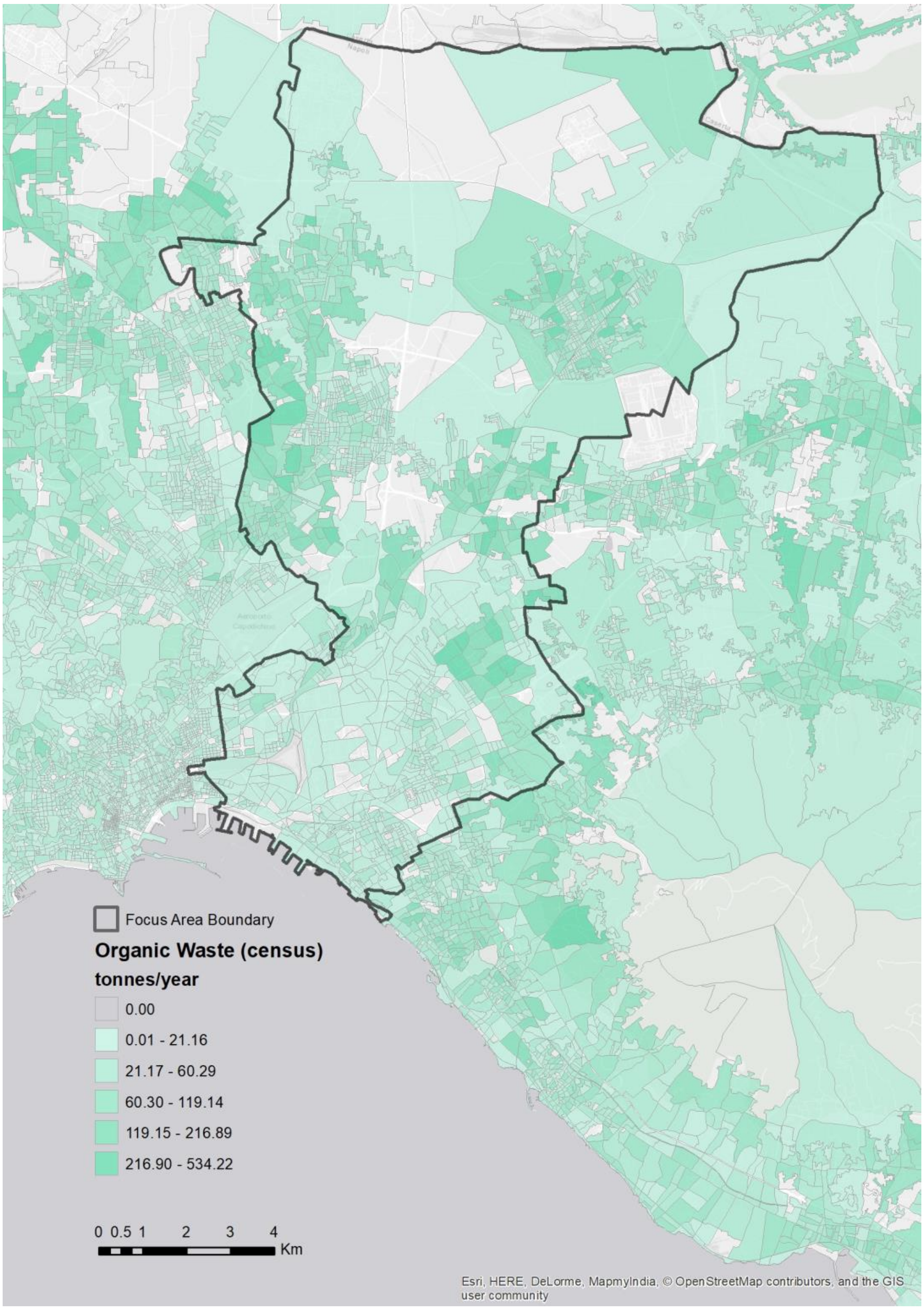

Figure 85: OW collected per year for each census unit in the Focus Area scale (Data source: ISPRA 2015) (P. Inglese elaboration)

FW related waste collector in the Campania Region and beyond

Waste collector for FW from OW.

Figure 86: The localization of the waste collector company of OW from the Campania Region (Data source: ISPRA 2015) (P. Inglese elaboration)

Waste collector for FW from RSW.

Figure 87: The localization of the waste collector company of RSW from the Campania Region (Data source: ISRWO 2015) (P. Inglese elaboration)

The following figures show which collector company collects FW from OW/RSW waste at the Focus Area scale.

Collector_Q_Tab

Quantities_t/y: 0.00 – 500,000.00

			WC_Detailed / Collection Methods					
			OW_200108		OW_200201			
OTA (Pro)	Municipalities (Pro)	Collector: Name (Col)	door to door	on road	collection center	door to door	on request	on road
NA 1	Acerra	ECOLOGIA FALZARANO S...	13,226.81		397.25		583.82	46.88
	Afragola	CONSORZIO GEMA	117.92			5.08		
		SI.ECO S.P.A.	6,756.14					
	Caivano	BUTTOL S.R.L.	2,815.37			386.71		
	Cardito	C.I.T.E. - CONSORZIO STA..	3,674.62					
	Casalnuovo di Napoli	ECOLOGIA FALZARANO S...	8,865.96				135.86	
	Casoria	CASORIA AMBIENTE S.P.A.	11,400.40			758.81		
	Crispano	CONSORZIO STABILE GOS..	742.36					
		RENT LINE S.R.L.	1,071.56					
	Frattaminore	CONSORZIO STABILE GOS..	777.10				47.10	
		RENT LINE S.R.L.	1,053.32				17.60	
	Napoli	A.M. TECNOLOGY S.R.L.						198.66
		BOCCIA S.R.L.		2,184.62				
		ECOLOGICA SUD SERVIZI ..		20,138.80				
		FRATELLI OREFICE VILLAN..						701.09
		T.L.Z. S.R.L.		21,260.62				
NA 3	Cercola	GPN S.R.L.	1,999.26				35.40	
	Volla	LANGELLA MARIO S.R.L.	3,320.36				97.21	

Sum of Quantities_t/y broken down by WC_Detailed and Collection Methods vs. OTA (Pro), Municipalities (Pro) and Collector: Name (Col). Color shows sum of Quantities_t/y. The marks are labeled by sum of Quantities_t/y. The data is filtered on FA_Municipalities, which keeps 11 members. The view is filtered on WC_Detailed, which keeps OW_200108 and OW_200201.

Figure 88: OW waste per EWC Code collected by collector company at the Focus Area scale (Data source: ISRWO 2015) (P. Inglese elaboration)

Collector_Q_Tab

Quantities_t/y: 0.00 – 500,000.00

			WC_Detailed / Collection Methods										
			RSW_200301		RSW_2003..	RSW_200303		RSW_200307					RSW_2003..
OTA (Pro)	Municipalities (Pro)	Collector: Name (Col)	door to door	on road	equipped mobile vehicle	equipped mobile vehicle	on road	collection center	door to door	equipped mobile vehicle	on request	on road	on road
NA 1	Acerra	ECOLOGIA FALZARANO S..	7,392.24	626.44			815.62	998.10			281.24	7.68	
	Afragola	CONSORZIO GEMA			461.06					427.00			
		SI.ECO S.P.A.	15,373.52		8.88					244.02			
	Caivano	BUTTOL S.R.L.		10,784.12		219.90			9.84		235.88		
		ECOCE S.R.L.		21.74									
	Cardito	C.I.T.E. - CONSORZIO STA..	5,805.80								133.22		
	Casalnuovo di Napoli	ECOLOGIA FALZARANO S..		8,266.51			547.28				902.12		
	Casoria	CASORIA AMBIENTE S.P.A.		14,214.50							1,535.46		
	Crispano	CONSORZIO STABILE GOS..	898.48					69.29	199.36				
		RENT LINE S.R.L.	1,307.38					27.59	41.56				
	Frattaminore	CONSORZIO STABILE GOS..	1,258.60								133.74		
		RENT LINE S.R.L.	1,393.64								40.52		
	Napoli	A.M. TECNOLOGY S.R.L.		11,705.76									
		ASIA NAPOLI S.P.A.		353,579.96			107.78					4,341.63	
		DE.FI.AM. S.R.L.										6,991.60	
		DI GENNARO SPA										7,818.56	
		EDIL CAVA SANTA MARIA..					3,537.32						
		L'IGIENE URBANA SRL		1,444.92									
		LRS TRASPORTI S.R.L.		2,140.82									
		NEW ECOLOGY S.R.L.		2,609.42									
		PROGEST S.P.A.											164.22
NA 3	Cercola	GPN S.R.L.	3,894.86			39.02		85.28					
	Volla	LANGELLA MARIO S.R.L.	3,275.18			514.92					217.88		
		LAVORGNA S.R.L.	325.72										
		PACIELLO ALBA	25.08										

Sum of Quantities_t/y broken down by WC_Detailed and Collection Methods vs. OTA (Pro), Municipalities (Pro) and Collector: Name (Col). Color shows sum of Quantities_t/y. The marks are labeled by sum of Quantities_t/y. The data is filtered on FA_Municipalities, which keeps 11 members. The view is filtered on WC_Detailed, which keeps RSW_200301, RSW_200302, RSW_200303, RSW_200307 and RSW_200399.

Figure 89: RSW waste per EWC Code collected by collector company at the Focus Area scale (Data source: ISRWO 2015) (P. Inglese elaboration)

FW related treatment in the Campania Region and beyond

Waste treatment plant for FW from OW.

Figure 90: The localization of the waste treatment plant of FW from OW from the Campania Region (Data source: ISRWO 2015) (P. Inglese elaboration)

Waste treatment plant for FW from RSW.

Figure 91: The localization of the waste treatment plant for FW from RSW from the Campania Region (Data source: ISRWO 2015) (P. Inglese elaboration)

The following figures show which treatment plant treats FW from OW/RSW.

Plant_Q_Tab

Quantities_t/y: 0.00 – 150,000.00

						Waste Category / WC_Detailed / Treatment: OW_Organic Waste			
						OW_200108		OW_200201	
OTA (Pro)	Prov (ProSL)	Municipalities (Pro)	Municipalities (Pla)	Prov (DesSO)	Plant:Name (Pla)	R3	R13	R3	R13
NA 1	NA	Acerra	Acerra	NA	ECOLOGIA ITALIANA S.R.L.		13,226.81		1,027.95
		Afragola	Manocalzati	AV	HGE AMBIENTE SRL (EX I.R.M. S.R.L.)				5.08
			Scafati	SA	HELIOS S.R.L.		6,874.06		
		Caivano	Acerra	NA	ITAL AMBIENTE SRL		557.12		24.76
			Caivano	NA	C.E.A. CONSORZIO ENERGIE ALTERNATIVE S..				69.47
			Pastorano	CE	GE.S.I.A. S.P.A.		2,258.25		292.48
		Cardito	Torre del Greco	NA	F.LLI BALSAMO SRL		3,674.62		
		Casalnuovo di Napoli	Acerra	NA	ECOLOGIA ITALIANA S.R.L.		8,863.50		135.86
			Casoria	NA	ECO AMBIENTE SRL		2.46		
		Casoria	Acerra	NA	ECOLOGIA ITALIANA S.R.L.				5.12
					ITAL AMBIENTE SRL		11,297.60		751.06
			Caivano	NA	C.E.A. CONSORZIO ENERGIE ALTERNATIVE S..		102.80		2.63
		Crispano	Caserta	CE	IMPRESUD S.R.L.		1,813.92		
		Frattaminore	Acerra	NA	ECOLOGIA ITALIANA S.R.L.		1,830.42		64.70
			Scafati	SA	HELIOS S.R.L.		0.00		0.00
		Napoli	Este	PD	S.E.S.A. S.P.A.	43,584.04			
			Salerno	SA	DANECO S.P.A.			692.23	
			Scafati	SA	HELIOS S.R.L.				207.52
NA 3	NA	Cercola	Battipaglia	SA	SELE AMBIENTE SRL		1,960.24		35.40
			Volla	NA	LANGELLA MARIO S.R.L.		39.02		
		Volla	Acerra	NA	ECOLOGIA ITALIANA S.R.L.		2,669.54		
			Gricignano di Aversa	CE	ECO TRANSIDER SRL		650.82		
			Volla	NA	LANGELLA MARIO S.R.L.				97.21

Sum of Quantities_t/y broken down by Waste Category, WC_Detailed and Treatment vs. OTA (Pro), Prov (ProSL), Municipalities (Pro), Municipalities (Pla), Prov (DesSO) and Plant:Name (Pla). Color shows sum of Quantities_t/y. The marks are labeled by sum of Quantities_t/y. The data is filtered on FA_Municipalities, which keeps 11 members. The view is filtered on WC_Detailed, which keeps OW_200108 and OW_200201.

Figure 92: OW waste per EWC Code treated by Plant company at the Focus Area scale (Data source: ISRWO 2015) (P. Inglese elaboration)

Plant_Q_Tab

Quantities_t/y: 0.12 – 150,000.00

				Waste Category / WC_Detailed / Treatment: RSW_Residual Solid Waste							
				RSW_200301				RSW_200302	RSW_200303	RSW_200307	RSW_200399
OTA (Pro)	Municipalities (Pro)	Municipalities (Pla)	Plant:Name (Pla)	D13	D14	D15	R13	R13	R13	R13	D15
NA 1	Acerra	Acerra	ECOLOGIA ITALIANA S.R.L.						815.62	213.20	
			ITAL AMBIENTE SRL							1,073.82	
		Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.		8,007.82	10.86					
	Afragola	Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.	73.66	15,189.04	102.46					
		Gricignano di Aversa	ECOTRANSIDER SRL							301.52	
		Scafati	HELIOS S.R.L.				8.36	469.94		369.50	
	Caivano	Acerra	ITAL AMBIENTE SRL						21.04		
		Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.		10,777.82	28.04					
			DI GENNARO SPA							245.72	
		Pastorano	GE.S.I.A. S.P.A.						198.86		
	Cardito	Acerra	ITAL AMBIENTE SRL							0.12	
		Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.		5,805.80						
			DI GENNARO SPA							14.16	
		San Vitaliano	AMBIENTE S.P.A. (ERA AMBIENTE S.R.L.)							118.94	
	Casalnuovo di Napoli	Acerra	ECOLOGIA ITALIANA S.R.L.						547.28		
			ITAL AMBIENTE SRL							650.04	
		Airola	ECO ENERGY S.R.L.							0.84	
		Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.		8,184.85	81.66					
		Volla	LANGELLA MARIO S.R.L.							251.24	
	Casoria	Acerra	ITAL AMBIENTE SRL							1,511.62	
		Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.		14,214.50						
		San Vitaliano	AMBIENTE S.P.A. (ERA AMBIENTE S.R.L.)							23.84	
	Crispano	Arzano	ECOCART SRL							114.74	
		Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.		2,193.34	12.52					
		Caserta	IMPRESUD S.R.L.							223.06	
	Frattaminore	San Vitaliano	AMBIENTE S.P.A. (ERA AMBIENTE S.R.L.)							174.26	
		Tufino	SAPNA SISTEMA AMBIENTE PROVINCIA DI N..		2,652.24						
	Napoli	Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.		151,881.24						
			DI GENNARO SPA							7,818.56	
		Giugliano in Campania	SAPNA SISTEMA AMBIENTE PROVINCIA DI N..		118,523.54						
		Gricignano di Aversa	PROGEST S.P.A.								164.22
		Napoli	ASIA NAPOLI S.P.A.			494.82				4,127.43	
			SECONDIGLIANO RECUPERI COOPERATIVA S..							214.20	
		Serino	DE.FI.AM. S.R.L.							6,991.60	
		Torre del Greco	EDIL CAVA SANTA MARIA LA BRUNA S.R.L.						3,645.10		
		Tufino	SAPNA SISTEMA AMBIENTE PROVINCIA DI N..		100,581.28						
NA 3	Cercola	Caivano	A2A AMBIENTE SPA EX ECODECO S.R.L.		3,894.86						
		Volla	LANGELLA MARIO S.R.L.						39.02	85.28	
	Volla	Tufino	SAPNA SISTEMA AMBIENTE PROVINCIA DI N..		3,625.98						
		Volla	LANGELLA MARIO S.R.L.						514.92	217.88	

Sum of Quantities_t/y broken down by Waste Category, WC_Detailed and Treatment vs. OTA (Pro), Municipalities (Pro), Municipalities (Pla) and Plant:Name (Pla). Color shows sum of Quantities_t/y. The marks are labeled by sum of Quantities_t/y. The data is filtered on FA_Municipalities, which keeps 11 members. The view is filtered on WC_Detailed, which keeps RSW_200301, RSW_200302, RSW_200303, RSW_200307 and RSW_200399.

Figure 93: RSW waste per EWC Code treated by Plant company at the Focus Area scale (Data source: ISRW) (P. Inglese elaboration)

4 Reflection & Conclusion

The following paragraphs present reflections on the application of the methodology for integrated analyses regarding both pilot cases, in order to inform the follow up cases as well as a wider field of application. In section 4.1, the focus is on waste-sensitivity of the two pilot cases in relation to physico-geographical manifestations. Next, in section 4.2, the dynamics of waste, resources, and wastescapes, as spatial and temporal phenomena, are addressed. In section 4.3, the accent is on data and modelling, particularly regarding how data availability in both pilot cases determined the level to which dynamic mapping could take place. In section 4.4, finally, the relevance of Enabling Contexts is addressed. Those are key aspects in relation to the further application and evolution of methods and tools introduced in this report.

With regard to the four follow-up cases, and their task of process modelling, the pilot cases have shown two different elaborations, rooted in a shared methodological structure. This provides a wide frame of reference to which the follow-up cases can position themselves. Furthermore, the results presented in this report feed into the PULLs in order to enhance the co-development process towards eco-innovative solutions and strategies. Last but not least, the novel methods aimed at convergence of resource flows and geo-referencing, tested on the two pilot cases, form a solid basis for other cities and city-regions with the ambition to move from linear to circular resource management. Not least by accentuating the systemic nature and spatial reality of this transition. Based on the preliminary results, several cities have shown an interest in the proposed methods, such as Oslo, Warsaw, and Barcelona. Moreover, the Campania Region in Italy has used the REPAiR methodology for its new territorial landscape plan.

4.1 Physico-geographical aspects and waste-sensitivity

Having regarded the complex socio-demographic situation of these two cases, show diverging trajectories of the two societies. The different physico-geographical situations posed different challenges. Relating the Amsterdam case, water is a critical element that determines further (peri-)urban development, for example the need for redevelopment of harbour areas such as Haven-Stad, an extensive area in the North-West of Amsterdam that will be transformed from mainly industrial to mixed functions with a heavy accent on housing (up to 70,000 new dwellings planned until 2040). In the Naples case, the physico-geographical situation determines the main economic sector to be agriculture, which had to be preserved for the future. Besides the changing economic situation, the special social system - in relation to the power of Camorra - caused a significant degradation in the values of agricultural lands. In the slipstream, this created Wastescapes, that form a significant challenge for the area.

Taking into account the secondary analyses of Euro barometer and the two pilot countries we could see that on household level as well as company level Italy has significantly higher waste-conscious behaviour or environmental sensitivity. When focusing on the case specific regional level the situation is the same, also concerning the WCB index or the number of EMAS certifications.

Inglehart (1977, 2000, 2005) argues that in post-industrial societies, post-material values, norms, and attitudes are more common. Socio-cultural and socio-moral phenomena – among other implications – are in favour of praxes like taking collective responsibilities and willingness for participation. Based on this argument, it can be assumed that societies with higher income rate (with better economic conditions) tend to show more commitment and care towards their natural environment i.e. collective waste consciousness is more common. However, our first investigation did not support this presumption. Although, The Netherlands has higher GDP (with 10,000 EUR more) than Italy, waste consciousness is significantly higher in the latter country. This finding is also true regarding the Italian case study region in comparison to the Dutch one. The reasons may be rooted in the different socio-psychological approaches. Supposedly, in Italy visible environmental consciousness has a more important role in the society, possibly because of the "history of pollution". However, it seems to be the opposite situation concerning the institutional level, as shown in earlier deliverables as part of work package 6 on decision models. In The Netherlands, on the other hand, environmental consciousness appears to be more under the surface, integrated in everyday life. The reason for this might be found in the high number of challenges The Netherlands faces, concerning e.g. the limited amount of productive land, the increasing population and its provision with products and services. Furthermore, in the Dutch case, governmental plans, strategies and programs for the CE transition are in place or in an advanced stage of development, whereas in the Naples case those are just being developed.

Finally, it is important to note that neither the socio-economic, nor the socio-cultural inquiry aimed to analyze theoretically developed causal relations. Both examinations, instead, tried to propose descriptive contextualization about eco/waste consciousness in order to understand more comprehensively these perceptions and attitudes. Of course, plenty of impacts could influence eco/waste consciousness, and it is also possible that some more locally unique factors are overshadowing rather general/universal relationships. This is why it is crucial to use diverse approaches in all case study investigations. Yet, these case-related specificities do not undermine the significance of applying broad theoretical-methodological perspectives on descriptive contextualization. Otherwise we could not shed light on local particularities. In Deliverable 3.8, the socio-economic and socio-cultural contexts of all case studies will be explored in more detail, clarifying certain causal relations between eco/waste consciousness on the one hand, and socio-economic/socio-cultural features on the other.

4.2 Waste(scape) dynamics in space & time

The spatial analysis presented in this deliverable shows how waste dynamics ultimately take place in space, and what the spatial consequences of linear processes of urbanisation, as well as production & consumption, are. Spatial representations appear to be very helpful to imagine place-specific multi-dimensional transitions to a circular economy. They act as visual synoptic instruments, synthesizing how multiple circular economy dimensions could merge in space. The projective images' accessible and attractive capacity, break through the status quo. In particular the visualisation of wastescapes help us to interpret these lands not as final result but as one dynamic system that can interact with the urban territory and reveal new relations. It emerged that wastescapes should be seen as processes rather than 'objects', whilst highlighting the temporal sense and the interrelations with socio-economic, spatial and material domains and related fluxes of wastes.

Ultimately, waste(scape) could be considered either the unexpected and conclusive result of a life cycle, or the possible starting point for the new one. That means "circularity in practice" or, in other words, trying to transform wasted (things, flows and places) into resources from which trigger new possibilities of sustainable development and growth. But it also means that waste(scape) matter has to be placed into time-scenarios, since it interacts with the active urban life and can be used to improve systemic efficiency and the environmental condition of the context in which they are placed or trough which they transit.

The various (green, grey and brown) nature of the waste(scape) has consequences on their spatial distribution in peri-urban contexts, structurally dispersed and porous, not comparable to hierarchical structures nor circumscribable in stable and concise functional areas. This has consequences on the methodologies by which their spatial features can be described and mapped. The attention shifts from stable characteristics of the individual objects to the relations between them and their contexts: with a focus on the production processes (in a broad sense, even of a social type) which they depend on and interact with. This interconnection is generally called a systemic relation.

From a systemic perspective, waste(scape) can offers ecosystem services (supporting, provisioning and regulating). Green wastes(cape) in peri-urban territories can regulate climate, air, and water quality; enable nutrient and water cycling, provide spaces for growing plant fibres, usable to develop bio materials for the construction industry, and for recreation.

The spatial analyses of the two pilot cases highlight how wastescape assumes distinctive morphological characteristics strongly related to the territorial processes of urban growth and shrinkage. In the case of Amsterdam, wastescapes are represented by scattered, small spaces with different morphologies and natures. They are composed by: 1) linear elements concentrated along water, road infrastructures, as a result of planning regulation, and within the port industrial area; 2) a fine grain of lands left as greenfield and without a specific destination; 3) a fragmented pattern of polluted and possibly polluted lands located within the port area of Amsterdam; 4) the safety and noise area relative to the airport infrastructure. This area is indeed limiting the surfaces for the building expansions but allowing other forms of urbanisations. In comparison to Naples case, and as the maps AFH18.1 and 18.2 show, the wastescape surface is very limited. This is mainly due to the strong urbanisation pressure that the AMA region is currently experiencing, in which every area counts as potential space to host building and infrastructures and the land value of real estate property.

In the case of Naples, the peri-urban context offers quite complex and articulated wastescape geographies. Their topologies can be represented by several figures and patterns, namely:

- "reticular wastescape", coinciding with the interstitial spaces that flank the large grey infrastructures (motorways, expressways, railways, aqueducts, power lines, gas pipelines, etc.) as well as canals and streams, often polluted and/or strongly artificialized;
- "wasted neighbourhoods", characterized by high social vulnerability and/or very low settlement quality, often due to their abusive genesis and to the public confiscation of buildings;
- "former rural patches" in abandonment, no longer cultivated, characterized by high ownership fragmentation, presence of fences, topologically located near main public facilities (for example the high-speed station of Naples-Afragola), waiting for building transformation;
- the "mosaic" of areas and buildings linked to the waste cycle: areas of different nature (deposits, treatment plants, active and inactive landfills) disposed causally, in a dispersed and scattered manner, within peri-urban contexts.

Last but not least, REPAiR, considers not only the wastescape, but also the resource-places or "regenerative-scape", as addressed in section 2.1.2. From REPAiR perspective, waste should become resource(s). Part of the wastescape may be subject to reactivation following the principles of circular economy and nature-based solutions, and be categorized as regenerative-scape. Moreover, the regenerative-scape identifies social-ecological systems, that combine complex adaptive systems, self-organization, emergent properties, resilience, adaptive capacity, heterogeneity, diversity, tipping points, synergies, constant change, scale:pattern:process:design relationships, multi-scale networks, connectivity, and the constant exchange of materials and energy between and within systems (Wu, 2013; Opdam et al., 2013; Viganò, 2013). In the case of the Naples sample area, for example, a property confiscated to criminal organization - the Masseria Ferraioli - today constitutes an element of social and community re-appropriation, with urban gardens and forms of aggregation quite relevant to the local context, which can also involve other places in the surroundings, in a network of regenerating elements.

In the category of regenerative-scape can also be included the identity elements: for example, the historical traces of peri-urban territories, even when these do not have the characteristics of wastescape. These are places with great potential as they are structurally arranged in a continuous territorial structure and recognized by the communities as symbols of their local specificity.

In this sense, they constitute almost an archaeological trace, which the territorial recycling project can assume, in the context of the necessary protection of integrated conservation of the historical and environmental heritage (Amsterdam Declaration, 1975).

In the case of the sample area of Naples, an old fifteenth-century rural church, near the former Scafatella landfill, still recognized as an identifying place by locals and peasants, testifies to an old, perfect, balance between built environment and nature. This place, still today a reference point for PULL participants, can become a regeneration center for the local context, linking the phyto-reclamation process of the former landfill with traditional crops (hemp, or other) to the possibility of having new landscapes of regeneration near the “core” of the site: the ancient rural church.

The environment, consisting of wastescape (former landfill) and identity element - the rural church - are therefore to define, if reactivated by a coordinated process, a landscape of regeneration, which can be defined as "regenerative- scape".

4.3 Modelling of material flows & Data intensity

With regard to the MFA methodology, specific attention should be drawn to processing of material flow data. In general, this step requires intensive prior data collection and processing, tapping into top-down and bottom-up data. The hypothesis that the type and level of difficulty of this step can differ greatly per case, was underscored by comparing the two pilot cases. For company related waste flows, for example, the Italian case had immediate access to high-level regional data-sets, whereas the Dutch case could only tap into such detailed data-sets until much later, initially necessitating a disaggregation method based on national data. The complexity and workload associated with this step thus depend greatly on aspects of data availability and accessibility. Time restrictions and limited means are points of attention with regard to acquiring representative data in the follow-up cases, and ultimately in establishing a generic GDSE framework. Through the two pilot case studies, substantial groundwork has been done that should make the work in the follow-up cases more manageable. The assistance of the Naples team and/or the Amsterdam team, however, remains important in the ongoing process. This requires a conscientious reflection on the division and allocation of hours in the various WPs.

An important consideration regarding the results presented in this deliverable, concerns the step from static information – e.g. notions and visualisations of amounts of waste per neighbourhood per year – to dynamic data i.e. the flux of these waste-volumes to processing plants, for example. Given the importance of ‘local impacts’ in the REPAiR project (as part of WP4’s sustainability impact assessment), information on transport between waste generation and processing steps is valuable, both in space (from where to where exactly, following which routes and transport modes?) and in time (when does a waste-flow leave one spot and reaches another?). Knowledge of the geolocation of food waste generation as well as geolocation of the treatment plants, allows us to build an origin-destination network over the infrastructural network. In a similar way the flows of construction and demolition waste are identified and represented taking into account the activities that produce them, the quantities produced and the distances to be covered for disposal. This builds the geometric backbone for the Activity-based Spatial MFA and the spatial Sankey diagrams used in the GDSE.

In the Italian as well as in the Dutch case, these dynamic aspects are addressed, but require further refining. Regarding households in the Dutch case, for example, there was no detailed data available that would allow us to perform an AS-MFA based on data that is spatially more precise than the municipal level. Therefore, a model had to be developed with regard to the amount of food waste, the flows between households per neighbourhood, and waste treatment facilities in the region and beyond. This model combines data from two main sources, namely the CBS database and a study by CREM, as described in section 3.3.1.5.

In the case of Naples, the data used to perform an AS-MFA are related to the Focus Area (FA), that identifies 11 municipalities and 2 Optimum Territorial Areas (OTAs). The main scales of information analysed for two levels of aggregation/disaggregation: the municipal boundaries for the aggregated information and the census area boundaries for the disaggregated information.

In order to define the material supply chain for food and product preparation, according to the general framework of the REPAiR project, a set of NACE codes was identified to represent the FW chain and is subdivided into Groups that includes different activities of the Chain. Indeed, for the selection of the NACE codes, the Orbis database was incomplete and not useful to perform a suitable analysis, and therefore the data used derive from National/Regional Database (cf. 3.2.1.4). In the Campania Region, the detailed information related to waste is organized in two databases, managed by two different regional bodies. The Regional Waste Registry (RWR), handled by the Regional Agency for Environmental Protection (ARPAC), collects all data related to waste production and management, and the Information System of Regional Waste Observatory (ISRWO), handled by Campania Regional Authority, controls and enhances the traceability of urban and hazardous waste, whilst analysing the trend of their production.

4.4 The relevance of Enabling Contexts

The notion of local dynamics leads to the concept of Enabling Contexts. Enabling contexts (EC) help to determine specific, high-potential areas and systems of interest with tangible and intangible, environmental and urban, social, cultural and economic relations that facilitate a process of innovation and trigger change with greater simplicity and effectiveness.

The EC presented in this deliverable were produced combining several layers of spatial, socio-economic and material flow information in an iterative and discursive process by consortium members. Therefore, these contexts are sensitive to different actors and interests in the territory and their meaning depends greatly on the precision with which data was processed, maps were generated, and perspectives of stakeholders and experts were employed. As such, within the framework of this deliverable, EC can “only” be understood as a guiding map - a representation model - to guide the further exploration and development of place-specific eco-innovative solutions (WP5). This means that for the enabling context and enabling conditions (Nonaka and Konno, 1998; Nonaka et al., 2000; Nonaka and Toyama, 2002) the identification of the two main dimensions of interactions:

the type of interaction (individually or collective) and the media used in such interactions, whether face-to-face contact or virtual media, needs to be identified – or verified – and updated if needed within the ongoing process of the PULLS.

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Annexes

Annex 1 - List of informative layers and posters

Annex 2 – Spatial Analysis maps Naples, scales: region, focus area, and sample area

Annex 3 – Spatial Analysis maps Amsterdam, scales: region, and focus area

Annex 4 – MFA maps Naples, scales: region, focus, and country

Annex 5 – MFA maps Amsterdam, scales: region

Annexes and data sources can be found via This Link

REPAiR

REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism

ADDENDUM D3.3 (Process model for the two pilot cases)
CDW in the Amsterdam Metropolitan Area

Version: Final - April 2019

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1.1	07-01-2019	Martijn Kamps, Tamara Streefland	TUD/Metabolic	Stock model
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1.4	23-04-2019	Alex Wandl	TUD	Adding Figures
1.5	24-04-2019	Bob Geldermans	TUD	Final edit

Acronyms and Abbreviations

AMA	Amsterdam Metropolitan Area
BAG	Basis Administratie Gebouwen
CDW	Construction and Demolition Waste
EC	European Commission
EWC	European Waste Catalogue
EU	European Union
FA	Focus Area
FW	Food Waste
GDSE	Geo-design Decision Support Environment
LMA	Landelijk Meldpunt Afvalstoffen
NACE	Nomenclature des Activités Économiques dans la Communauté Européenne
UMM	Urban Mining Model
WP	Work Package

Table of Contents

1. INTRODUCTION

1.1 Construction & Demolition Waste in the Amsterdam pilot

During the interviews conducted with stakeholders in the region (as part of Work Package 6 of the REPAiR project) and the Peri-Urban Living Labs (PULL) workshops in the co-exploration phase (WP5 of the REPAiR project), the importance of, both, Construction Demolition Waste (CDW) and Organic Waste (OW) value chains was confirmed. With regard to the OW flow, the subcategory Food Waste (FW) was pinpointed as a primary concern. Regarding the CDW flow, the focus shifted from specific renovation & transformation-related CDW to CDW in its entirety. Due to time restrictions and intensity of data collection and processing, the focus regarding the Amsterdam pilot in Deliverable 3.3 (D3.3) has been solely on FW. The CDW case was put on hold until the case study for FW had been completed. Underlying report is an addendum to D3.3, aimed at the CDW case-study.

First, in section 2, a Material Flow Analysis of CDW in the Amsterdam Metropolitan Area is described and visualized, following the steps formulated and explained in Deliverable 3.1 (D3.1, AKA 'The Handbook') and D3.3 [Geldermans et al., 2017 and 2018]. A key aspect is the 'Activity-based mass flow modelling' step, which couples CDW flows to geo-referenced economic activities, from 'source' to 'sink'. Data processing and visualization of flow maps takes place in the specially developed Geodesign Decision Support Environment (GDSE, as part of WP2 in REPAiR). Moreover, the indicated flows are the basis for a sustainability impact assessment, at the heart of WP4.

In section 3, subsequently, the focus is on building materials that are currently 'in stock' i.e. locked inside the built fabric of the Amsterdam Metropolitan Area. Those materials are regarded as a valuable future flow of disassembly and demolition materials (rather than future CDW materials). This notion has not been part of the design and construction process at the time of initiation and development. Hence, associated materials would - in a conventional scenario - predominantly end up in regular CDW flows. However, from the vantage point of 'circularity', the building stock represents materials we can capitalize on in the years to come. The current building stock can thus be unlocked as an 'urban mine'. Within the Amsterdam case, this notion of "urban mining" has been integrated in recent policy strategies and explorative studies, against the backdrop of regional circular economy ambitions. An example is the project Prospecting the Urban Mine of Amsterdam (PUMA), which focused on copper and steel stocks, as well as anticipated release time-frames [Blok and Roemers, 2016].

2. MFA OF CONSTRUCTION DEMOLITION WASTE

2.1 Determination of material scope

The data that is underlying the material flow analysis was provided by the Landelijk Meldpunt Afvalstoffen (LMA, *National Waste Registry*), which is the agency that registers company and hazardous waste for the Dutch Ministry of Infrastructure and Environment. For REPAiR, this agency provided a database with all registered transports of waste that was generated within the AMA in the year 2016 which was classified with the EWC code 17: Construction and Demolition Wastes (including excavated soil from contaminated sites).

2.2 Defining the material supply chain

The aforementioned LMA database includes information about the companies that generate, transport, handle, and treat CDW generated in the AMA. This information can be linked back to the ORBIS database, which allowed to define the waste chain and involved activity groups.

The economic activities from the LMA were classified according to the European *Nomenclature des Activités Économiques dans la Communauté Européene* (NACE) standard for industry classification. This was done by matching company activities to NACE codes. Although the majority of the dataset could be matched automatically (60%), the remaining data required manual matching. However, due to large data volumes and time restrictions, this has not been completed, resulting in 28.14% of the total CDW weight to remain unattributed to a NACE code. However, this limitation only affected the NACE codes, and did not extend to the type of CDW materials, or treatment processes. An overview of the NACE sections, and CDW production are presented in Table 1.

Table 1, overview table of NACE activity levels and their production of CDW

NACE: section level	Description	CDW (tonnes)	Share of total (%)
A	Agriculture, forestry and fishing	23,728	0.06
B	Mining and quarrying	5,109	0.01
C	Manufacturing	2,039, 225	5.31
D	Electricity, gas, steam and air conditioning supply	53,902	0.14

E	Water supply; sewerage; waste management and remediation activities	3,687,576	9.61
F	Construction	3,803,254	9.91
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	353,221	0.92
H	Transporting and storage	332,479	0.87
I	Accommodation and food service activities	5,957	0.02
J	Information and communication	10,083	0.03
K	Financial and insurance activities	214,126	0.56
L	Real estate activities	1,327,325	3.46
M	Professional, scientific and technical activities	1,402,586	3.65
N	Administrative and support service activities	63,565	0.17
O	Public administration and defence; compulsory social security	14,078,384	36.68
P	Education	35,407	0.09
Q	Human health and social work activities	124,217	0.32
R	Arts, entertainment and recreation	13,164	0.03

S	Other services activities	9,668	0.03
W	Unmatched	10,801,257	28.14
Grand Total	-	38,384,233	100.00

The NACE codes selected for the activity groups as well as the interrelations between activity groups are displayed in the comprehensive system diagram in Figure 1 below.

SYSTEM DIAGRAM OF ACTIVITIES AND FLOWS

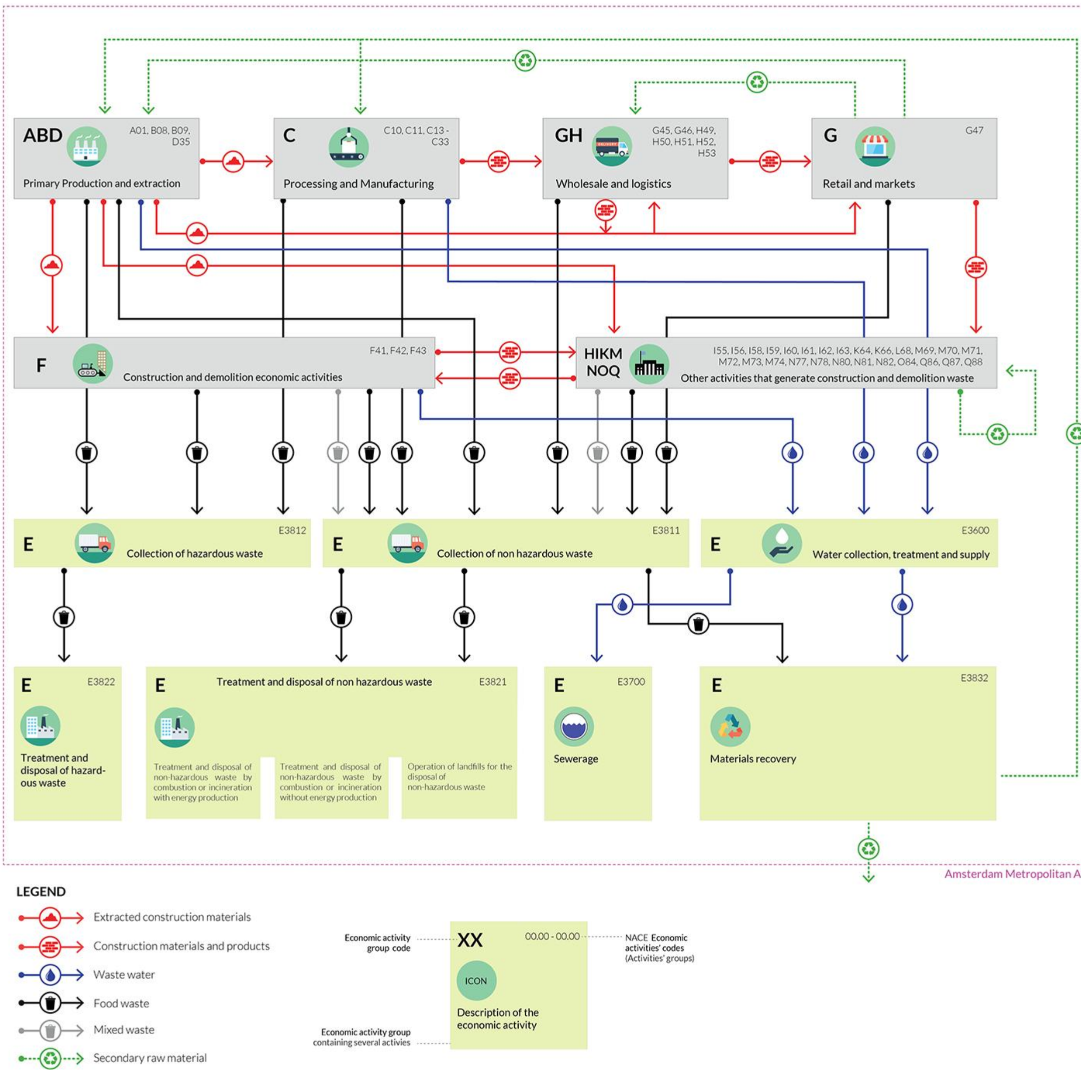

Figure 1: The system diagram of activities and flows that build the system of the CDW value chain in the Amsterdam metropolitan area.

2.3 Selection of geographical areas and spatial scales

As detailed in D3.1, the Focus Area (FA) as a boundary is not relevant for the MFA as the FA is not an administrative boundary, which would lead to great difficulty collecting (top-down) data. Instead, the geographical area for which data is collected, is defined by the boundaries of the 33 municipalities in the Amsterdam Metropolitan Region. As the treatment of CDW generated in the AMA takes place outside the AMA, the geographical area of the MFA also exceeds the AMA.

Similar to the FW case, the geographical location of waste production was divided into specific areas called “wastesheds”. The boundaries of these wastesheds are based on the FW wastesheds from D3.3 to maintain consistency. The connection between the wastesheds and Amsterdam municipalities is presented in the appendix.

2.4 Defining case-specific supply chain

Not applicable (For the CDW process model of the AMA case, this step completely overlaps with the one described in subsection 2.2: ‘Defining the material supply chain’).

2.5 Activity based mass flow modelling

In order to analyze the relationship between the material flows and their geographical location, several operations were performed to the raw data received from the LMA. First, data concerning the treatment processes and CDW materials were translated from Dutch to English. Second, using open source data from the Dutch Bureau for Statistics (*Centraal Bureau voor de Statistiek, CBS)*, the data were allocated to the aforementioned wastesheds.

The overview of waste from NACE activities per wasteshed in 2016 is presented in Table 2, whereas Table 3 displays the division per treatment process.

Table 2: overview of CDW amounts (tonnes) per NACE activity per wasteshed

NACE Code	WASTESHED						
	AEB	HVC Middenmee	HVC Purmerend	Indaver	Meerlanden	Orgaworld	Grand Total
A	171	9721	5928	2118	5785	5	23728
B	5097			12			5109
C	517114	6885	209790	70683	1228308	6446	2039225
D	46066	1852	4161	16	0	1807	53902
E	2062820	33237	1014123	234178	1900	341320	3687576
F	1735214	192380	159258	149871	1345588	220943	3803254
G	178611	40215	1139	50663	46242	36351	353221
H	136004	158224	4947	22920	5909	4475	332479
I	2597	2343	26	160	741	90	5957
J	85	22		9898	3	75	10083
K	121648	13436	7349	3922	53519	14252	214126
L	129070	33522	1123465	27447	13812	10	1327325
M	181140	17987	374	6703	1141801	54581	1402586
N	18364	8514	2930	26403	1954	5401	63565
O	11707576	735797	200910	233912	906613	293575	14078384
P	35310	62		35			35407
Q	119963	150	697	791	2035	581	124217
R	654	10125	5	928	169	1283	13164
S	7925	281	169	10	1247	36	9668
W	9103218	719009	14754	57451	147503	759322	10801257
Total (tonnes)	**26,108,645**	**1,983,762**	**2,750,024**	**898,120**	**4,903,127**	**1,740,552**	**38,384,233**

Table 3: overview of CDW amounts (tonnes) per treatment process per wasteshed

	WASTESHED						
Treatment Process	AEB	HVC Middenme	HVC Purmeren	Indaver	Meerlanden	Orgaworld	Grand Total
Annealing (ground)	178	1		25	20	300	523
Biological cleaning	60	2					62
Composting, aerobic							
Crushing	2319	878	227	163	490	201	4277
Direct landfill	13942	128	2	10	1244		15326
Extractive cleaning	753	75	29	321	50	6	1234
Immobilize for reuse	71	10					81
Incineration with recovery energy	117	66	1	10	38	273	504
ONO is detoxifying, neutralizing and		7					7
Recovering metal (chemically)	26	1					28
Separating chemically / physically				1			2
Shred / cut	141	6	1	2	3	85	239
Sort / separate	461	49	77	175	12	116	890
Storing	217				93		310
Transshipment /	7548	642	2413	150	812	187	11752
Use as building	24					173	198
Use other as raw	253	118		41	2141	399	2952
Total (tonnes)	**26,109**	**1,984**	**2,750**	**898,000**	**4,903**	**1,741**	**38,384**

2.6 Visualizing the results

Figure 2 shows the complete CDW flow that originated from the AMA in 2016. It is clearly visible that the depicted network exceeds the borders of the AMA by far. Figure 3 shows only the wasteflow containing concrete, and Figure 4 shows the wasteflow containing wood. These images can also be found in the appendix.

Figure 2: Complete CDW flow originating from the AMA (2016)

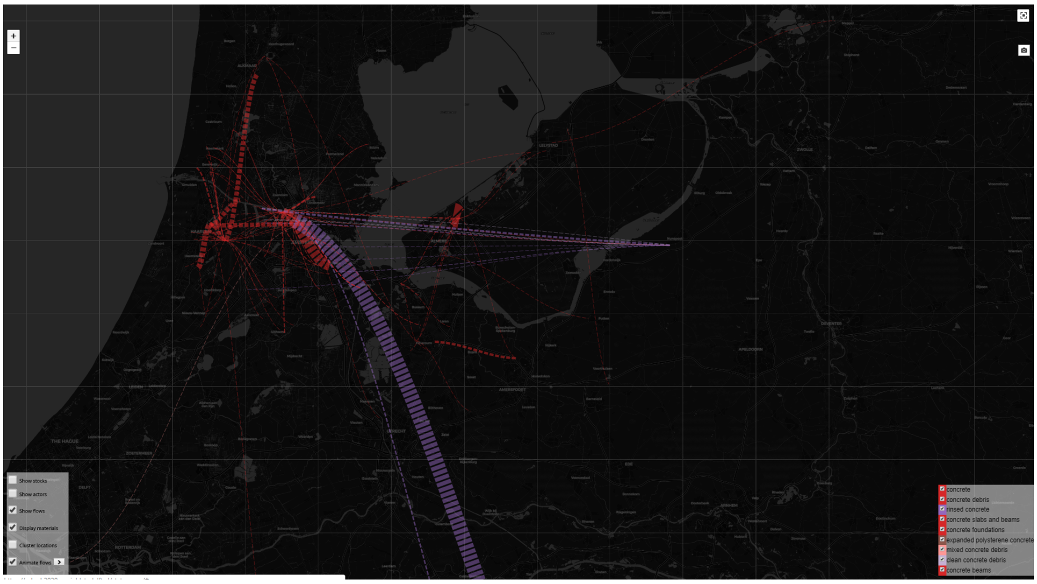

Figure 3: CDW flow: Concrete, originating from the AMA (2016)

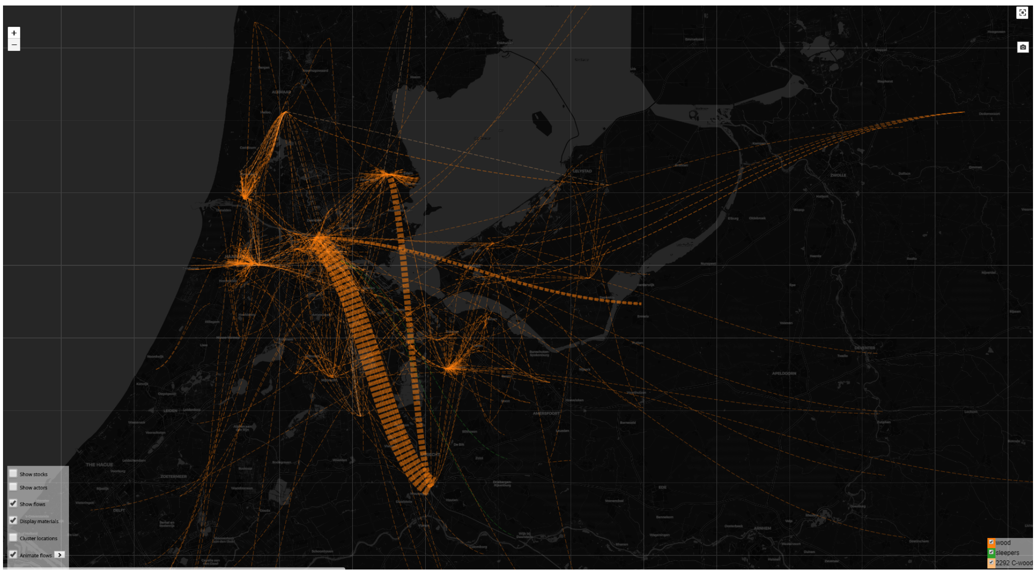

Figure 4: CDW flow: Wood, originating from the AMA (2016)

3. URBAN MINING MODEL: MAPPING THE STOCK

3.1 Introduction to the Urban Mining Model

Urban Mining can be defined as the process of reclaiming raw materials from spent products, buildings and waste. Making an inventory of the amount of raw material that exists within a product or building as a basis to calculate the stock of building materials in the AMA, is an extensive task. Therefore we approached this through the use of an open source Urban Mining Model (UMM). The UMM used in REPAiR was co-developed by the building inspection company SGS Search in collaboration with the sustainability consultant Metabolic[1]. The next section will elaborate on how the model works.

The model distinguishes six building classes: 'row-houses', 'semi-detached houses', 'apartments', 'free-standing houses', 'offices', and 'other utility'. For every building class, we derived the occurrence and quantity of approximately 500 building elements (NL-SFB) from operation budgets and cost-estimates from construction contractors. We then multiplied the quantity of these elements by the volumetric mass density to obtain individual element weight per building class[2].

To obtain the raw material weight from the 500 building elements, every element was classified into 50 material classes. These material classes were further classified into 14 main material types that formed the basis to calculate the material stock for REPAiR. The material types include: sand and soil, concrete, bricks, ceramics, glass, gypsum, steel and iron, copper, other metals, wood, paper, plastics, bitumen, and other (isolation material etc.).

The UMM uses index values to calculate the material stock based on the building class and the number of square meters. We classified the Dutch Key Register for Addresses and Buildings (BAG)[3] to obtain the input parameters to do so.

3.2 Classification Method

For REPAiR, we expanded the original UMM from SGS Search & Metabolic by including a fine-scale spatial component (on building level), and adding a spatial component by using geographical data as an input.

In order to calculate the material stock per building within the AMA, we first classified every building into one of the six building classes using a decision tree in ArcMap. In this process, we use the BAG as a building reference. The BAG includes

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[1] Example project cases where the UMM is used in practice:

https://www.metabolic.nl/brochures/een-circulaire-bouwketen/

https://www.metabolic.nl/publications/circulaire-bouwketen-amersfoort/

[2] Additional features included in the UMM are: a distinction in which building layer every element is situated, what the element-specific new price is, a percentual estimation of re-usability and disassembly, an estimation of the value per element when reused, and a calculation regarding the environmental gain of reusing elements compared to primary production.

[3] https://www.pdok.nl/introductie?articleid=1948911

the georeferenced polygons of all buildings, their respective size, how many accommodations (Dutch: '*verblijfsfunctie*') are situated within one building, and what the usage function (Dutch: '*gebruiksfunctie*') of a building is.

3.2.1 Data preprocessing

Before classification, we preprocessed the data to remove outliers (buildings smaller than 10 m^2 or larger than 1,000,000 m^2), clip the data to the geographical area of the AMA (including a 1 km buffer), and remove buildings that were not in use or planned for demolition (Dutch: '*Pand in gebruik*'). After preprocessing, the dataset still contained 1,139,600 buildings. Subsequently, the use function of each building was determined. Using the relationship classes inherent to the BAG-2018 dataset as a primary key, the building polygons were joined to the point layer containing the use functions (the BAG specifies a total of 81 use functions; residential, offices, industry, schools etc.). After the join, a total of 449,099 building objects did not have an official use function. Based on visual inspection of the data, we concluded that these un-joined objects mainly included sheds and other small unspecified structures. Therefore, they were excluded from the analysis.

3.2.2 Classification

Data preprocessing was followed by performing actual classification. First, we made a distinction between residential and non-residential buildings based on the use function of a building. If a building contains a residential function in any form (including double-functions e.g. residential and offices) a building is classified as residential. This resulted in 624,957 buildings with a residential function and 65,437 buildings with a non-residential function. Based on the use function 7,056 non-residential buildings were classified as 'offices'. The remaining 58,386 buildings were classified as 'other utility'.

Subsequently, the residential buildings were divided into freestanding and non-freestanding buildings based on a spatial join to self (JOIN_ONE_TO_ONE, INTERSECT). The spatial join returned a value higher than one if a building had adjacent buildings (non-freestanding), and a value of one when it was freestanding. This resulted in 53,093 freestanding residential buildings in the AMA. To classify the non-freestanding residential buildings the amount of accommodation addresses within a building polygon were counted using a spatial join of the building polygon to the accommodation address point layer, (JOIN_ONE_TO_ONE, COMPLETELY_CONTAINS, SUM). The spatial join returned a one if only one accommodation address was present within a building polygon, which corresponds to a 'row-house'. It returned a two if two accommodation addresses werepresent, which corresponds to a 'semi-detached house', and three or more addresses correspond to an 'apartment'. Based on the spatial join, the remaining residential buildings were classified as; 'row-house' (494,626), 'semi-detached house' (21,308), and 'apartment' (55,930). In total 91 buildings remained unclassified, these were removed from the analysis.

3.3 Calculating the urban stock

After classifying the BAG into the six building classes that are at the basis of the UMM, the data was exported as a .dbf. We subsequently loaded the .dbf with a python script to calculate the material stock. The UMM requires only three inputs: a primary key (specific to each building), the area of this building, and the building class. In the BAG the primary key is a field called the Identification-key (Dutch: '*Identificatie*'). The calculation of the urban stock itself is based on the area and the building class. After calculating the urban stock, the primary key was used to join the results (.tsv format) directly back to .dbf in ArcGIS using a python script. Finally, we used ArcGIS and ArcScene to obtain descriptive statistics and visualize the results.

3.4 Results of the UMM in the Amsterdam pilot

The results are divided into three main sections: 1) an overview figure of the classification and its descriptive statistics, 2) a zoomed-in detail classification map of the focus area, and 3) a 3D ArcScene figure.

1) Classification overview

Figure 5 shows an overview of all the buildings in the AMA classified into the six building classes.

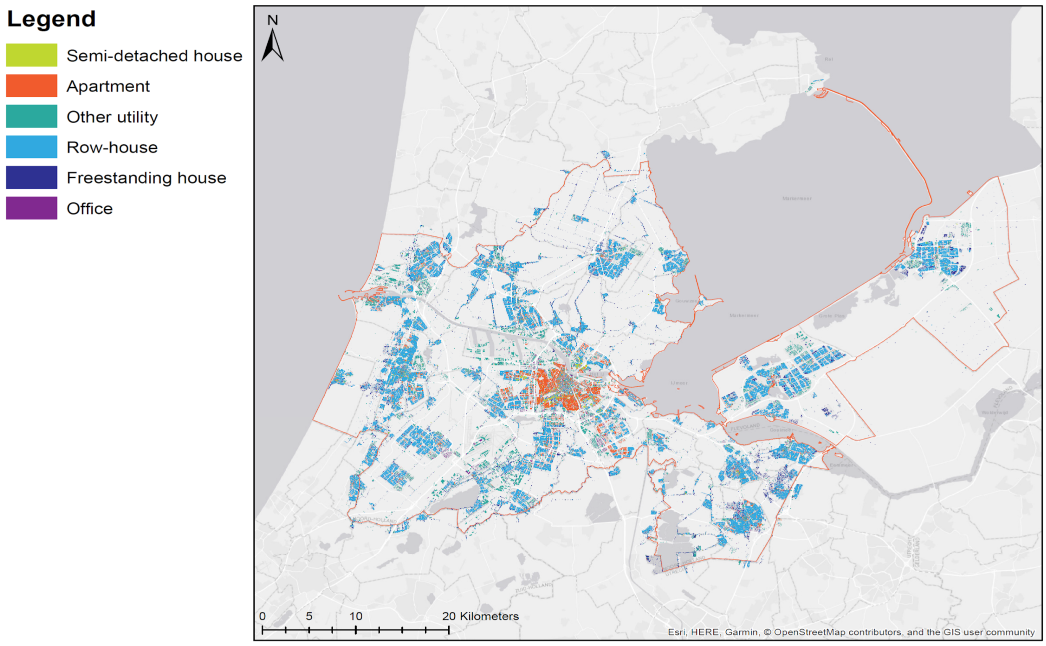

Figure 5: Building classification AMA

Table 4 shows an overview of the descriptive statistics regarding the classification.

Table 4: Descriptive statistics of the classification

Building class	**Number classified**
Row-houses	494,626
Semi-detached houses	21,308
Apartments	55,930
Free-standing houses	53,093
Offices	7,056
Other utility	58,381
Unclassified	91
Building without use function	449,099

2) Classification map of the focus area

Figure 6 shows an overview of all the buildings in the Focus Area classified into the six building classes.

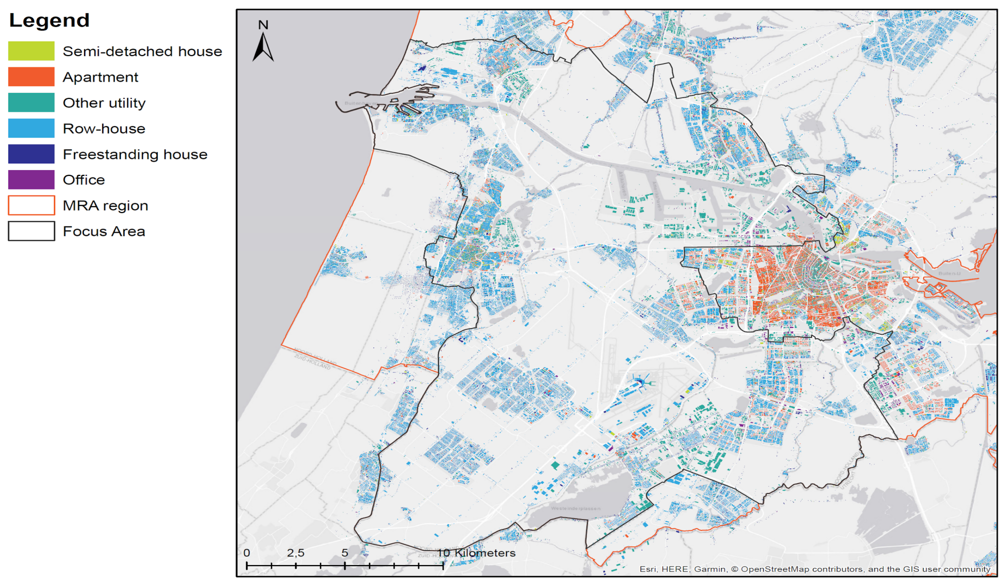

Figure 6: Building classification Focus Area

3) 3D Visualisation of map of material stocks

Aggregated material stock files were produced, in order to better understand and easier communicate the results. Data on material stocks are dissolved on the district level. Multipoint shape-files are then joint with the district polygons. Data are sorted according to material type. ArcScene is used to visualize the data, using the amount of specific material in tonnes per district as value for the extrusion height of the district polygon.

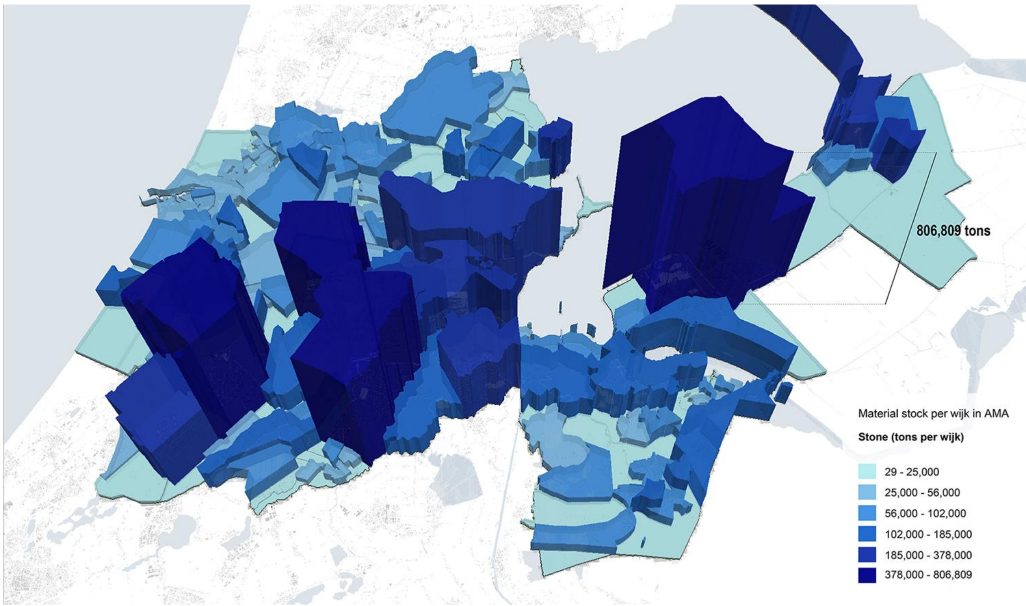

Figure 7: Stone stocks AMA

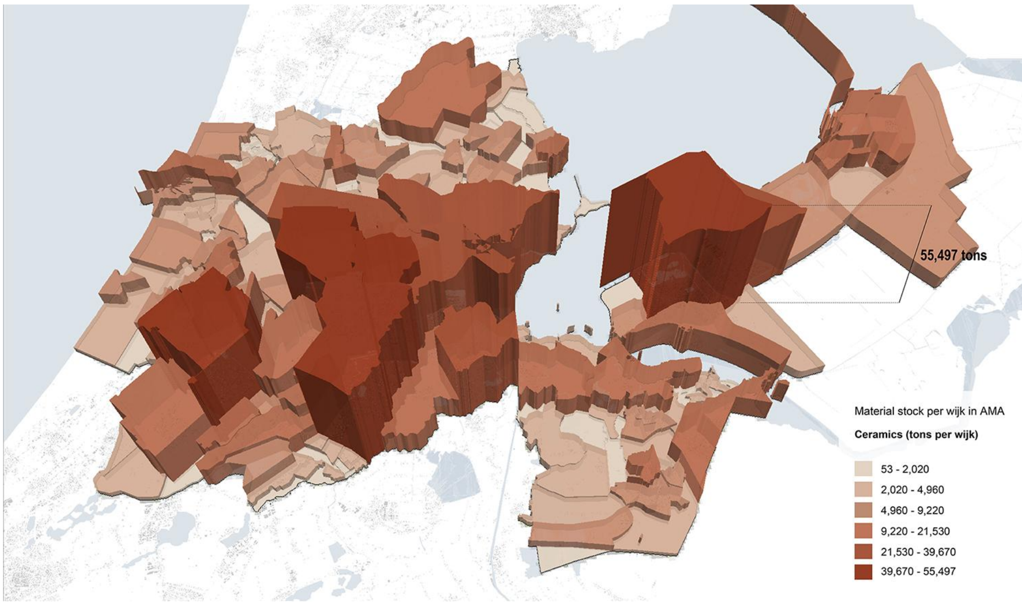

Figure 8: Ceramics stocks AMA

Figure 9: Concrete stocks AMA

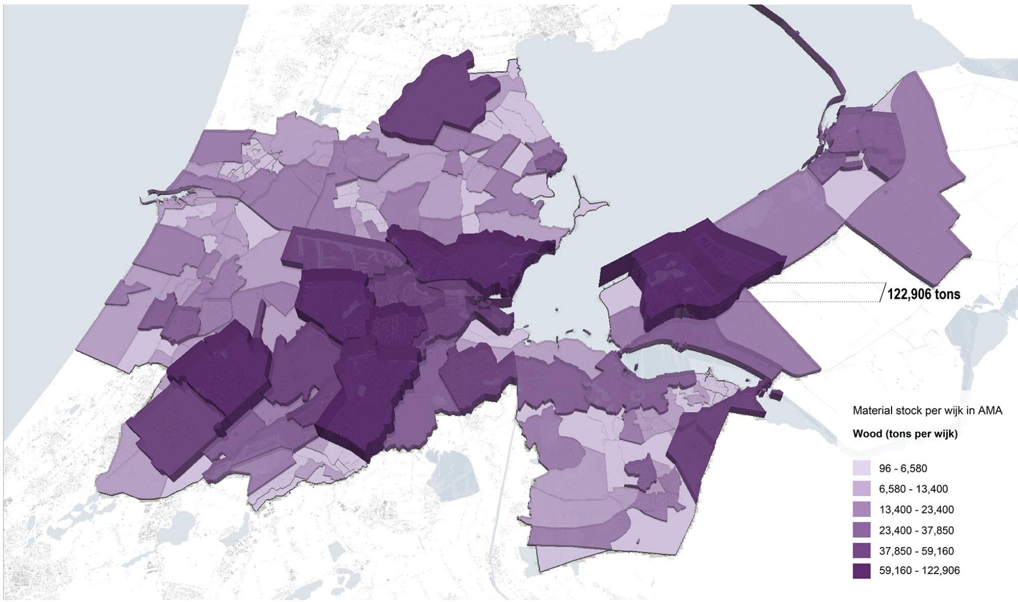

Figure 10: Wood stocks AMA

Material stocks have orders of magnitude very different and this makes difficult to develop visualizations of different materials that can be comparable. Concrete stocks, for example, are four orders of magnitude higher than plastics. In order to visualize all different materials on the same view, different height factors are applied in each case. Materials are sorted in three groups, according to their orders of magnitude:

1) Height = kg / 200,000: Concrete
2) Height = kg / 40,000: Brick, Gypsum, Sand and soil, Stone, Wood
3) Height = kg / 4,000: Ceramic, copper, glass, insulation, other materials, other metals, paper, plastic, iron and steel.

A second option to visualize stocks has been tested, using kernel density and raster files. Stocks in point shapefile are converted into raster files using kernel density function in ArcMap.

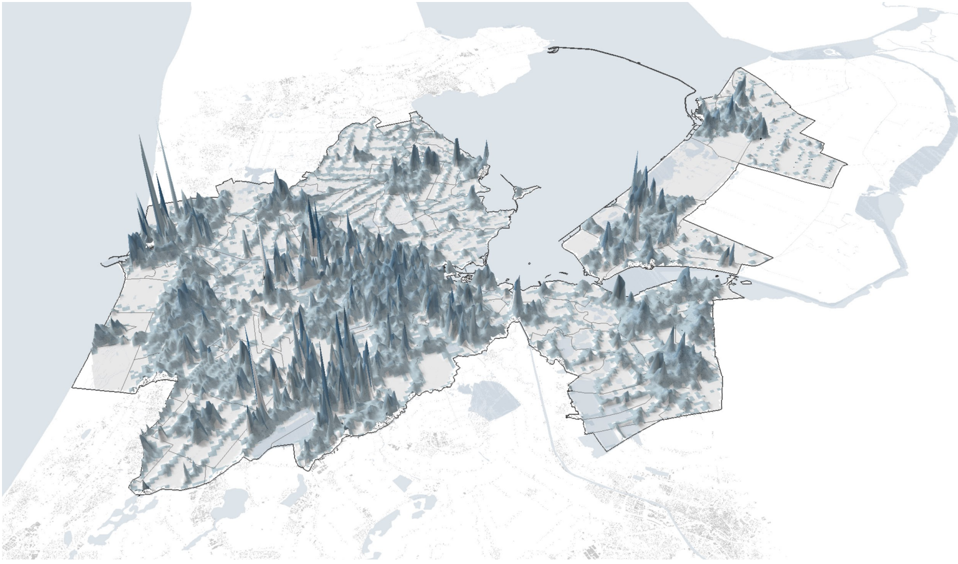

Figure 11: Glass material stock using kernel density. Size of the raster cell: 200m

This method has nevertheless some limitations. In order to calculate density, a raster cell-size has to be defined. The smaller the cell, the most accurate the values will be shown. Data is on points that represent buildings, therefore, the closer the cell size is to the area of the building, the most accurate visualization will be. Having super accurate visualization might not always be the best. Isolated buildings with very high building stocks will be very prominent in the 3D (by showing super high peaks), while areas with high but more evenly distributed stocks will not highlighted. In Figure 11 a 200m cell-size is used, which has already much more information than Figure 12, with a 500m cell size.

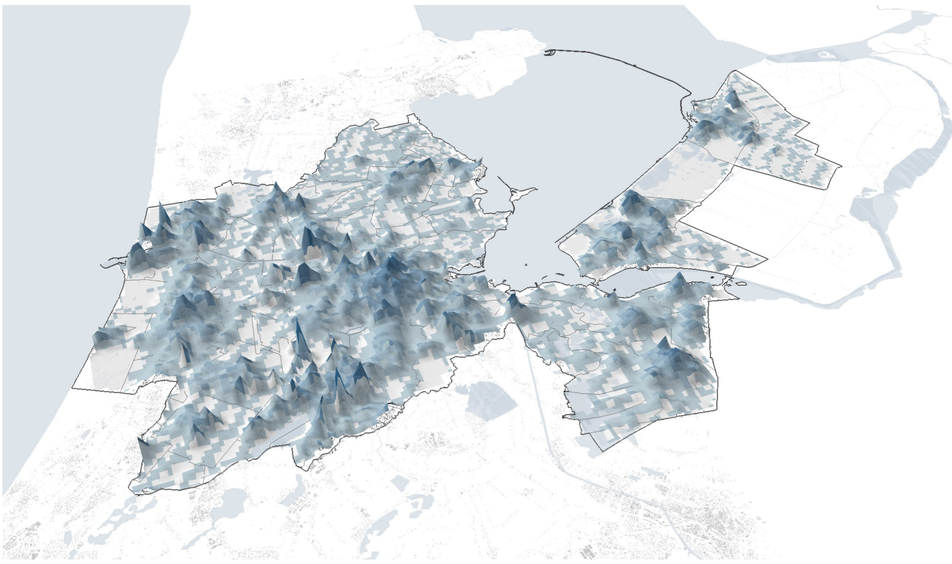

Figure 12: Glass material stock using kernel density. Size of the raster cell: 500m

It is decided to use visualization on the wijk level as a preferred method in this stage, even though kernel density could be used to develop further visualizations, such a cross section, that can be used to combine different sorts of data.

3.5 Limitations, and outlook

3.5.1 Limitations

One of the main limitations of the UMM is the very small sample size used to obtain the index values that form its basis. Every building class only has one sample. This raises the question to what extent the samples are representative of their class. However, based on interviews with building and demolition experts, the UMM is thought to be representative of the AMA since all samples were located within the geographical vicinity of the AMA. The consulted experts estimated the UMM to have an error margin of approximately 20-30% for structures with a concrete skeleton. For buildings with a wooden skeleton the error margin is a lot higher. Nonetheless, most buildings in the AMA have a concrete skeleton.

Furthermore, the clustering of the 500 building elements to the 13 material types and removal of small fractions of materials (that might be very relevant cost-wise) involves data simplification. Most elements contain multiple materials, but due to clustering only the material with the absolute largest share is accounted for.

In the process of defining a visualization method, two issues were when working with the material stock data. First, BAG data is not always accurate on the building function. The model might use some methodology to sort out or double check cases in which buildings with big surface fall into the wrong type and create high deviations.

Second, the building type classification is sometimes limited. There are functions, such as hotel, nursing homes, farms or glasshouses, that are often found in the AMA and have a specific material composition that might not fall into the defined building types or in ‘other function’ type, as they are usually classified as. It might be worth to define specific typologies for them in a further step.

3.5.2 Outlook

The urban stock model provides a rough indication of the 13 main material types in the built environment in the AMA. If these stocks are linked to both building- and demolition projects that will occur in each other’s vicinity in the near future; material sources and sinks can be matched effectively. Metabolic is collaborating with Madaster (the Dutch cadastre for materials) to obtain more building samples to further improve the UMM.

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Appendix

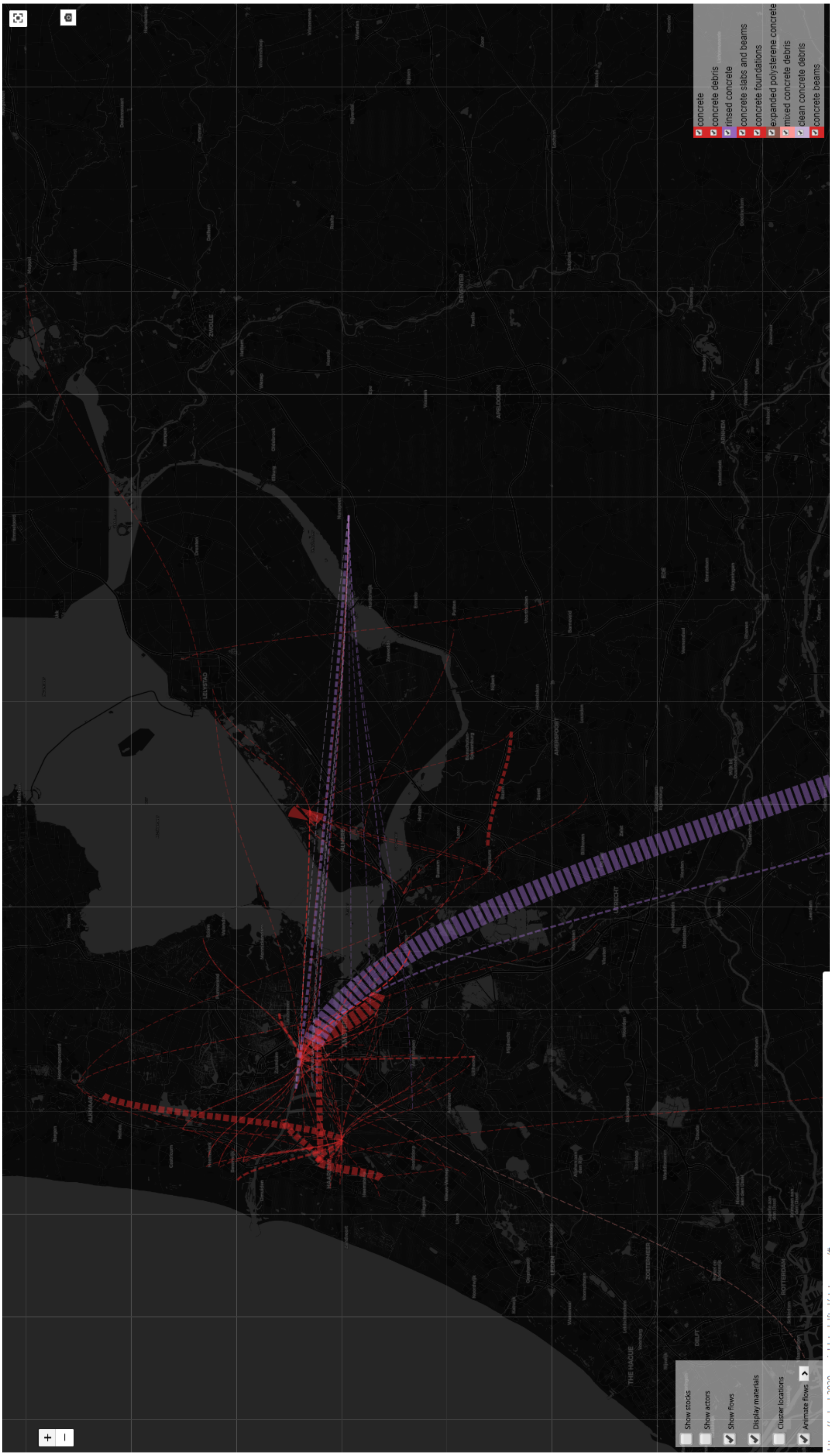
Table: Wasteshed-municipality relation

Wasteshed	Municipality
Wasteshed_AEB	Amsterdam, Ouder-Amstel, Ouderkerk aan de Amstel, Uithoorn
Wasteshed_HVC_Middenmeer	Beverwijk, Edam-Volendam, Haarlem, Heemskerk, Spaarndam, Velsen, Wormerland, Zaanstad
Wasteshed_HVC_Purmerend	Beemster, Landsmeer, Oostzaan, Purmerend, Purmerland, Uitgeest, Waterland
Wasteshed_Indaver	Blaricum, Bussum, Gooise Meren, Hilversum, Huizen, Laren, Muiden, Muiderberg, Naarden, Weesp, Wijdemeren
Wasteshed_Meerlanden	Aalsmeer, Amstelveen, Bloemendaal, Diemen, Haarlemmerliede en Spaarnwoude, Haarlemmermeer, Heemstede, Zandvoort
Wasteshed_Orgaworld	Almere, Lelystad

Figures:

1. *Complete CDW flow originating from the AMA (2016)*
2. *CDW flow: Concrete, originating from the AMA (2016)*
3. *CDW flow: Wood, originating from the AMA (2016)*


Plastic
Glass
concrete
stones
tiles and ceramics
wood
glass, plastic and wood containing or contaminated with dangero…
bituminous mixtures containing coal tar
coal tar and tarred products
roofing
other bituminous mixtures
copper, bronze, brass
aluminium
lead
zinc
iron and steel
tin
soil and stones containing dangerous substances
dredging spoil containing dangerous substances
dredging spoil other than those mentioned in 17 05 05
track ballast other than those mentioned in 17 05 07
insulation materials containing asbestos*
insulation materials other than those mentioned in 17 06 01 and 1…
construction materials containing asbestos
gypsum-based construction materials other than those mentioned…
mixed construction and demolition wastes other than those menti…
waste from the mechanical treatment of plastics and rubber
other wastes (including mixtures of materials) from mechanical tr…
separately collected glass fractions (except 15 01)
Show stocks
Show actors
Show flows
Display materials
Cluster locations
Animate flows


concrete
concrete debris
rinsed concrete
concrete slabs and beams
concrete foundations
expanded polystyrene concrete
mixed concrete debris
clean concrete debris
concrete beams
Show stocks
Show actors
Show flows
Display materials
Cluster locations
Animate flows


wood
sleepers
2292 C-wood
Show stocks
Show actors
Show flows
Display materials
Cluster locations
Animate flows