REPAiR

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

D3.9 Comparison report for policy makers

Version 2.1

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Acronyms and Abbreviations

AMA	Amsterdam Metropolitan Area
AS-MFA	Activity Based Spatial Material Flow Analysis
CE	Circular Economy
CDW	Construction and Demolition Waste
EB	Executive Board
EC	European Commission
EEA	European Environmental Agency
EIS	Eco-Innovative Solution
EU	European Union
EWC	European Waste Catalogue
FA	Focus Area
FP	Framework Programme
FW	Food Waste
GDSE	Geo-design Decision Support Environment
GW	Gardening Waste
KW	Kitchen Waste
ŁOM	Łódź Metropolitan Area
LMA	Landelijk Meldpunt Afvalstoffen
MAN	Metropolitan Area of Naples
METÁR	Megújuló Támogatási Rendszer
MÁV	Magyar Államvasutak
MFA	Material Flow Analysis

MSW	Municipal Solid Waste
MWh	Megawatt hour
MR	Metropolitan Region
NSC-VFG	Non-Separately Collected VFG
NUTS	Nomenclature des Unités Territoriales Statistiques
OECD	Organisation for Economic Co-operation and Development
ORGR	Osservatorio Regionale per la Gestione dei Rifiuti
OW	Organic Waste
PET	Polyethylene terephthalate
PULL	Peri-Urban Living Labs
R&D	Research and Development
UB	User Board
VFG	Vegetable, Fruit and Gardening Waste
WCB	Waste-conscious Behaviour
WP	Work Package

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Publishable Summary

The target of this deliverable is to summarise the findings of resource and waste management strategies in the six case study areas in the REPAiR project, mainly based on the relevant deliverables (D3.3-3.7 (D3.3: Geldermans et al., 2018; D3.4: Taelman et al., 2018; D3.5: Czapiewski et al., 2018; D3.6: Arlati et al., 2018; D3.7: Varjú et al., 2018), and to give recommendations for policy makers, not only on EU but on regional level as well. The reason is that the six case study areas, with their key flows and challenges are embedded into their socio-cultural, socio-economic and geographical circumstances. As such, the case study contexts - due to a common approach - have similarities but also differ substantially from one another at certain points.

Based on this comparison, this deliverable draws up policy recommendations on different spatial scales (EU/regional level). Policy recommendations as a result of each subtopic are given at the end of the sections.

Recommendations are given with the highlights from the analysis and comparison of the six cases (in some parts of the report analysis is given individually in others comparatively where possible) of REPAIR regarding their main flow types, waste generation, collection, treatment habits and 'Wastescapes', revealing their peculiarities and characteristics.

The comparison of the flows explains the key waste category in each case study area as a fraction of Organic Waste (chosen as the key flow in all cases) and as a result of introduction of a new method named Activity Based Spatial Material Flow Analysis (AS-MFA). The main object of the comparison is the bio-waste or Organic Waste[1] (OW) with a special focus on Vegetable Fruit and Garden (VFG) and Food Waste (FW). Comparisons are focusing on the choice of flows, data gathering and the case specific peculiarities of flows as well.

'Wastescape', as a special but integrated topic both of the REPAiR and Circular Economy (CE), is also discussed. Six case studies are summarized comparatively in this report regarding their 'Wastescape' types as defined and categorized in scope of REPAIR.

The results of interviews, meetings and workshops which were conducted with stakeholders are also integrated in this report as the real life reflection of the individual features, strategies, policies and opportunities of each case study.

The comparison of the cases was focusing on four items: data collection processes; the choice of key flows; the generation and the treatment of waste in the cases. These aspects can give a picture to the reader about the state of the circular transition.

[1] The term of bio-waste was used in the preparation phase of the REPAiR project whilst Organic Waste (OW) was used during the project as a more often used terminology in the case study countries.

1. Introduction

Waste as a local resource is a development opportunity in the hands of resource owners, as it can be one of the fundamentals for bottom-up development at local level. It can as a resource be spatially localised or have a local impact and has many untapped potential uses (Mezei-Varjú 2019). However, going beyond urban metabolism (towards circularity), treating waste as a resource is only one step. Going back and forth on the findings of REPAiR relating the resource strategies this deliverable aims to reflect on the challenges and responses (to those resource strategies) and opportunities in the six case study areas of the REPAiR project, from the viewpoint of waste reuse and circular approaches (with its limitation).

Hence the target of this deliverable is to summarise the findings of resource strategies in the six case study areas in the REPAiR project, mainly based on the relevant deliverables D3.3-3.7 (D3.3: Geldermans et al., 2018; D3.4: Taelman et al., 2018; D3.5: Czapiewski et al., 2018; D3.6: Arlati et al., 2018; D3.7: Varjú et al., 2018), to give recommendations for policymakers about strategies to reuse/recycle/regenerate wasted materials and territorial resources not only on EU but regional level as well. The reason is that the six case study areas, with their key flows and challenges, are embedded into their socio-cultural, socio-economic and geographical circumstances, might differ from one another.

As the Deliverables D3.3-3.7 (D3.3: Geldermans et al., 2018; D3.4: Taelman et al., 2018; D3.5: Czapiewski et al., 2018; D3.6: Arlati et al., 2018; D3.7: Varjú et al., 2018) give a very detailed description of processes of the six case study areas, and additionally D3.8 (Varjú et al. 2019) is summarising their socio-economic situation, this deliverable - revisiting the aforementioned ones - is comparing the main findings by contextualising them and highlighting the crucial point of the cases for potential policy interventions.

However, this comparison report has several limitations. First of all, this deliverable only focuses on the processes and flows analysed in the above-mentioned deliverables. Challenges of other fields – for instance in governance – are or will be discussed in other deliverables (e.g. in D6.5). Secondly, although the deliverables and the underlying analyses followed a common structure, due to several reasons (e.g. data availability (c.f. D3.3 -3.7 and also see in this deliverable), case specificity (c.f. WP5 results), different socio-cultural or economic background (c.f. D3.8), different geography, different challenges, targets and objectives (c.f. also D6.1 (Arlati et al. 2017a) and D6.2 (Obersteg et al. 2017) the approach and the highlights are different, hence the comparison itself is a huge challenge. Thirdly, the basis of this comparison is the mentioned deliverables (D3.3-3.7) that were finished in 2018, while the project has been going on. Hence, in some case we also refer to the relevant results of Peri-Urban Living Laboratories (PULLs - c.f. the terminology in Russo et al. 2017-D5.1) (that were going on after the deadlines of WP3 deliverables, December 2018). This might seed the lights to other relevant issues, which are not in the former deliverables (D3.3-3.7). The fourth limitation is that the terminology - related to waste management - is not always defined in the same way in the different focus areas, which complicates the comparison even more. In some cases, we tried to use only one terminology (e.g. Vegetable, Fruit and Garden-VFG waste), even if this terminology is not used similarly.

The first chapter aims to revisit the deliverables of 3.3-3.7 to reveal the chosen flows, as well as the reason behind the choices, whilst reflecting on them from the viewpoint of resource reuse. The comparison of the cases was focusing on four items: data collection processes; the choice of key flows; the generation and the treatment of waste in the cases. These aspects can give a picture to the reader about the state of the circular transition. The forthcoming chapter - using the same sources - focuses on the Wastescapes[2] as potential resources for the case study areas.

One of the key methodologies of the REPAiR project is the Peri-Urban Living Laboratory (PULL). In all the six case study areas, partners have been organising PULLs in order to involve the local stakeholders to 1) identify challenges of the Focus Areas (cf. D3.1, D3.2 (Geldermans et al. 2017; Grünhut et al. 2017), 2) specify the targets (target values) that should be achieved 3) bridging the gap with the co-created Eco-Innovative Solutions (EISs) (cf. D5.1 Methodology of PULL (Russo et al., 2017). Hence, to integrate some key messages of PULLs via D3.3-D3.7 and beyond is also obvious. After each chapter, we aim to conclude the lessons for policy makers and draw up recommendations about resource strategies. Due to the limitations of the comparison (explained above), additionally, some "direct recommendations" of stakeholders of PULLs can be found at the end of this deliverable. Additionally, during the Naples Consortium Meeting, a workshop with local stakeholders, consortium members and user board members from the six case study areas was organised. Case study working groups were asked to discuss what they can suggest for policy makers based on their experience in PULLs, focusing on the flows and resource use.

[2] In the REPAiR project, Wastescape is used for the lands that are drosscapes or operational landscape of waste. A more detailed description can be find in Geldermans et al. 2017 (D3.1).

2. Comparison of the flows

2.1 The choice of flows

REPAiR aims to reveal the local space-specific challenges and opportunities of waste and resource management using - amongst others - material flow analysis. The project addressed five preliminary flow categories: construction & demolition waste (CDW), bio-waste[3], post-consumer plastic waste, electrical waste and electronic equipment, and municipal solid waste. Furthermore, REPAiR innovates by focusing on 'Wastescapes' which apply to open spaces as well as built entities, like buildings and infrastructure.

Although, there were several flows chosen by each case study areas, for the process model (D3.3-3.7) mainly one – bio-waste in different form (organic waste for the case of Pécs, food waste – as one of the EU's key flow in its CE policy – for AMA, Naples and Hamburg, VFG for Ghent, biodegradable fraction of MSW for Łódź and Pécs, green (gardening) waste for Hamburg and Pécs - have been chosen as a key flow for analysis (for household and company levels) and represent the main trends of resource use in the six case study. The reason was twofold: 1) the analysis was data-intensive, and there was a relatively short time for that; 2) the flows were chosen as a key flow that represented the main resource use tendencies. Furthermore, further flows are appearing in the Geo-Design Decision Support Environment (GDSE)[4].

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 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 (D3.3, pp.30). However, in some cases, due to the difficulty of the identification of actors, additional data gathering was applied (details below).

The choice of flows (and challenges) to analyse in Task 3.2 was based on discussions with stakeholders during the PULLs (cf. D5.1).

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. As the metropolitan areas of **Amsterdam (AMA)** can provide a better livelihood, population concentrates here. 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 (cf. Figure 9 in D3.3). 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 pinpointed as a primary concern (D3.3). The importance of the choice of

[3] The term of bio-waste was used in the proposal and later on, during the project we switched to the term of Organic Waste (OW) as it was the term used by most of the case study areas.
[4] More details about GDSE can be found in WP2's deliverables.

food waste is also confirmed in the recently published evaluation of Amsterdam's circularity programme, where several perspectives for action are identified regarding a shift towards circular food systems (Municipality of Amsterdam, 2018).

In the Naples case, Campania Region introduced 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. 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) (D3.3). As on the map of flows (Figure 1) can be seen, Naples is not the only case where the collected materials are treated outside the region, due to the (de)location of treatment infrastructure (causing longer transportation)[5]. There are cases (Pécs, Hamburg, Ghent, Łódź) where treatment facilities are mainly within or close to the Focus Area, and cases (Naples, AMA) where mass flows have to go outside the Focus Area.

[5] More detailed impacts can be found in the sustainability assessment of the cases in WP4 deliverables and Taelman et al. (2019a) and Tonini et al. (2019), *submitted*.

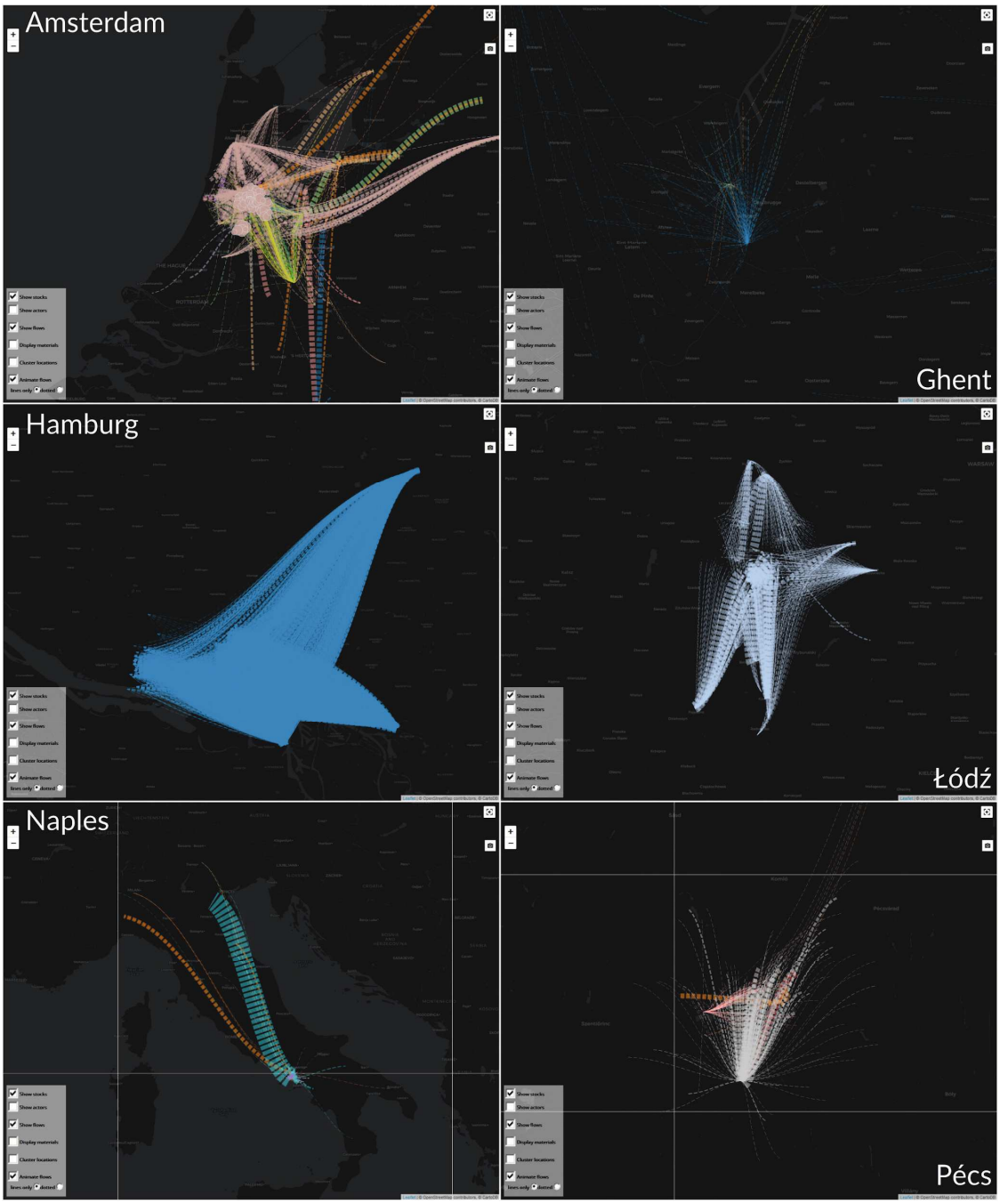

Figure 1: Household and company organic flows in the six case study area
Source: GDSE

Since 2012 Flanders has been engaged in the transition from waste to materials management. The need to further reduce the amount of residual waste - one of the key objectives of the current implementation plan - is a generally accepted objective, as confirmed by several stakeholders in the REPAiR project. Since organic waste still represents a considerable amount of the residual waste from households, increasing the separate collection of organic waste of household (and more specific vegetable, fruit and garden waste: VFG) contributes to the policy objective of the Implementation Plan to further reduce the amount of residual household waste. It is also in line with the

Ketenroadmap Voedselverlies '15-'20 (Roadmap food waste '15-'20) which aims to reduce food waste with 15%.

The adoption of the transversal policy paper 'Vision 2050, a long-term strategy for Flanders' further paved the way for the transition to a Circular Economy, integrating materials, water, energy, land and food.

With the development of its food strategy 'Gent en garde' the city of Ghent engaged already 2012 in an ambitious plan to raise awareness for the climate impact of food. With numerous initiatives, citizens (schools, catering industry, municipal staff, local farmers) are encouraged to reflect on (the impact of) their food consumption and to avoid food waste.

These local and regional strategies and the consultations with stakeholders from Ghent and Destelbergen (WP5 PULL workshop and WP6 local stakeholders interviews), and the EU targets for recycling of municipal solid waste (MSW) by 2030 (EEA, 2016), emphasised the organic waste have to be considered as a key flow (D3.4).

In the case of Łódź – one of - the main challenge the diverting of organic waste from the MSW, to going further for process towards a more selective waste system. The reason was that new regulations in waste management came into force practically from 2013, when the Waste Act was introduced (of 14 December 2012). Overall, the entire waste management system has been reformed. According to the Act, municipal wastes should be collected selectively, and communal self-governments are responsible for compliance with the principles adopted by the Act. Hence, in the case of Łódź, MSW as a focus point has been chosen for analysis in order to reveal its composition, the rate of OW fraction and the potential to divert it from the (MSW) flow (D3.5).

In the case of Hamburg, according to the interviews conducted with stakeholders in the region (WP6) and the PULL workshops in the co-exploration phase (WP5), the currently most urgent topic is the increase of the quantity and quality of organic waste collection. In Hamburg, the residual waste bin is still filled up partly with recyclables. In particular, the percentage of compostable organic waste in the residual waste bins is rather high (35.8%) (Oetjen-Dehne & Partner Umwelt-und Energie-Consult GmbH, 2018), which precludes its reutilisation (D3.6). Another challenge for Hamburg region was that County of Pinneberg is characterized by a very diverse structure of built areas and open spaces with the largest European area of tree nurseries. Therefore, the scope of Pinneberg's MFA is the garden waste generated in the tree nurseries, which consists of a woody fraction and a wet fraction. Both follow different procedures when it comes to recycling. Currently, the wet part is thrown away, while the woody one is often incinerated on the ground (cf. D6.2).

Although the city of Pécs does not have a circular economy plan, 'green thinking' is rooted in the 1990's. The first attempt was that in 1996 Biokom introduced separate collection of (paper, plastic and glass) waste, first in the country. The City of Pécs does not have a Circular Economy concept just as the country does not. The main goals of city's waste management are fixed in the Integrated City Development Strategy for the period of 2014–2020 (ITS 2014). It is an overall but general development plan which contains only

one relevant goal and indicator, namely the higher selective proportion within the municipal solid waste generated in the city. According to these strategies, one of the most important waste flows is linked to organic waste. A key challenge of the investigated case study area defined by the experts and key stakeholders (in PULLs and interview in WP6) is the high biodegradable part of MSW.

As a common element in all the cases, Organic Waste has been highlighted as the main issue for different reasons. As we mentioned above, it was analysed both as a separate flow and as a part/fraction of MSW (Figure 2).

Case	Selected Flow
AMA	OW-FW, CDW- Overall
Naples	OW-FW, CDW- waste associated with landscape renovation
Hamburg	Altona: OW- KW and GW
	Pinneberg: GW
Lodz	Municipal Solid Waste (MSW), VFG
Ghent	Biowaste- VFG (Vegetable, Fruit and Garden)
Pécs	OW,MSW, Plastic Packaging waste

Figure 2: The selected flows for analysis in the six REPAiR case study areas
Source: Own contribution

Separate collection of plastic, paper and cardboard, and glass has been ongoing for years or decades, however, separate collection of (any kind of) OW is limited. Both the collection and treatment of the waste fraction of OW are challenging. The fraction still mostly appears in residual waste, and divert it from MSW is a challenge in every case and appeared in most of the EISs (cf. WP5's EIS catalogues).

On the other hand, food value chain in the EU's Circular Economy Action Plan – and EU's requirement was cited in several cases - is one of the focuses, hence food waste (as a fraction of OW) has received a special attention in all six cases.

2.2 Comparison of the analysed flows

2.2.1 Data collection and processing

With regard to the AS-MFA methodology, specific attention had to be drawn to the process of material flow data. In general, this step required intensive prior data collection and processing where the type and level of difficulty could differ greatly per case. For instance, for company-related waste flows, in the first version of the Dutch analysis a novel disaggregation method based necessitated on national data, whereas the Italian case had access to high-level regional data-sets and Ghent used many primary bottom-up data for focus area (besides the regional data confidentiality provided by institutions). In the case of Hamburg, data were provided by the public waste management company (SRH - Stadtreinigung Hamburg) and extrapolated later on by HCU. These data are based on a study made by a consultancy company which presents a rather detailed sampling per household typologies in specific parts of Hamburg. In the case of Łódź MSW data calculations were based on the compulsory waste reporting of self-government units.

After the closure of the deliverables (D3.3-3.7), modelling of the flows carried on due to their integration into the GDSE. In the update of D3.3, in the case of AMA, new insights on data collection and processing regarding the Material Flow Analysis were addressed. They were particularly relating to case-specific supply chains and mass flow modelling. It meant, that beyond the first data gathering process, in the updated version of the deliverables (and in the GDSE), high-resolution data for the year of 2016 by LMA (Landelijk Meldpunt Afvalstoffen) were used. This database provides the most complete data on: which type of waste is collected from which company, by whom it is collected, and where the waste is sent to for further handling (D3.3). In the deliverable, the availability of the data for **Ghent** had a different resolution standing mostly at the municipality level, not at neighbourhood level. After the closure of the deliverable, due to the follow-up activities, the level of data aggregation is now at the neighbourhood cluster level (intramunicipal sectors). In the **Hungarian** case, to achieve central data was time consuming, although, it resulted in a higher resolution of data relating to company level[6]. Gathering data from companies and other waste treaters was very challenging while gathering data from local waste management companies resulted in the most fruitful results. The data on biodegradable waste (VFG) flows in **Łódź** presented in report D.3.5 were disaggregated into smaller spatial units - villages. The amount of waste according to subgroups of European Waste Code (EWC) 200108, 200201 and 200302 in each locality for the ŁOM area was estimated by calculating the proportion of the amount of each fraction depending on the number of inhabitants. Due to the limitations of the application, the data were rounded to whole numbers. In the case of the city of Łódź, the data were disaggregated into housing estates. The results were used in the flow analysis in the GDSE application, where modifications of individual flow values are possible depending on the implemented eco-innovation solution (EIS). Moreover, in further studies, flows between installations collecting and processing biodegradable waste were taken into account.

[6] Ministry of Innovation and Technology - similar to the Dutch case - provided company waste data based on the compulsory annual report of major companies.

Nowadays, there are several attempts and researches on MFA (or similar flow analysis such as substance flow analysis) and what they have in common is that they are focusing on macro-regional level due to better data availability (sc. Eurostat datasets). Based on the Aarhus Convention, all EU member states are obliged to collect waste data (collection and treatment) for monitoring of environmental aspect, and these data are made public in an aggregated form by national statistical offices as well as Eurostat, but the potential of this data for informing a CE transition is completely underused. On the other hand, there are several data assumptions on critical flows, such as food waste or waste treatment (cf. https://stats.oecd.org/) where the challenge is multiform. The period covered or the sources used may vary across different countries depending on data availability. Hence the structure and the content of food waste may differ. However, these data are available only for the countries themselves. Based on the REPAiR team experience, national statistical offices and - especially - waste treatment companies usually have these data. However, there is no obligation for them to provide it for research purposes.

Recommendation(s) for policy makers

1. Based on REPAiR's research experience the resolution and the availability of data are crucial. On the other hand, there are several methods to assess circularity and its impacts[7]. Hence, we suggest **to the Commission** a
    a. commonly use methodology for different waste streams measurement (as it is the case in food waste has been started recently[8]);
    b. and readily available data in waste management for research purposes on member states levels, where companies and (all kind of) waste treaters provide data for national statistics for research purposes.
    c. Furthermore, we recommend the development of a data classification that goes beyond EWC or product codes, but considers the potential of waste/resource flow as secondary raw material. It can support the smoother implementation of EU's Circular Economy Action Plan not only on macro-regional but also on micro-regional level as well.
    d. We also suggest applying a method as presented in D3.3 to D3.7 that allows spatial (dis)aggregation of data on different scales, from neighbourhood, to municipality and region.

2. There is no collaboration concerning waste between the different European countries. However, the information is crucial for the transition towards the desired Circular Economy. Hence, we suggest **to the Commission** to organise a cross-European session on waste flow data (and its harmonisation)[9].

[7] For the details of impacts visit the deliverables of WP4 of the REPAiR project too.
[8] The Delegated Decision establishing a common EU methodology to measure food waste has been published in the Official Journal on 27 September 2019 and enters into force on 17 October 2019. Member States shall start collecting data on food waste as of 2020 and report on national food waste levels by mid-2022.
[9] REPAiR - following the initiation of LMA (Landelijk Meldpunt Afvalstoffen - National Waste Registration under the Ministry of Environment and Infrastructure) - is planning to make a first attempt to organise a cross-European discussion (involving the waste administrations in the six cases) at the final event of the project (June, 2020).

2.2.2 Waste generation

2.2.2.1 Ratios and amounts

Analysing the waste generation in the different case study areas, one can find **different ratios** of OW or OW fraction in MSW generated, that allows to compare the importance of the OW generation challenge. However, it has to be noted here that both the denominator and the numerator differ case by case. Hence, the comparison cannot be entire, although a comparative-style picture can be gained. To do so, besides REPAiR process data we also use Eurostat data here.

It is worth emphasizing that the amount of municipal waste collected per one inhabitant per year is strongly correlated with the economic status of individual regions of the country, at least in the case of Poland (D3.5, pp. 34). (Antczak's (2019) analysis proved that after the population density, the average salary is a variable that influences the quantity of the municipal waste the most in 80% of the regions in Poland). Following the Polish analysis and realising that the (statistical) trendline is linear (having regarded the GDP and quantity of municipal waste in the six cases) (see Table 1 and Figure 3) (despite the small number of items) we made some statistical correlation analysis. We can say that there seems to be a relatively strong positive correlation (r=0,73; r2=0,53) between GDP and Municipal waste on country level, however, we cannot say that this is the case between WCB and Municipal waste generation since the correlation here is weak (r=0,46).

	Poland	Hungary	Belgium	Italy	The Netherlands	Germany
GDP per capita (2018)	12,430	12,560	35,600	26,740	41,540	35,860
Municipal waste (2018)	329	381	411	499	511	615
WCB index (2014)	6.82	5.9	7.7	6.98	6.32	7.65

Table 1: Municipal waste generated in (kg/capita) and GDP/capita in current market prices (EUR/inhabitant) and Waste-consciousness Behaviour (WCB) indices[10] (c.f. D3.8) in the six case study countries.
Source: Eurostat, D3.8

[10] WCB is a composite index based on the Flash Eurobarometer 388 survey in 2014. More details in D3.8.

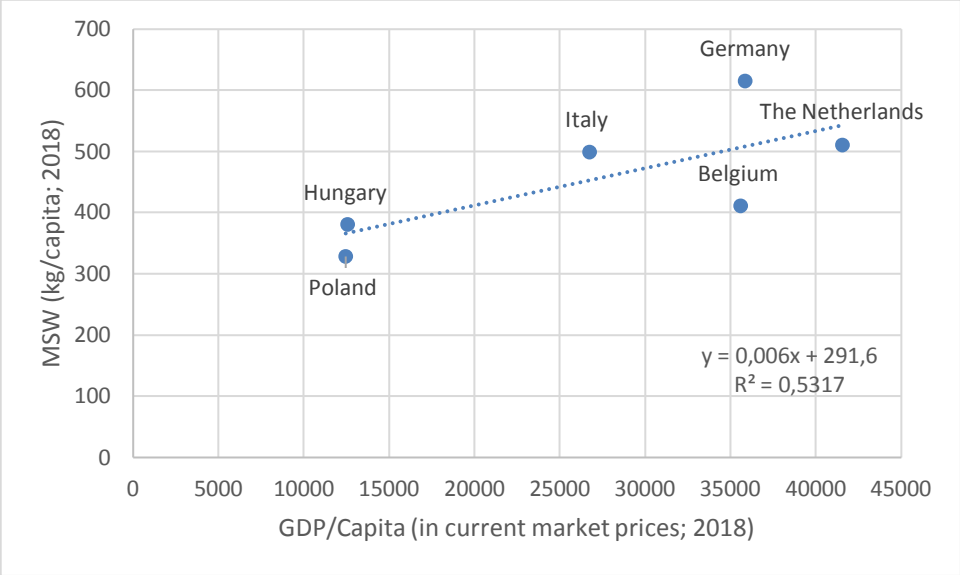

Figure 3: Trendline of the items of GDP per capita and Municipal waste per capita in the six case study countries (2018)
Source: Eurostat

Narrowing the spatial scale towards the case study regions of REPAiR (Table 2) we can find a stronger correlation (r=0,886) and significance (sig.=0,019[11]) between the rate of municipal waste and regional GDP. (On the other hand, we cannot find a correlation (r=0,081) between regional WCB index and municipal waste rate.)

	Łódź MR	Pécs MR	Gent MR	Naples MR	Amsterdam MR	Hamburg MR
GDP per capita (MR[12] - 2016)	12,000	7,000	43,000	19,000	52,000	47,000
Municipal waste by NUTS 2 regions (2013)	296.53	314.69	456.11[13]	441.17	511.69	455.52
WCB index (2014) (NUTS2)	6.88	5.91	7.81	6.74	6.06	6.16

Table 2: Municipal waste generated in (kg/capita) and GDP/capita in current market prices (EUR/inhabitant) and Waste-consciousness Behaviour (WCB) indices (c.f. D3.8) in the six case study regions.
Source: Eurostat, D3.8

[11] Correlation is significant at the 0.05 level (2-tailed).
[12] Metropolitan regions (MR) are differ from the regions we used in REPAiR, although they cover the "regions" of REPAiR (c.f. D3.3-3.7 scale levels within REPAiR). The reason to use MR here is to provide an opportunity for comparison using the same types of data. Metropolitan regions are NUTS 3 regions or a combination of NUTS 3 regions which represent all agglomerations of at least 250 000 inhabitants. These agglomerations were identified using the Urban Audit's Functional Urban Area (FUA).
[13] The amount was 470 kg/capita in 2018 in Flandres (Acke et al. 2018)

A large share of food waste was produced at the household level in 2016 in AMA. 10% of neighbourhoods with the highest amount of avoidable food waste from residual waste - higher than 40.3 kg per person per year - are located in the west and northwest within the focus area. The highest values of unavoidable food waste were in rather urban areas and of course, in Amsterdam. The neighbourhoods with the most unavoidable food waste from residual waste were the large neighbourhoods with a high population density. Households and the included companies had a nearly half share in the food waste generation. The spatial analysis of the company related food waste production revealed that a small amount of companies produced more than half of the food waste. Most of those companies were concentrated north of Amsterdam. The activity group P2 (Processing and Manufacturing) was responsible for more than 90% of the food waste. The biggest share of material within food waste, independent from way of collecting were bread, fruit, vegetables and coffee grounds, with bread having the largest share in the avoidable waste category (D3.3).

In the Naples case, 35% of MSW of Campania Region corresponds to the organic waste, which is collected separately. Moreover, a significant amount of organic and green waste can still be found in the residual waste. Data from different mechanical-biological treatment sites in the region ranged from 12.1% to 35.5% (depending on the peculiarities of the collection area), an average rate of OW in the residual waste for the region is defined as 17.7% (D3.3). The highest rate can be found in the most densely inhabited areas of Campania (see Figure 73 in D3.3).

In 2015, a total of 142 million tons of waste was generated in **Poland**, of which 11 million tons comprised municipal waste, and 131 million tons - other waste, more than half of which is attributable to mining and related industry. The largest group of biodegradable municipal waste collected comprised waste generated by gardens and parks and kitchen waste. In Łódź Metropolitan Area VFG waste mass was estimated to be 76.57 thousand tons, which comprises 22% of all municipal waste (D 3.5). The economic relation is evidenced by the mass of collected municipal waste per capita as the value for the region was 10% lower than Poland's average where the **region of Łódź** is not one of the most economically developed in Poland (D3.5).

In the case of the focus area of **Pécs**, the amount was the highest in the city itself. The waste production is only higher in the agglomeration settlements very close to Pécs. Going towards the poorer rural area, the waste production is declining. The reason here can also be that in the rural areas households treat the waste on site, partly they compost the OW, and partly they burn the plastic and the paper (D3.7) that has serious health and environmental risk.

Household waste generation in **Belgium** and in Flanders has been decreasing and remains somewhat below the OECD average. In Ghent, the initiative 'Gent en Garde' played an important role to make its citizens and visitors aware of the climate impact of food. By focusing on local, tasty and sustainable food, the initiative aims to drastically reduce the environmental impact of the food system. Gent en Garde offers citizens, organisations and companies a participation platform in which they can find like-minded people,

recognize shared interests, share expertise with the outside world and lift initiatives to the next level (Acke et al., 2020).

All the Flemish municipalities generated VFG waste as a fraction of residual household and percentages were comprised between 5 and 12% (D3.4). In the case of Ghent, the percentage of vegetable and fruit waste fraction in residual waste was significantly higher in green areas (without VFG separate collection), both in urban and rural environments. There are many possible reasons for this fact, but the most important one is the fact that there is no separate collection (for households). This is among others due to practical problems related to collection (D3.4). In the similar urban size category (in the REPAiR project), **Pécs** has separate collection for gardening waste (for households). Due to Pécs's waste management company's measurement, the biodegradable fraction of households' residual waste was around 26% percent (we do not have data for VFG to compare), that is very similar to that can be seen in Łódź's VFG fraction (cf. Figure 16, page No. 36 in D3.5 - Kitchen and garden waste in municipal waste and in Figure 17, page No. 37. in D3.5 - Other organic waste+Food waste=25.1%). (Also see the 'comparative' Table No.2)

In Hamburg, the amount of kitchen waste generated is circa four times higher than the garden waste. The reason for that is the number of inhabitants in single-family houses (which are the ones who normally have gardens) is around 23 % of the total (D3.6).

In Hamburg, the ratio of recyclables in residual waste bin is still an important issue. In particular, the percentage of compostable organic waste in the residual waste bins is rather high (35,8%) which prevents its reutilisation. Data for the amount generated in a year per person divided into different waste fractions according to the housing type cannot be published due to the confidentiality of the information and strict data protection policy in Germany. However, calculations done with some approximations show that the amount of kitchen waste (KW[14]) generated is around four times higher than the garden waste (GW). The reason for that is the number of inhabitants in single-family houses (which are the ones who normally have gardens) is around 23 % of the total. The other housing categories have considerably less waste produced from gardens than from the kitchens, where for the single-family houses KW/GW ratio is ½. Most of KW is generated in Altona where a higher concentration of people lives mainly large housing estate or mixed-use buildings while GW is concentrated in the areas with intensive single family houses with garden. Large housing estates account for the highest share of the amount of organic waste (i.e. kitchen waste plus garden waste) which is thrown in the residual bin (wrongly separated). This is due to several reasons, like cultural issues (D 3.6).

[14] The definition for kitchen waste is the same in food waste in the Hamburg case. It has been adopted from the EU Fusions project. KW is used instead of FW because the former is the translation from the Organic Waste Decree (BioAbfallVerordnung, BioAbfVO) of 2010, updated in 2017 by the city of Hamburg. (More details in D3.6.)

	AMA	Naples	Łódź	Pécs	Hamburg	Ghent
OW fraction in residual waste	23%[15]	17,7%	24%[16]	26%	36%	26%

Table 3: Percentage of organic waste fraction in residual waste in REPAiR regions. Source: D3.3-3.7

As in the Table 3 (and in the deliverable reports) can be seen, the fraction of organic waste is varied, however the percentages in all cases are high and in several cases (e.g. Pécs), and this is the highest fraction in residual waste.

Recommendation(s) for policy makers

3. Waste sensitivity needs to be increased across Europe[17]. ***EU*** should make or should support and motivate member states to make multilanguage campaigns for increasing waste sensitivity, using conventional (e.g. classic TV, billboard) and modern (e.g. social media, Netflix) tools at the same time. The campaign should include the emphasis of donation to reduce food waste[18]. For ***regional policy makers*** the example of *Gent en Garde* can show that such campaigns can decrease the amount of food waste. What is important in the campaign is to focus on to prioritize the material/food recovery as high as possible in the waste hierarchy (also cf. Figure 11).

2.2.2.2 Per capita waste and food waste within the focus areas

In the city of Amsterdam, VFG type of waste is hardly collected. The highest amount of VFG per person per year was collected in the neighbourhoods around Schiphol with rather low population densities. The highest amount of residual waste with more than 265 kg per person per year is collected in the west of the **AMA** which are all peri-urban municipalities. Inhabitants in the **AMA** produced approximately 44.8 Kg/ person of VFG (vegetable fruit garden) household waste per year (D3.3) (Figure 4).

[15] Food waste in the service sector
[16] VFG
[17] cf. the detailed WCB analysis in D3.8.
[18] Also see the food donation EISs in several cases in the EIS catalogues in WP5 and recommendation on food donation below.

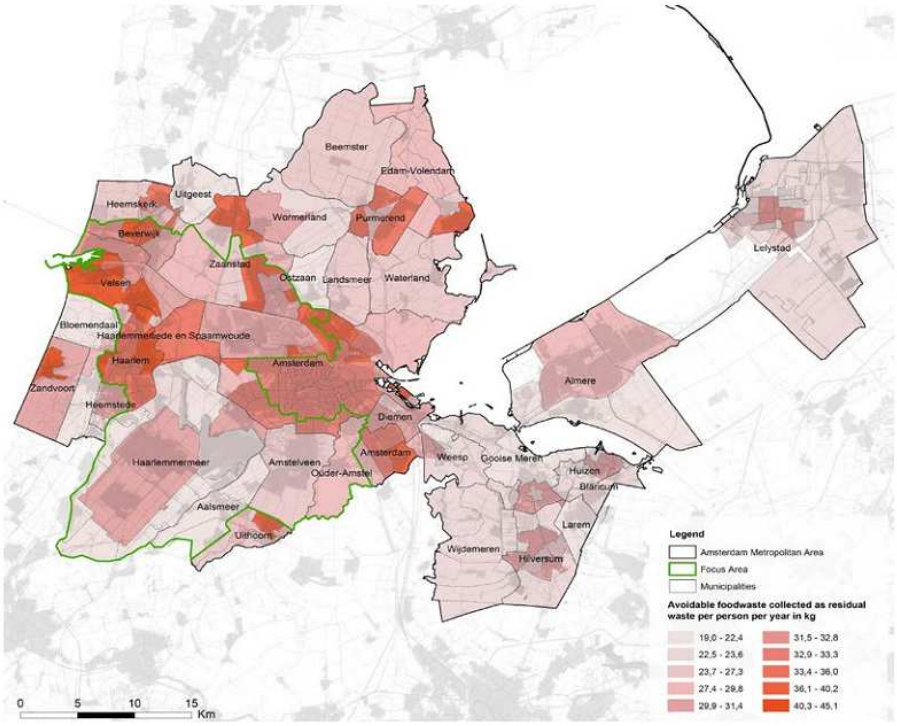

Figure 4: Avoidable food waste collected as residual waste per person per year in kg.
Source: D3.3

Having regard to Campania, as on Figure 5 can be seen, the condensation of MSW is in densely populated areas, in the core of Naples. Taking into account the data for OW, the concentration is much higher.

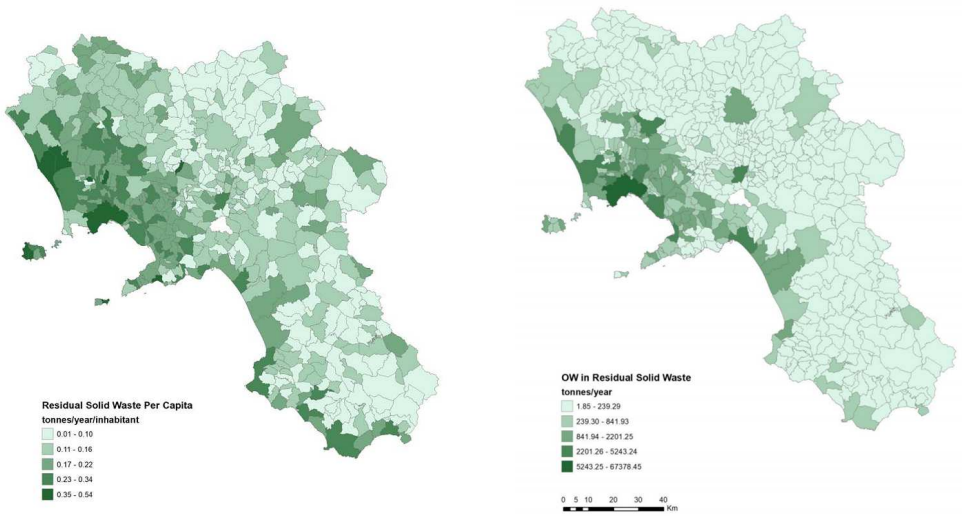

Figure 5: Residual Solid Waste and OW in Residual Solid Waste collected per person per year for each municipality in the Campania Region.
Source: D3.3; ISPRA 2015) (P. Inglese elaboration)

In Hamburg, concerning kitchen waste, the results of process analysis (D3.6) clearly show that most of it is generated in Altona, where a higher concentration of people live. However, these are mainly the large housing estate or mixed-use buildings. A considerable amount is also produced in the northern part of the Focus Area (FA), where the large housing estates are located (Osdorfer Born) (Figure 6).

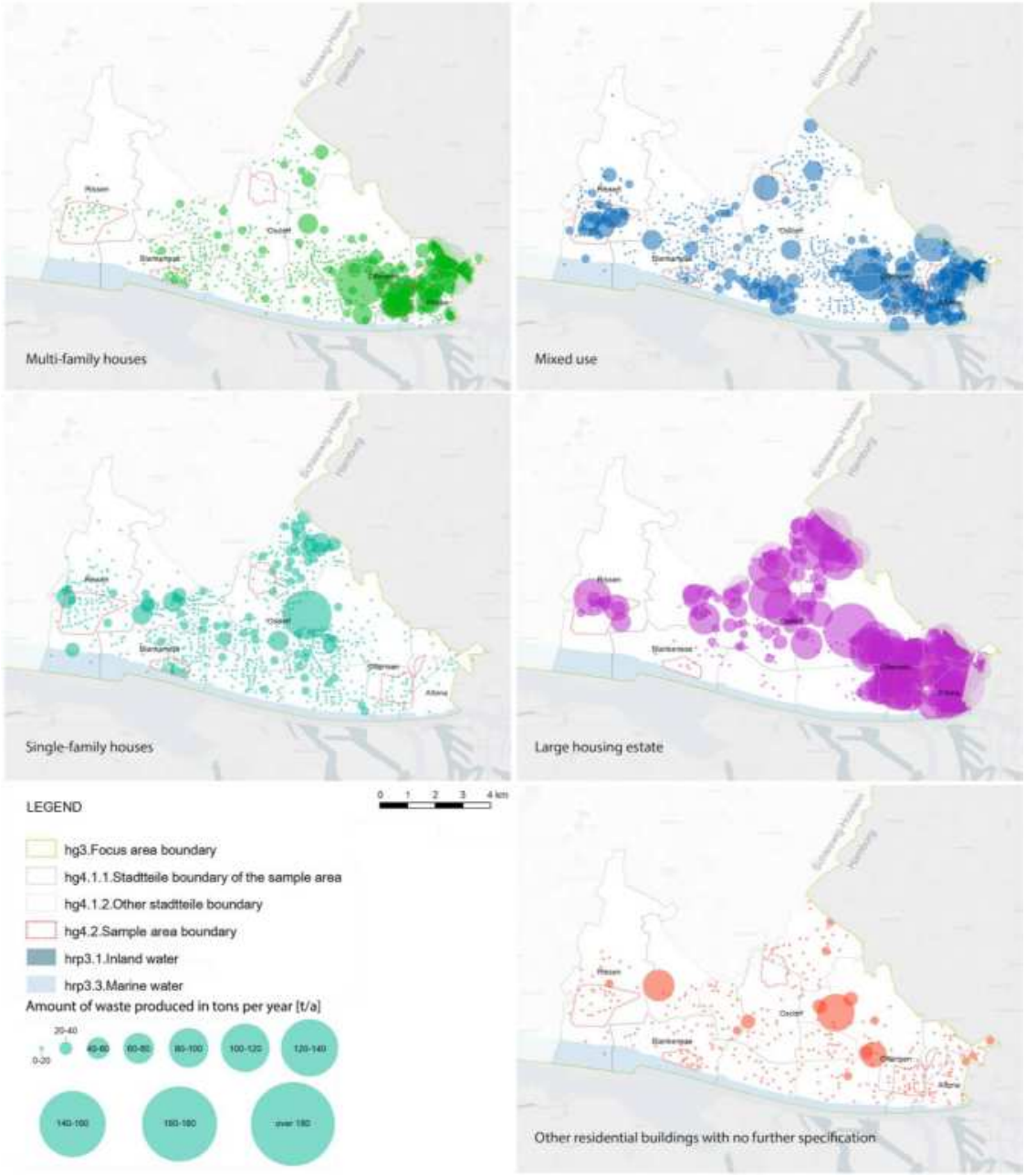

Figure 6: Kitchen waste generated in Hamburg case
Source: Arlati et al. 2018: D3.6, p. 63. Figure – 3.16

Having regard to other cases, one can see that - for instance in **Pécs, Ghent and Łódź** too - the per capita amount of biodegradable/OW/VFG waste had high disperse within the territorial units in the focus area. For instance, in Łódź Metropolitan Area it varied from 42 kg/capita to 112 kg/capita. The organic waste generation in Pécs ranges from 37.7 kg per capita to 268.8 kg per capita. The reason might be derived from the urbanisation level

and the human behaviour and its socio-economic, socio-cultural situation. Another reason might lie under the waste collection typology and possibility (see also in the next chapter). In the case of Pécs, the higher amount of per capita OW can be found in the city and its close suburb, while in the case of Łódź, the concentration is mainly in the suburb (see the maps in Figure 7).

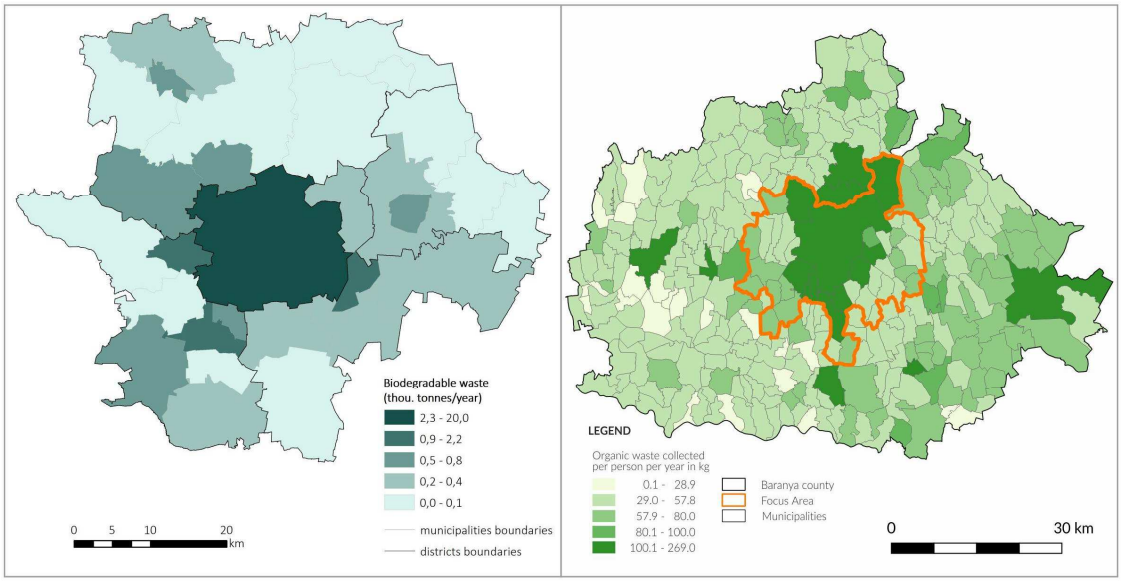

Figure 7: The territorial distribution of different types of biodegradable - per capita - waste in Baranya county/region (with Pécs) and in ŁOM.
Source: Deliverables No. 3.5, 3.7

Construction & Demolition Waste (CDW) is another crucial issue and was partly analysed by some cases in REPAiR. For instance in the Metropolitan Area of Naples (MAN), it is 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 (D3.3).

In the case of AMA, the approach towards CDW is different. The focus is on building materials that are currently 'in stock' i.e. locked inside the built fabric of the Amsterdam Metropolitan Area. A database was developed to analyse the content and value of materials in the current building stock, in order to 1) anticipate future recovery at higher rates and higher qualities relative to current practice, and 2) start anticipating circular building material models. Disassembly and high-grade reutilisation have not been common in design and construction processes 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 (D3.3). What is challenging here is that reuse of materials and eco-design are labour intensive. For instance, in the construction sector, reuse of construction materials can be more labour intensive (hence more expensive) than (non-sustainable) demolition of old-buildings and constructing new buildings from newly produced materials.

In the case of Pécs, CDW – as key flow – was not analysed in the deliverable of process model, although, a crucial issue appeared during the PULL workshops, after the closure of D3.7. It was the improper treatment and landfill of asbestos that was finally elaborated as a challenge (c.f. in Pécs EIS catalogue due later in the project). To respond to these challenges, several ideas appeared (during the PULL) relating to the proper treatment and landfill of CDW containing asbestos.

The above mentioned and analysed flows and processes were the basis of several EISs that are formulated (or will be formulated later in the project) and presented in the WP5's EIS catalogues, that also can be seen as (more concrete) recommendations for policy and decision makers (and via transfer (c.f. deliverables in WP7), for other stakeholders as well). (Also see the PULL process in D5.1 from co-exploration to co-design and co-production). However, as it can be seen, the ideas and development activities are on different level in waste hierarchy (Figure 8).

Figure 8: CDW treatments appeared during PULLs in AMA, NAP and Pécs and their positions in the waste treatment hierarchy.
Source: Own elaboration

It partly seems to be contradicting to WCB (cf. D3.8) where the Dutch region bears - among other - the lowest WCB score, however, our experience shows the leadership of The Netherlands in circularity. The reason for this contradiction can be that there is a difference between households' and stakeholders' waste consciousness: stakeholders are much more engaged towards circularity. The latter notion is supported by the result of PSCA analysis. Concerning it, comprehensive regularisation over waste/resource management is in the top 3 in institutional features for the stakeholders of Amsterdam (and Ghent) (see details in D3.8).

Recommendations for policy makers

4. As it can be seen above, terminology in use of biodegradable or food related waste are different in different cases. Different terminology is used both by academics and professionals (waste management actors). Furthermore, taking into account international measurements one can face several assumptions for food waste generated by households/per capita (cf. the measurement and reports of OECD and Eurostat). Hence, it is suggested to **EU** policy makers to create a common measurement and terminology for 'bio-waste" types using the example of the definition of 'food waste' in the amended waste directive[19].

5. In waste management, place matters, both in the sense of urbanisation level and socio-demographic situation. Hence, we recommend **regional policy makers** to use background data to support a tailor-made waste management system according to different socio-demographic characteristics within the city.

6. Taxation policy in the **EU** is country specific, in some cases EU maximise the rate of tax. However, - as it appeared in REPAiR's PULLs and AMA case in connection with CDW there would be a need for a direction/strategy by the EU to greening the tax system: change taxation from labour to resources, as reuse of materials and eco-design are labour intensive.

[19] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste.

2.2.3 Waste treatment

Challenges, highlights of waste treatments are different in the six cases (as it is the case in the rest of the issues considered in scope of REPAIR), although a common key issue – with different answers – is the (way towards a more) separate collection on the one hand, and the availability of collection infrastructure on the other.

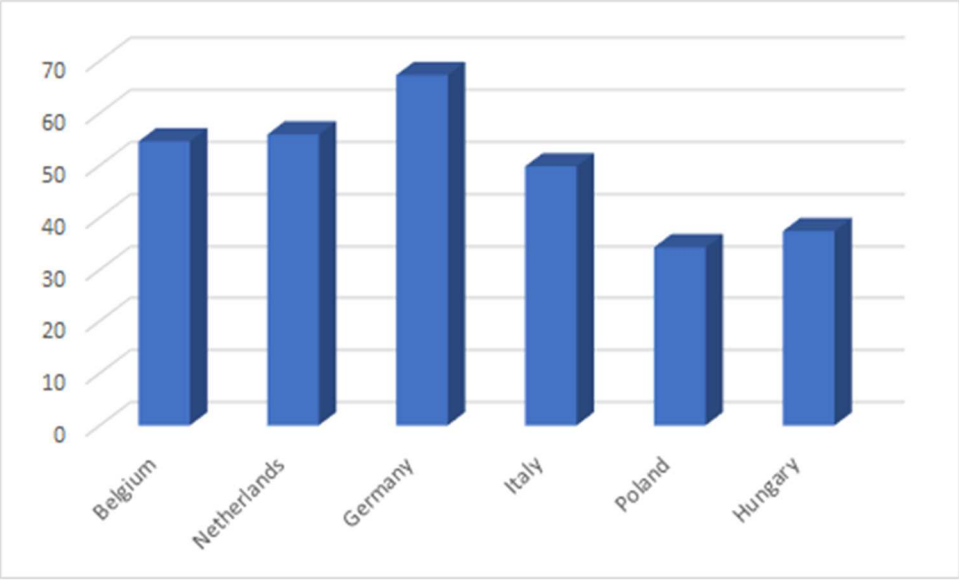

Figure 9: Recycling rates of municipal waste (2018)
Source: Eurostat.
Note: The indicator measures the share of recycled municipal waste in the total municipal waste generation. Recycling includes material recycling, composting and anaerobic digestion. The ratio is expressed in percent (%) as both terms are measured in the same unit, namely tonnes.

The material flow analysis highlights that the amount of **food waste**[20] collected as residual household waste is significant and that there is a large potential for more efficient and sustainable collection and treatment, in all cases of AMA, Hamburg and Ghent. Harvesting the material value of food waste can be done more optimally than is the case in the existing situation in AMA.

The method for collecting waste in the Łódź agglomeration (and majority of places in Poland) fosters the dominance of mixed waste (up to 71.8% of the total mass). In Poland, the differences between particular types of areas are especially noticeable in respect to 'paper and cardboard' fraction – there is a gradual decline in the share of this fraction in an order of 'big cities - small towns - rural areas' , on the contrary considering 'kitchen and garden waste' - a progressive increase may be observed along the axis 'big cities - small towns - rural areas' and the finest fraction is the share of this type of waste increases in rural areas in relation to the amount observed in cities.

One of the most important challenges facing waste management in the Łódź Metropolitan Area (ŁOM) (and Poland as a whole) is a more accurate recognition of composition of generated waste. In Poland (as it is also almost all the common in other

[20] In the case of Ghent, food waste is part of the VFG.

case study areas) crucial issues in the field of municipal waste management including food waste and other biodegradable waste are considered as; lack of social awareness, excessive share of mixed municipal waste in the overall municipal waste flow, lack of adequate cooperation between private and public sectors, insufficient quality of collected waste, lack of operating monitoring system for municipal waste management, no statutory minimal fee for waste management, insufficient share of waste collected selectively at source which results in inadequate progress in subjecting waste to recycling processes, confined supervision of communal authorities over proper treatment of municipal waste caused by the selection of a joint tender for collection and management of waste, excessively high share of municipal waste subjected to storing without being processed, low market prices of certain secondary raw materials, therefore obtained funds do not allow for lowering the fee rate, lack of research in the field of municipal waste management, including analysis concerning composition and properties of waste (D 3.5).

According to the act (due to EU requirements) in Poland (and in all the case countries) municipal wastes should be collected selectively and communal self-governments are responsible for compliance with the principles adopted by the Act. As provided by research conducted by the Ministry for the Environment, about 70% of Poland's residents segregate waste. Among the reasons for not segregating waste are the lack of dedicated space for waste segregation or **lack of appropriate containers** around the area of residence takes the first place. It should be emphasized that the share of all municipal waste (not only mixed waste) utilized in landfills remains at distinctly higher level in the region of Łódź in relation to Poland's average. In 2016, approximately 9.3% of municipal waste collected in the Łódź agglomeration was reused and recycled. The average paper, metal, plastics and glass recycling level in the Łódź agglomeration amounted to 28.8%. Approximately 53% of municipal waste collected in the Łódź agglomeration was gathered by installations operating within its area. The largest number of municipal waste was collected by installations operating in the area of Łódź, accounting for 51.5%. The property owners' duties include participating in waste management expenditure and proper waste segregation. Individuals segregating waste pay a lower fee in Poland (D3.5).

In Hamburg, the residual waste from private households is being incinerated and part of the heat is converted to electricity. The organic waste fraction from households in Hamburg includes garden and kitchen waste. It is treated in the compost facilities and used to produce biogas supplying it to households. The end product of compost is used for agricultural purposes. Normally waste from private households is collected with a four-bin system separating residual waste, organic waste, paper/cardboards, and packaging waste, however, not all households - especially in dense urban areas - have the four-bin system. Therefore, the waste company of Hamburg started the so-called recycling offensives over the last years to increase awareness among citizens on the importance of separation. Despite information campaigns, there is still a need for convincing housing companies, facility managers and tenants of the advantages of a better waste separation. On the other hand, in some densely built areas of Altona there is lack of space to place bins/containers and therefore in these areas the separation of organic waste and residual waste has not been done so far, calling for eco-innovative solutions. The part of the OW collected together with the residual waste, which is then incinerated results in a loss of potential compost and biogas production. Estimated values

for the households in Altona, made possible to observe a significant amount of Food Waste and Gardening Waste (GW) found in the residual waste bins. If such amount was to be disposed of in bio-waste bins, the total amount of bio-waste would then end up almost three times higher which can provide 6,135 MWh of heat and electricity to supply 4,742 households with two persons living. Most of the wrongly separated organic waste (i.e. garden and kitchen waste thrown in the residual bin) is generated in areas with high building density indexes together with the presence of high unemployment and low-income rate which can also be linked to a high concentration of the presence foreigners with a possible concern of cultural and language barriers. Although according to the European Environmental Agency (2016), Germany is situated at the third place in terms of amount of kilogram of municipal waste generated per capita in 2014 (EEA 2016: 2) it is also located first for what concerns recycling of municipal waste for the same year (EEA 2016: 3). The value of recycled municipal waste is circa 64% (EEA 2016: 5) (D3.6).

In Ghent and Destelbergen also the key objective is to reduce the amount of VFG in residual waste, and thus improve the separate collection efficiency. Unfortunately, not all VFG of households is collected separately in the focus area, and a large fraction still ends up in the residual waste (residual organic waste). The main activities considered are collection, storage, transport, incineration with energy recuperation, pre-treatment, digesting, composting and secondary material production. Municipalities and cities are responsible for collection and treatment of waste, however, they often outsource the task to inter-municipal WM companies. Proper sorting is often missing and in densely populated areas where a lack of space hinders proper sorting. Thus, much of the VFG is collected as residual waste (NSC-VFG (Non-Separately Collected VFG) however the exact amount is unclear), which results in a substantial loss of resources with higher valorisation potential. Collection of VFG as a separate waste gives the opportunity that the waste can be treated in biogas or composting plants in Flanders. Two final products are produced from VFG: compost and electricity in Ghent (D3.4).

In the case of Ghent, the collection of VFG waste from households (as a fraction of the residual household waste or provided as a separate fraction) is done by regional organisations. The same is valid in the case of Pécs where separate collection is going on in detached house areas, and it appears in residual waste in urbanised areas. However, the treatments are different. The main factor concerning the treatment of VFG in residual waste (in Ghent) is the energy recuperation by incineration. (This is not the preferred treatment due to the particular environmental and social drawbacks of incineration, and also because it does not utilise the full potential for the valorisation of the waste.) This is the case (energy recycling) in AMA as well. When we have a look at Pécs and Łódź; there is no incineration practice for residual waste in Pécs (there is only one residual waste incinerator in Hungary, near Budapest) and only 10% is incinerated in Łódź. Residual wastes in the latter case - after mechanical and biological treatment - are deposited in landfills (D3.3-D3.7).

In the case of Pécs a door-to-door separate collection is available for organic waste in the peri-urban areas for houses with gardens. In some hilly areas, home compost boxes were distributed (2000 boxes) for initiating home composting. In densely populated areas there is no separately collection for food or other organic wastes: ‘OW is collected as residual waste’. Residual waste is transported to the waste treatment site near Pécs,

within the focus area. There, the mechanical-biological treatment centre performs the mechanical pre-treatment of non-separately collected waste, followed by the biological treatment of its biodegradable fraction. (There are some business actors who also collect the different categories of food waste, mostly from the hotel, restaurant and catering (HORECA) sectors and food manufacturers, but the private households also can transfer their oil and fat waste into the collection points (at about 20 petrol stations).

Another important issue of the organic waste chain is ***transportation*** of waste/potential resource. Having regard to the flow figures and modelling results it can be observed that some flows do not go to the nearest facility, in some cases they go through much further points. This is the case with sorted and unsorted VFG in Ghent and organic waste in Naples (D3.3, D3.4). 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) (D3.3). In Poland, for instance, in order to ensure a constant inflow of waste stream, following one of the basic principles of waste management, the so-called "Proximity principle" highlighting the need to treat and/or dispose waste in reasonable proximity to their point of generation. This means that the waste is processed at the place where it is produced and, if this is impossible, it is transferred to the nearest place where it can be processed, however bearing in mind that it is forbidden to transport it outside the region of origin.

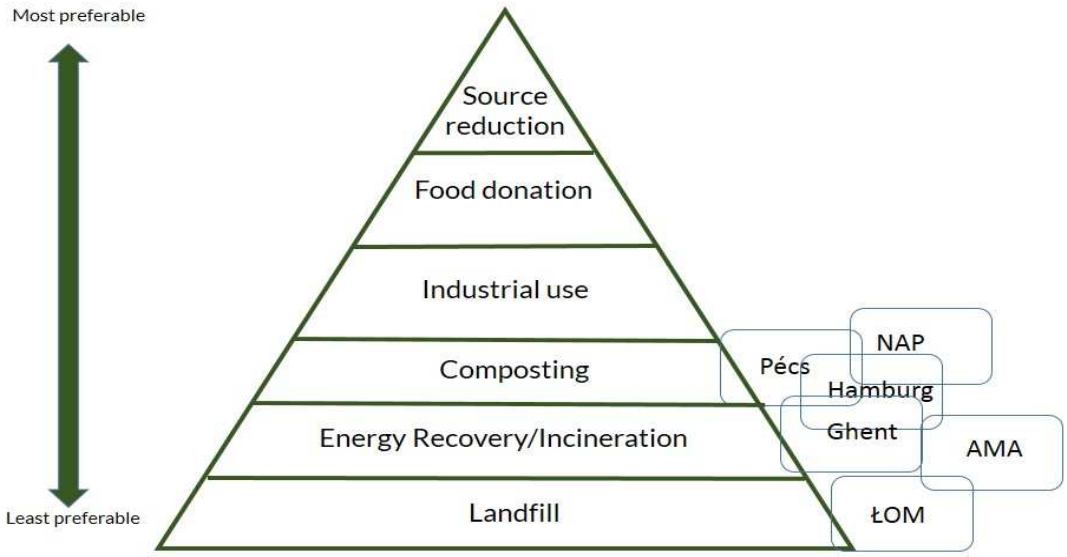

Figure 10: Dominant treatment of organic waste in the organic/food waste hierarchy in the six cases
Source: Own contribution based on Papargyropoulou et al. 2014.

In Belgium disposals to landfills have been entirely eliminated and a much higher share of non-landfill waste is recycled or composted than in many other countries. In Germany also the strategy seeks for minimizing the landfills and hence this is a rare practice. In Hungary central government quadrupled the cost of landfill deposition in two years in two steps in order to decrease the amount of deposition.

Recommendation(s) for policy makers

7. In almost all case studies lack of space as a challenge appeared. In some cases, in densely populated area hinders the proper sorting, or the narrow, hilly lanes (in case of Pécs) hampers the effective collection itself. Hence, **local interventions** are needed. Besides best practices (like underground container systems, several EISs can be found in REPAiR's EIS catalogues (e.g. home composting, shredder service, RTS/'uber for trash'). These EISs[21] can directly provide concrete solutions for local decision-makers to solve the 'combined' challenge of (over)urbanisation and space-consuming wide-range separate collection.

8. Waste separation and storage facilities should be included in **local building regulations**, in order to end the current situation that they are only fit in in the last phase of building projects.

9. Support **of local decision makers:** It is a crucial point to make locally relevant decisions once a **local/regional policy maker** considers on building new waste treatment site or **national policy maker** keens to reduce the transportation of waste/potential secondary raw material. Besides data, GIS based visualisation tool is essential. Hence, we suggest using a visualisation tool - like GDSE - for supporting local decisions relating to local waste/material streams in order to achieve a
    a) better resource use and
    b) to use waste as resources locally.

[21] See the detailed descriptions in D5.2 (Remøy et al. 2018), D5.3 (Russo et al. 2018), D5.5 (Taelman et al. 2019b), D5.6 (Czapiewski et al. 2019), D5.7 (to be concluded), D5.8 (Mezei et al. 2020).

10. In several cases (e.g. Pécs, Łódź, AMA) either in the process modelling (D3.3-3.7) or in the later phase of PULLs (practically appeared in the EIS catalogues), based on the result (summarised above) the need for food donation raised. However, in several case, the national legislation does not allow the reuse (donate) of leftover food that goes against the food recovery hierarchy (Figure 11). Hence, we urge **EU policy makers** (besides the recent EU rule on compulsory separate collection by 2023) to regulate and allow the use of residual food at the highest level of food recovery hierarchy at EU level.

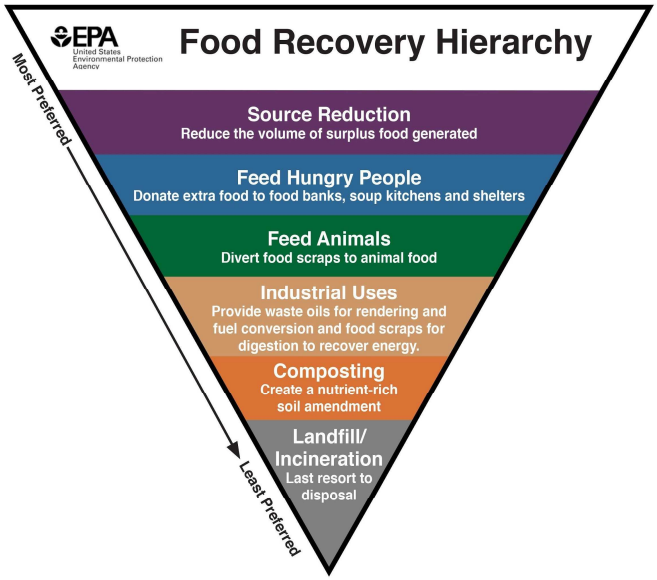

Figure 11: Food waste reduction, recovery, and recycling hierarchy.
Source: U.S. Environmental Protection Agency, http://www2.epa.gov/sustainable-management-food/food-recovery-hierarchy.

3. Comparison of Wastescapes as a resource

REPAiR defines 5+1 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 investigated. These 5+1 categories are grouped in 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) and OPERATIONAL INFRASTRUCTURE OF WASTE (W6) (D 3.3).

As defined in D3.1 and updated in D3.3, Wastescapes are related to the spatial effect of material waste flows on the territories and to the configurations of the infrastructures for their management. The notion of drosscape (Berger, 2006) emphasizes the opportunity to reuse the 'in-between' areas and abandoned spaces going beyond the mere spatial reference of soils and fields and embrace the wider and multidisciplinary field of landscape (D 3.3).

A common feature of the involved countries (and case study areas) is that they all have a significant fertile land treasure, and thus the foundation for sufficient agricultural use, demonstrated by the fact that they are all among the EU's 12 most dominant agricultural producers (cf. D3.8). Hence land use is a crucial issue for them. Therefore, revisiting the Wastescapes as a potential resource for further agricultural use can be an option towards circularity. 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 (D3.3)

In the case of Amsterdam, Wastescapes are represented by scattered, small spaces with different morphologies and natures composed by: 1) Road infrastructures concentrated along water 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; 4) the safety and noise area relative to the airport infrastructure. In comparison to Naples case, the Wastescape surface is very limited (see Figure W). This is mainly due to the strong urbanisation pressure that the AMA region is currently experiencing, in which every area counts as potential space for building and infrastructures and the land value of real estate property. Similarly, in Ghent the Wastescapes for the focus area appears as a fragmented molecular landscape made up of scattered, small elements and without any large prominent figures. In case of Ghent one of the patterns is infrastructure waste and underused spaces, especially green spaces located in the port area of Ghent. Due to recent renovation processes and current urbanisation pressure of Ghent, within the core of the focus area the Wastescape elements are becoming very rarely like AMA. The few linear Wastescapes features available are located along specific transect of large road and rail infrastructures (D3.3, D3.4). These Wastescape related challenges (viz. urbanisation pressure and their consequences) appeared during the PULLs, and besides the initiations of the affected cities and settlements, REPAiR's stakeholders also raised solutions for these challenges (e.g. circular tendering, beyond INTERTIa[22]).

[22] See more details in D5.2 (Remøy et al. 2018), D5.3 (Russo et al. 2018).

On the other hand, in the case of Naples, the peri-urban context offers quite complex and articulated Wastescape geographies such as large grey infrastructures (motorways, expressways, railways, aqueducts, power lines, gas pipelines, etc.) and related buffer zones, as well as canals and streams, often polluted and/or strongly artificialized, problematic 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 combination of areas and buildings linked to the waste cycle: deposits, treatment plants, active and inactive landfills disposed causally, in a dispersed and scattered manner, within peri-urban contexts (D3.3).

In the case of Łódź, the area has been strongly affected by suburbanization. This phenomenon is accompanied by degradation processes in rural areas, mainly those identified as peri-urban primarily due to uncontrolled changes in land use. Therefore, some areas convenient for agriculture were allocated for housing purposes. In addition to such consequences as problems in the development of technical infrastructure, transport, and providing basic services (such as public transport), these areas are also characterized by increased pressure on the natural environment. Intensive housing development is concentrated in larger cities and in the immediate vicinity of Łódź. On the other hand, in rural areas there has been excessive extension of settlement along roads, which is regarded unfavourable both considering spatial order as well as aesthetic aspect. The strategy of the city authorities includes designation of agricultural and forested areas to be developed by logistics infrastructure where investors are obliged to compensate for losses arising from degradation of the natural environment through investment in green areas in commune's territory (D3.5).

The concept of Wastescape is rather difficult to apply in the German context, mainly due to its planning system. However, such areas have been identified as sites related to dumping activities and where the planned developments have not taken place yet. In Hamburg, Wastescapes have been categorised as 'land without use' and 'abandoned productive site'. The most Wastescapes in Altona- Hamburg are related to dump sites, land without current uses and to underused infrastructures. In Pinneberg, it has been identified that the area is characterized mainly by the presence of many mineral extraction sites and landfills and the abundance of such areas are present along the borders between Hamburg and Pinneberg County, where most of the tree nurseries are located (Figure 12).

In Pécs, three main challenges were defined as the closed mining sites and their deposition areas, the leftover military sites and the abandoned industrial areas. The challenge of former military sites rooted in systemic change of post-soviet era and there are still some regenerative needs relating to the sites. Coal mining ended up finally in 2004 and some rehabilitation processes have started afterwards. Deposition area - between the two parts of the city (see Figure 12) - still needs a solution for regeneration. The contamination of waters was an issue until the near past, however, monitoring is still needed.

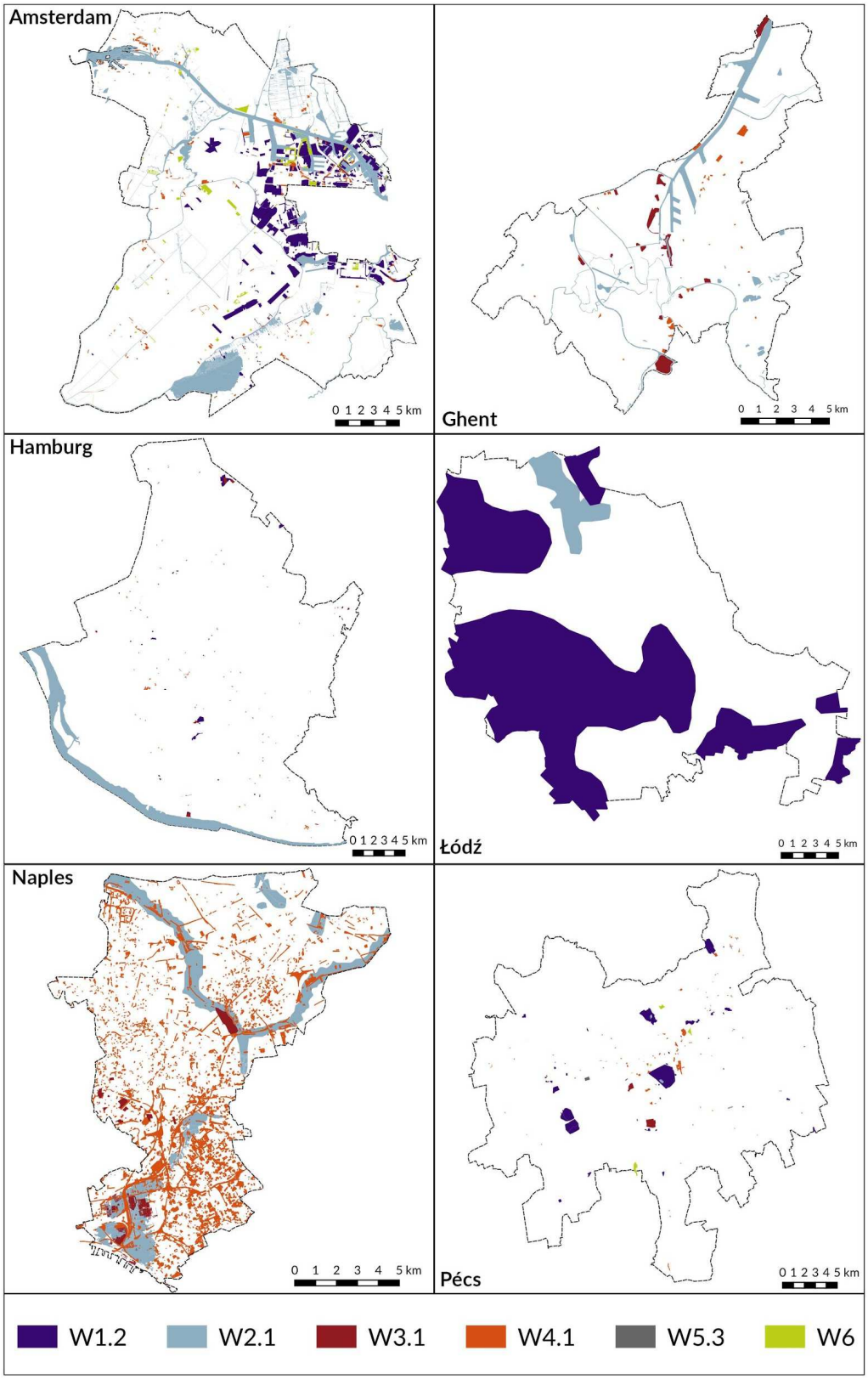

Figure 12: Wastescapes in the six focus areas (FA)
Source: Based on the SHP files provided by the six cases, own contribution
Legend: W1.2=Degraded land; W2.1=Degraded water; W3.1=Declining fields; W4.1=Settlements and buildings in crisis; W5.3=Dross of public facilities and infrastructures; W6=Operational infrastructure of waste

Regarding the categorization defined by REPAIR:

W1- Degraded Lands: In the case of Amsterdam, polluted lands contamination depends mainly on the presence of lead in the soil. In Pécs, on the other hand, degraded lands are mostly the closed mining sites and their deposition areas, approximately three-quarters of the brownfield (wasted landscape) zones in Pécs in the early 1990s were somehow linked to coal mining. 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 caused a significant degradation in the values of agricultural lands. In the slipstream, this created Wastescapes that form a significant challenge for the area. Similarly in Pécs the economic transition history of the country and regions (the industrial transition around the systemic change, the economic history and the trajectory of mining – as a significant industry in the case of Pécs) has had a huge impact on the creation and revitalization of Wastescapes giving challenges to be solved for the city and its agglomeration both in the form of brownfields/wasted landscapes and in the image of residential areas in need of rehabilitation. In Łódź Metropolitan Area, the process of suburbanization is associated not only with consumption of agricultural areas, but also with severe degradation of soils. The processes of soil degradation and pollution of surface and underground waters is closely related to the development of settlements in the ŁOM area. At present, almost the entire area being examined is characterized by poor or medium quality soils. However, the most important from developmental point of view are degraded areas requiring restoration or granting a new function. The process of identifying degraded and areas intended to be revitalized takes place at communal level as part of the Local Revitalization Programs. In the analysed areas there have been identified sites strongly affected by pressure of transport infrastructure and settlement exerted upon the natural environment.

W2- Degraded water and connected areas: The contamination of waters in Pécs was an issue until the near past also due to the former mining sites. In Hamburg the proximity to the port area of the focus area is the reason for the presence of chemicals in the water, although concentrations are not high. Urban areas within the ŁOM are characterized by a high extent of pollution with respect to atmospheric air as well as groundwater and surface water. The surface water pollution particularly affects ŁOM's urban areas and majority of rural areas in the western part of the Łódź Metropolitan Area. The suburban areas of Łódź are characterized by very poor quality of underground and surface waters. The largest concentration of exceeding air quality standards occurs in the central part of the Łódź Metropolitan Area and in larger cities, where the air pollution emitters are concentrated.

W3- Declining fields: In the case of Amsterdam, many abandoned areas are located in the industrial port area. 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. Moreover, other kinds of contaminated sites depend on the criminal practice to dispose or recycle waste by burning, furthermore it could be due to the illegal abandonment of waste along roads. Also, 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. For the pilot cases

only the Volcanic main risk of Vesuvius and Campi Flegrei has been indicated. Those areas are in a "red zone" and Regione Campania intends to promote the decreasing of inhabitants in those areas in the next decade. Abandoned lands in Pécs are the leftover military sites and the abandoned industrial areas.

W4 Settlements and buildings in crisis: In Naples 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. Unauthorized buildings and settlements are defined as result of the work on the Naples-pilot, since in the Amsterdam case this kind of Wastescape is not relevant. In the Naples peri-urban area, many buildings and settlements are built-up without permission and confiscated buildings are resulting from mafia organizations. That is a condition of informality common all over Southern Italy.

W5 Dross of public facilities and infrastructures: In terms of noise pollution on the other hand in 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. Similarly, the activities of the Hamburg airport are contributing to the noise pollution in the eastern part of the Focus Area.

W6 operational infrastructure of waste: In MAN, one of the main issues under this category is the high number of illegal waste dumping sites. Similarly, ŁOM is struggling with problems of municipal waste management and the most common issue identified in this regard concerning peri-urban and rural area are illegal waste dumps, located mainly in forests. Public spaces in cities where waste management is often disordered are also being degraded. This is mostly evidenced by insufficient or inadequately arranged space designated for waste management.

	Amsterdam	Naples	Ghent	Hamburg	Łódź	Pécs
W1.2 - Degraded land	4.75%	X	X	0.18%	40.78%	1.35%
W2.1 - Degraded water and connected areas	9.76%	13.33%	6.78%	4.12%	2.88%	0.02%
W3.1 - Declining fields	2.17%	1.56%	1.5%	0.18%	X	0.13%
W4.1 - Settlements and building in crisis	0.43%	5.16%	0.47%	0.11%	X	0.24%
W5.3 - Dross of public facilities and infrastructures	X	X	X	X	X	0.02%
W6 - Operational infrastructure of waste	0.77%	X	X	X	X	0.08%
Total	***17.89%***	***20.05%***	***8.75%***	***4.59%***	***43.66%***	***1.83%***

Table 4: Wastescape categories and their extent - Percentage of covering in the Focus Area
Source: Based on D3.3-3.7 own contribution

As it can be seen in Table 4 (and in Figure 12) the least Wastescape can be found in Pécs, and Hamburg, while a significant area appears in AMA, Naples and Łódź. The reasons are multi-layered - as it was described above - and place specific, h**ence mapping and visualising the Wastescapes, their categories for local/regional decision makers** is essential, as it was recommended in the case of flows above as well.

Recommendation(s) for policy makers about the regeneration of Wastescapes

11. **Metagoverning/EU** tools against waste crime**:** Waste crime is still an issue in several countries all over Europe. Crime relating to waste(scape) appeared both in the case of Naples and Łódź (and was mentioned during PULLs in Pécs) as well. Hence, there is a need for **EU** directive for a stricter legislation of waste management, precluding organised crime being implicated with the waste management.

12. As it can be seen above, urbanisation and suburbanisation and their 'result' of intensive housing development is a challenge in territorial occupation in the case of AMA, MAN, ŁOM and Ghent explicitly. It increases pressure on the natural environment as well. The relevancy of the introduction of Wastescape into the thinking on CE has been proved in the process models and in this comparison as well. Hence, we suggest to **EU policy makers** to include Wastescape into the EU's CE Agenda.

4. Further recommendations for policy makers

REPAiR, based on its findings, has been created and is creating policy recommendations based on its sustainability assessments' results/outcomes (WP4, Taelman et al. 2018, 2019) and governance analysis - barriers and opportunities (WP6 D6.1-D6.4: Arlati et al. 2017a; Obersteg et al. 2017; Arlati et al. 2017b; Acke et al. 2018). D6.5 will be a cross-analysis on decision making feeding policy recommendation as well. Therefore, this deliverable focuses on WP3 findings and case-specific material flows, including the outcomes of PULL workshops where the following suggestions appeared:

13. Increase the possibility of separate collection on streets/at households: In the REPAiR project, field visit is a common tool during consortium meetings[23]. Hence stakeholders could face that waste management companies are collecting several (20-30) fractions of waste separately as a potential resource. Although these separate bins are only available at waste/recycling centres. In general, (for household waste collection) households can separately collect waste from two to five fractions (depending on their neighbourhoods). REPAiR thinks that there is a need for forcing member states and **regional decision makers** to increase the separate collection fractions for households on site (even as door-to-door facility or collection points at neighbourhood levels), with a special focus on food waste[24] while city planning activities, allowing solutions and spaces for separate collection facilities. (This recommendation is for short- or medium term, as in long term the main aim is to avoid waste creation and recovery waste as high as possible in the waste recovery hierarchy - c.f. recommendation No.2).

14. Valorisation of waste: It is crucial to channel the functioning of waste management system towards the hierarchy of waste handling methods, and above all to diminish the share of mixed municipal waste in the entire waste collection stream. In addition, it is advisable to discontinue storing of selectively biodegradable waste, cease storing of mixed municipal waste without treatment, reduce the number of illegal municipal waste storing sites and establish a monitoring system for municipal waste management. Today's legal conditions preclude proper cooperation between the private and public sector in the field of waste management system.

15. More concrete recommendations based on PULL activities (and not mentioned in the deliverables): The European Parliament approved a new law banning single-use plastic items such as plates, cutlery, straws and cotton buds sticks by 2021. However, some stakeholders (and ideas discussed in PULL) suggested to go further with plastic packaging waste banning small (0.33 cl) PETs (plus plastic bags) (and beyond EU's 2030 100% plastic recycling target) and there is a

[23] c.f. also its role in knowledge exchange in D7.1 and D7.2.
[24] By 2023, due to the rules of EC's Circular Economy agenda, bio-waste (organic waste in REPAiR's term) has to be collected separately.

recommendation **to the EU** to support the R&D projects on the sustainable way of substitution of PETs[25] (for instance in the FP9 grants).

5. Conclusion

This deliverable aimed to compare the process models of WP3 (elaborated in the deliverables of REPAiR project No. D3.3-3.7). Based on this comparison, this deliverable draws up policy recommendations on different levels. The main object of the comparison is the bio-waste or organic waste[26] with a special focus on Vegetable Fruit and Garden (VFG) and food waste. CDW was only discussed in some part of the cases. Comparison is focusing on the choice of flows, data gathering and the case-specific peculiarities of flows as well. Wastescape as a special but integrated topic of CE and REPAiR was also discussed.

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. From a systemic perspective, reconditioned Wastescape can offer ecosystem services (supporting, provisioning and regulating). Green infrastructure in peri-urban territories can regulate climate, air, and water quality; enable nutrient and water cycling, provide spaces for growing plant fibres, usable for developing biomaterials for the construction industry, and for recreation. 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. These are places with great potentials as they are structurally arranged in a continuous territorial structure and recognized by the communities as symbols of their local specificity. Hence, co-creation of eco-innovative solution either for a certain flow or a Wastescape cannot be feasible without the understanding of place, and practically without its complex but easily understandable visualisation, in order to show the critical and key aspects for decision makers.

Values like social togetherness, cohesion, sharing collective responsibilities, and voluntary devotion, openness for change, belief in progressive capacities, deliberative communicative actions, optimism about the future, participation as well as reflexive agency and critical activity are considered as important bases and motivations to a sustainable resource management regarding the survey results in our study (D 3.7). Local factors and history, the trajectory and the changes of the economic structure influence

[25] Concerning some energy calculation, glass bottles are not necessarily the best was for substitution as production of bottles made from glass need 40 times more energy than PET.
[26] The term of bio-waste was used in the preparation phase of the project whilst organic waste was used during the project as a more often used terminology in the case study countries.

different cases' social and socio-cultural situations that affects the attitudes and behaviours towards the environment and waste problems.

Societies having problem backgrounds and dealing with current challenges show more tendency towards waste and environment conscious behaviour, like in the case of Campania, bad experience of waste management crisis in Naples - that culminated in 2007-2008 - resulted in an increase of environmental consciousness (c.f. D3.3 and D3.8).

Territorial disparity within the same country (cf. Italy) and within the same focus area too (cf. Ghent, AMA, Hamburg) is an important factor affecting waste management practices, including to increase the environmental consciousness of different social groups (e.g. age, culture).

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 Northern Europe) suitable waste management plants; moving the related economic activities outside the territory, that could be a potential source of income and employment (Especially in the case of South-West division).

In the REPAiR project the six case study areas have on different state of the transition towards CE. In strategy and in pilot applications there are frontrunners (e.g. AMA) and followers (e.g. Lodz, Pécs). However, in everyday practice solutions for the wide audience (households) are on lower levels on the waste hierarchy (see Figure 10), still facing separate collection as a key problem that is still rather a linear approach in sustainability discussions. Hence, policy interventions are needed on multilevel. This document made an attempt to add recommendations to this discussion.

6. Lessons and messages

It is advisable to discontinue storing of selectively biodegradable waste, cease storing of mixed municipal waste without treatment, reduce the number of illegal municipal waste storing sites and establish a monitoring system for municipal waste management. For the efficient functioning of waste management system, it is crucial to develop a proper cooperation between the private and public sector. The hierarchy for waste management/material recovery methods and objectives to be achieved in the perspective of the year 2030 imposes the need to significantly reduce the amount of deposited waste and to constrain storage only to previously treated waste (D 3.5).

Paying attention to the fact that going for a circular system does not mean automatically going for a sustainable system. Tonini et al. 2019 *(submitted)* provides a first glimpse on this, as the more innovative scenarios score sometimes worse than the reference - burning scenario. (A more detailed discussion and conclusion on circularity vs. sustainability will be available in WP4 deliverables on sustainability assessment (D4.6, D4.8).

Key message: In waste management and Wastescape treatment place (with its socio-cultural diversity) matters. EU has its Circular Action Plan, however, without taking into consideration the differences among agents (member states, households vs. companies, local governments, neighbourhoods) going towards waste and Wastescape as a resource cannot be an effective progress. Hence, there is a need for insisting (with financial support and legal tools (that allows them more rooms for manoeuvring and governance) local strategies, actions with a support of visualisation of status quo and potential streams and impacts.

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