REPAiR

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

D3.7 Process model Pécs

Version 2.1
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Acronyms and Abbreviations

AMA	Amsterdam Metropolitan Area
BGPW	Biodegradable Garden and Park Waste
BvD(ID)	Bureau van Dijk – (Identification of a company used by ORBIS, operated by Bureau van Dijk)
CPI	Consumer Price Index
CSR	Corporate Social Responsibility
EC	European Commission
EIS	Eco-innovative Solution
EU	European Union
EWC	European Waste Catalogue
FA	Focus Area
FDI	Foreign Direct Investment
GDSE	Geo-design Decision Support Environment
KSH	Központi Statisztikai Hivatal (Hungarian) Central Statistical Office – same organisation as HCSO
KSH ID	Hungarian Statistical Office Identification Number
KTJ	Környezetvédelmi Területi Jel (Site ID for Environmental Protection Registry)
LAU	Local Administrative Units
MÁV	Magyar Államvasutak (Hungarian Railways)
MSW	Municipal Solid Waste
MTA RKK	Magyar Tudományos Akadémia Regionális Kutatások Központja (Centre for Regional Studies of the Hungarian Academy of Sciences)
NAP	Naples Metropolitan Area
NACE	Nomenclature statistique des activités économiques dans la Communauté Européenne (Statistical classification of economic activities in the European Community)
NHKV	National Coordination of Waste Management and Asset Management Plc. (Hungary)

NUTS	Nomenclature des unités territoriales statistiques (Nomenclature of the Statistical Territorial Units)
OKIR	Országos Környezetvédelmi Információs Rendszer (National Environmental Protection Information System)
OTKA	Országos Tudományos Kutatási Alapprogram (National Scientific Research Programme)
OECD	Organisation for Economic Co-operation and Development
ORBIS	Data resource on private companies operated by Bureau van Dijk
OW	Organic Waste
P&G W	Park and Gardening Waste
PHARE	Poland-Hungary: Assistance for Restructuring the Economy
PSCA	Primer Socio-cultural Analysis
PULL	Peri-Urban Living Labs
R&D	Research and Development
RDF	Refuse-derived fuel
SSCA	Secondary Socio-cultural Analysis
TeIR	Területfejlesztési és Területrendezési Információs Rendszer (Territorial Development and Spatial Planning Information System)
UB	User Board
WCB	Waste-consciousness Behaviour
WP	Work Package

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Publishable Summary

Deliverable 3.7 of Work Package 3 concerns an integrated analysis of the follow-up case of Pécs within the REPAiR project, from the point of view of waste production and processing, and the transition (or rather the first steps) towards circular economy. It comprises spatial, social and material flow analyses of the case of Pécs and its agglomeration as a territory to treat as a unit, following the innovative methodology that was introduced and explained in Deliverable 3.1 (D3.1) (Geldermans et al., 2017).

While writing this deliverable, as a follow-up case, authors followed the D3.1 methodology and pilot deliverable (D3.3) on AMA and NAP in the elaboration of spatial, social and material flow analysis. In the wastescape categorisation stakeholders' knowledge was also integrated. With regard to the Material Flow Analysis, new insights on data collection and processing are addressed, in order to provide a successful representation of the most important flows. After a rudimentary spatial and socio-economic analysis at national level the reader can get a deep inside about the region (Baranya county) and the Pécs agglomeration. This analysis enables to understand the challenges and solutions more deeply regarding to both the wastescapes and the peculiarities of flows represented in this document.

The analysis in this deliverable revealed that the history of the country and regions (the industrial transition around the systemic change), the trajectory and the changes of the economic structure had a major influence on the wastescapes and their revitalisation processes. Although, there is no circular economy plan or strategy neither for Hungary nor for the investigated area, it can be seen that Pécs – as a frontrunner in sustainability strategic planning and implementation – has positive examples that can contribute to closing the loop, reducing waste, especially when making comparison within the region.

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 (D3.3, Chapter 2.1.5).

1. Introduction

This report concerns an integrated analysis of the follow-up case of Pécs within the REPAiR project, from the point of view of waste production and processing, and the transition (or rather the first steps) towards circular economy. It comprises spatial, social and material flow analyses of the case of Pécs and its agglomeration as a territory to treat as a unit, following the innovative methodology that was introduced and explained in Deliverable 3.1 (D3.1) (Geldermans et al., 2017).

In Chapter 2, the methodological approach from D3.3 is briefly revisited and new insight and adjustments are indicated.

The structure of the Chapter 3 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. Structure enables the identification of key activities and actors, which reveals where responsibilities lie and therefore surfaces distinct points for policy or business interventions. In Chapter 3.1 – following the deliverable for pilot cases (D3.3) – spatial and socio-economic analyses were conducted for Hungary. This is followed by a deeper analysis in Chapter 3.2 where the region (Baranya county), the focus area (Pécs agglomeration) and the sample area of Pécs were 'walked around' from the viewpoint of socio-economic and spatial sense, taking into account the temporal scale as a key to better understand the processes and representations. Social patterns, socio-cultural peculiarities and socio-economic and demographic conditions influence the agents'/actors' way of thinking, their possibilities, and their way of addressing environmental challenges. Hence, besides socio-economic, spatial or complex geographical analysis, it is essential to understand the socio-cultural background of the given area.

In Chapter 3 having regarded the standardisation (based on D 3.1 and D3.3) of the mapping process all the data have been ordered into informative layers, according to different scales and topics.

In Chapter 3.3 new insights on data collection and processing regarding the Material Flow Analysis are addressed. Obstacles for data gathering and methods to successfully conduct a material flow analysis are clarified. In this chapter the AS-MFA methodology and structure – made by AMA in D3.3 – was also followed, however, due to the case specificity, the context and the data availability, the report emphasised and structured the flows according to the specificity of the case.

Chapter 4 is dedicated to a reflection on the analysis of the Pécs case. 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. Challenges are addressed regarding data collection and modelling of material flows. The Enabling contexts, and its relevance for the REPAiR scope, is further discussed in this chapter.

2. Spatial, material flow and social analysis – methods in use

Having regarded the spatial, material flow and social analysis, in this chapter we are revisiting the methodology outline in D3.1 and the method in use in the process models of pilot cases in D3.3 and here, we are only referring how we used them. We are trying to avoid to repeat the detailed description of methods in Chapter 2, hence we are pointing out what can be different from the above-mentioned deliverables.

2.1 Spatial and socio-economic analysis

Elaborating the spatial, socio-economic and socio-cultural related analysis, the structure and methodology described in the deliverables No. 3.1 and 3.2 (Grünhut et al., 2017) and 3.3 (Geldermans et al., 2018) are followed.

The maps in the deliverable No. 3.1 and No. 3.3 (and in the accompanying tables provided for the follow-up cases on the google drive) are completely defined, therefore the work and representation in this deliverable (D3.7) could follow the pilot mapping procedures. On the other hand, the resulting maps are not completely ultimate and will be further updated in the following months. The reason is that there is a considerable difficulty regarding the availability and the quality of datasets that can be considered complete and appropriate to the analysis of environmental matters. Hence in some cases, not all the layers are represented as it is in the pilot cases. Furthermore, some maps are missing. The reason for that is that they are not relevant (either from geographical or from socio-economic point of view) for the Pécs case. Additionally, there are unique maps for this deliverable that are not represented in the pilots. The reason for that is the same but on the other way round: they are relevant for this follow-up case.

Layers, graphics and titling follow the description of Chapter 2.1.4 in D3.3.

Having regarded the socio-economic analysis, the pilot deliverable was followed. However, there are some additional subchapters that are relevant for the Hungarian/Pécs case to understand better the situation and the enabling conditions. As in the Pécs case, continuously changing institutional settings is important (as it has direct influence on the flows), findings from D 6.2. were integrated. Furthermore, a new OECD report was published in 2018 for Hungary on its state on circular economy, therefore it was essential to summarise it for a better insight.

2.2 Wastescapes

In Hungary (and in several other countries) wastescapes (as defined in REPAiR in the Deliverables 3.1, 3.3, and in the paper van Timmeren and Amenta, 2018) is usually defined as brownfield. The notion of brownfield is researched and defined in several EU (and US) projects (c.f. Dannert, 2016). The commonly used Hungarian definition is based on Barta (2002, 2004) that refers the underused or empty territories of former industries.

Abandoned buildings, railways and military sites are also the part of this definition (Barta, 2002, 2004).

In her PhD research, Dannert (2016) analysed and evaluated the Hungarian brownfields, dedicating a separate chapter for the brownfields of Pécs. Therefore, Dannert's (2016) investigation was the basis for the identification of wasted landscape in the Pécs case. Following this baseline position, in the first PULL stakeholders were asked to verify and further identify the wasted landscapes for Pécs. In PULL, not the brownfield but the REPAiR wastescape definition was used (cf. in D3.3 and in van Timmeren and Amenta, 2018), because this latter categorisation is more detailed and extended compared to brownfield definition. The REPAiR categories that this follow-up case used are:

'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)

+

6. OPERATIONAL INFRASTRUCTURE OF WASTE (W6)' (D3.3, pp. 13.)

However, we have mention that not all the categories can be found in the Pécs case. After this procedure, the experts of the Pécs team finalise the catalogue and categorise them concerning the updated wastescapea definition of the REPAiR project in D3.3, Chapter 2.1.2. That means that following the detailed description of wastescapes in the above-mentioned chapter, Urban Atlas was also used to verify and/or identify the drosscapes. For identifying polluted waters, the Pécs Environmental Protection Programme (2011-2016)[1] was also used. The programme – in its evaluation – is using the categorisation of the EU Water Framework Directive for the quality of waters.

Additionally, in the Pécs case, EISs for wastescape regeneration are also presented.

[1] www.okovaros-okoregio.hu/index.php/hu/letolt/category/1-pecsi-zold-informaciok?download=3:pmjv-telepulesi-kornyezetvedelmi-program-2011-2016

2.3 Scale matters

Following the levels of REPAiR project (Figure 1), the region for this follow-up case is Baranya county (NUTS 3 level).

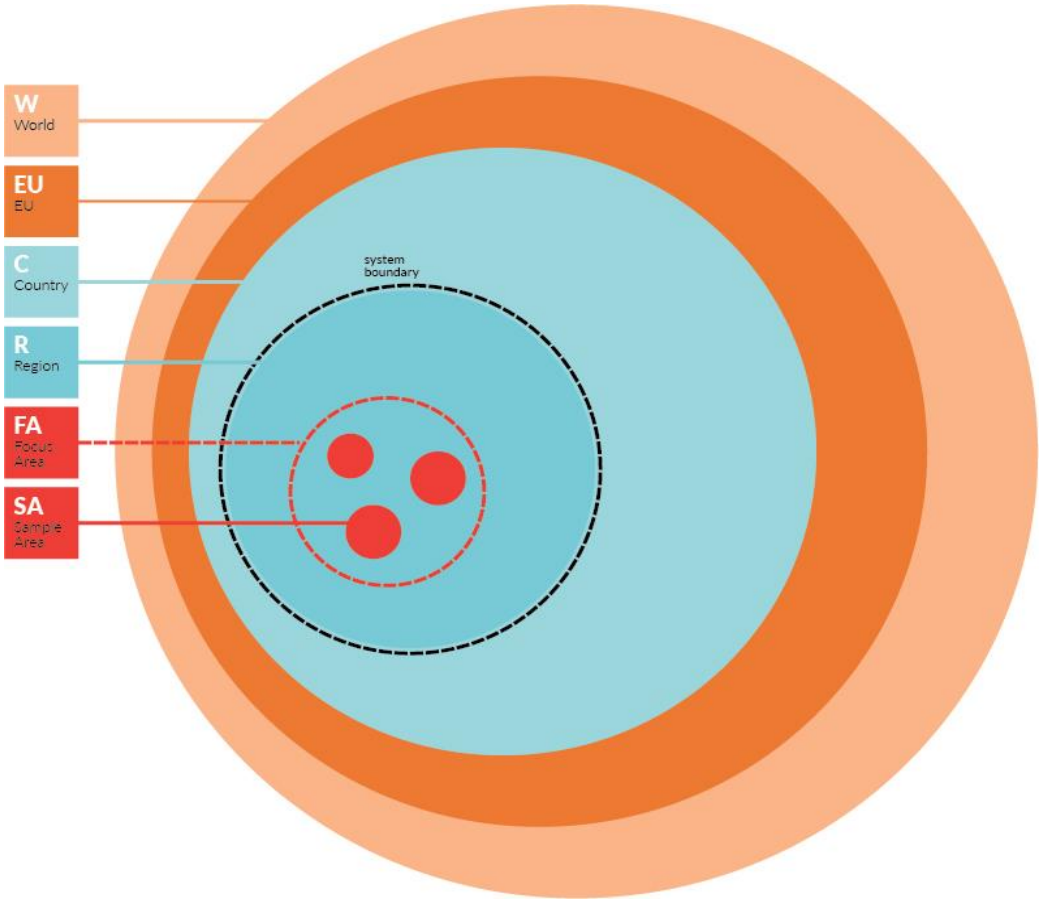


Figure 1: Scale levels within REPAiR
Source: D3.3, pp. 22.

The reason for that choice is the institutional settings of Hungary. While NUTS 2 level (South Transdanubia) is a statistical unit for EU regional policy, it does not have decision-making/territorial governance level. NUTS 2 region was created in the 1990's as an accompanying procedure of the EU accession of Hungary. Hence, this territorial level is not routed in the Hungarian spatial/territorial development system. On the other hand, county (NUTS 3) has a decision-making governmental body and the county has a 1000-year heritage in public administration, territorial governance and planning in Hungary.

For focus area (FA) Pécs and its agglomeration has been chosen. The reason is the phenomenon of suburbanisation that started in the late 1990's (Bajmóczy, 2000). From the point of view of MFA, the processes of Pécs are not understandable without its agglomeration as more and more people are living there, while working and shopping

in the city. Therefore, consumption is made mainly in the city, while the production of waste affects the agglomeration.

For sample area the city of Pécs is identified. However, the analysis for this sample area is appearing in few cases, accordingly.

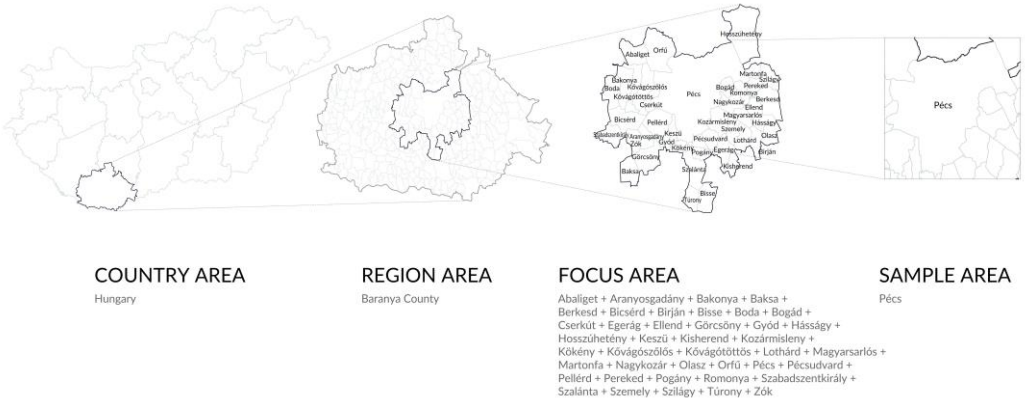


Figure 2: The country, the region, the focus and the sample areas.
Source: Own elaboration

2.4 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. Following that, this deliverable aims at the following:

- 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

Similar to the analysis of pilot cases (D3.3), the temporal scale applied in this report is one year. Recently, from the Hungarian Central Statistical Office (HCSO) the year of 2016 was available for the analysis. However, in the Pécs case, data from Biokom Nonprofit Ltd. (local city maintenance company, formerly responsible for waste collection in Pécs and responsible for several waste management issues recently) and Dél-Kom Nonprofit Ltd. (local waste collection company, 100% owned by Biokom) were used.

Orbis database was also available for the Pécs case, however, the database had major gaps (for details see below in the relevant chapters). Therefore, in order to conduct a

more reliable analysis, Biokom data, data from OKIR and from Ministry of Agriculture were also used, that data structure also follows EU classifications:

AS-MFA	Database
Activity	NACE Rev. 2
Location and actor for activity	Orbis, Biokom, Ministry of Agriculture, OKIR
Classification of products used or consumed in activity	CPA
Classification of "waste" produced by activity	EWC

In order to execute the AS-MFA, six methodological steps were followed in the Pécs case:

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
    - Flow data collection
    - Modelling decisions based on data availability
    - Downscaling and upscaling
    - Mass balancing
6. Visualising the results (in geographical context)

The paragraph on Data gathering and Mass flow modelling will address the obstacles of data gathering and discuss methods that can be used to successfully conduct a material flow analysis.

2.5 Socio-cultural 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.

In this deliverable the result of multi-phased, comprehensive secondary socio-cultural analysis (SSCA), primary 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, socio-economic analysis, and analysis on corporate environmentalism are presented.

3. Results of the Pécs case

3.1 Spatial and socio-economic analysis – Hungary

3.1.1 Geographical situation and the natural environment

Hungary is situated in the Carpathian Basin surrounded by the Alps, the Dinarides and the Carpathians' mountain ranges. This 93,028 km^2 area is largely dominated by plain land as *73% of the territory of the country is low (up to 200 m high), 20% hilly (up to 350 m high) and only 7% mountainous (*elevation between 750-1014 m)[2]. Considering natural resources, the country's most prominent asset is its thermal water treasure, furthermore bauxite and coal, that is mostly found in the Transdanubian Mountains. Black coal is only found in Mecsek Mountain (Budai and Konrád, 2011).

Natura 2000 is the key instrument to protect biodiversity in the European Union. It is an ecological network of protected areas, set up to ensure the survival of Europe's most valuable species and habitats. Natura 2000 is based on the 1979 Birds Directive (79/409/EEC) and the 1992 Habitats Directive (92/43/EEC). The green infrastructure it provides safeguards numerous ecosystem services and ensures that Europe's natural systems remain healthy and resilient[3]. Recently, 21% of the country is under Natura 2000 protection[4].

Soil in Hungary can be greatly utilised as it has very favourable conditions for agricultural use[5]. The Great Rivers of Hungary have foreign origin, and therefore the country is very vulnerable to its neighbours for example when it comes to water pollution. The Carpathian Basin is a rather closed basin, and whilst the amount of surface water is outstanding, its runoff within country is the smallest in Europe[6]. Across Hungary the *riverine flooding and excess water hazard are more common in lowlands, whereas flash flood hazards are primarily, but not exclusively, affect the mountainous and hilly regions of the country.* Cause of flood level rising is due to the combination of climate change and human activities, such as deforestation (Lóczy, 2010, pp. 1, pp. 8). The county has quite a variable moderate climate where significant differences are not uncommon, this is due to its geographical situation where the more balanced ocean, the more extreme continental and slightly the Mediterranean climate also have an impact. According to György Péczely's work (1981), and based on his division, more generally it can be concluded that in the majority of Hungary has moderately warm – dry climate. Milder variations occur depending on the terrain, and geographical

[2] http://www.mtafki.hu/konyvtar/Magyarorszag/Magyarorszag_terkepekben_Domborzat_es_taj.pdf p.1

[3] https://www.eea.europa.eu/data-and-maps/data/natura-2000/

[4] http://www.natura.2000.hu/hu

[5] http://enfo.agt.bme.hu/drupal/sites/default/files/Soils%20of%20Hungary.pdf

[6] http://mkweb.uni-pannon.hu/tudastar/ff/08-vizek/vizek.xhtml

location[7]. Hungary is divided into 7 statistical regions (NUTS 2 equivalent) and 19 counties with further micro-regions, see Figure 3.

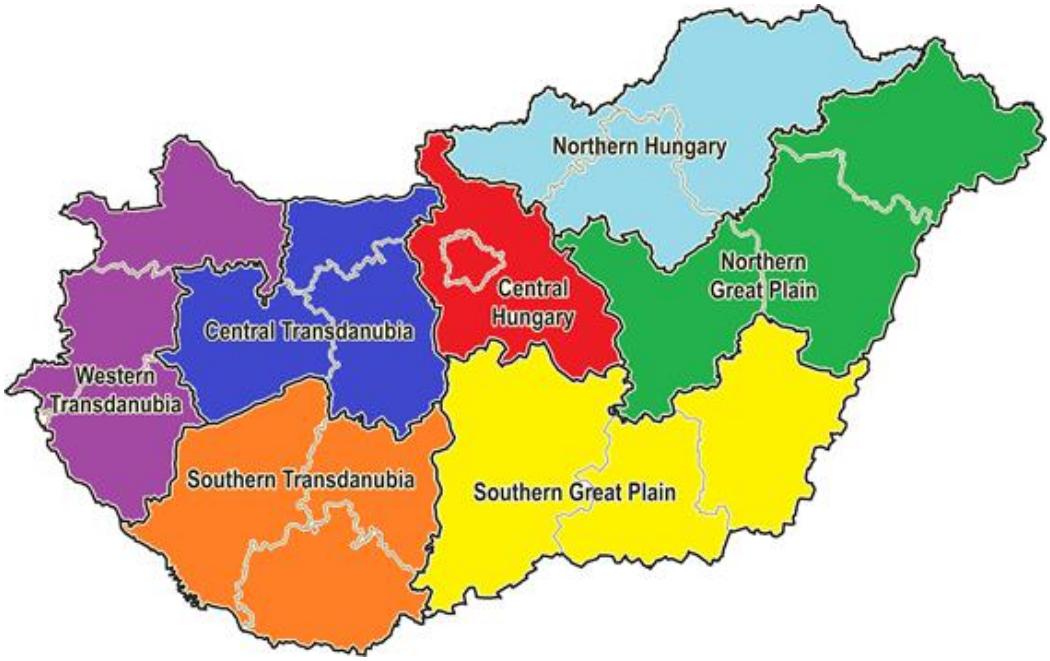


Figure 3: regions in Hungary, source: wordpress.com; https://hungaryforyou.files.wordpress.com/2013/08/regiok_magyarorszc3a1g_angol_regioszin.png

3.1.2 Demography

The Hungarian population is mostly characterised by significant ageing and population loss in the first place. The current population is 9.9 million, after it peaked in 1980 with 10.7 million inhabitants, and this number has been shrinking ever since. The tendency is accompanied with the process of ageing, and changing in age structure; the current average age of the population, that is 41.0 years (2012), stood fifty years ago almost ten years lower, and it is anticipated to be 51 years by 2100. Similarly to its neighbour of Austria and Germany, Hungary was one of the first nations experiencing the population ageing, and although it is a common feature now among many European countries or in East Asia, this process is at least slower and less intense in Hungary when compared to the latter or to the Mediterranean (Gál and Törzsök, 2017). The natural decrease indicator was -4.1 in 2017, a number that increased from -3.1 in the last ten years. In Hungary women have significantly higher life expectancy (78.99 years), compared to males (72.4 years)[8]. Among the regions, the eldest population is in South Transdanubia and South Great Plain. Internal migration affects differently the regions, as in the past century migration surplus was documented in Central Hungary, Central Transdanubia

[7] https://www.met.hu/eghajlat/magyarorszag_eghajlata/altalanos_eghajlati_jellemzes/altalanos_leiras/
[8] http://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_wnt001b.html

and Western Transdanubia, whilst negative migration ratio in North Hungary and North Great Plain (Dusek, Lukács, and Rácz, 2014). The distribution of population in the 7 regions is quite similar, with the only exception of Central Hungary, that has *more than twice as much population as the other six regions. The population has decreased in each region of Hungary in the last twenty years,* with the only exception of *Central Hungary where the reduction turned over between 2002 and 2004 and the population began to rise again*. (Dusek, Lukács, and Rácz, 2014, pp.3-4). The average population density nationwide is 105.1 inhabitants per km2.[9]

3.1.3 Labour force

When it comes to employment rate and structure in Hungary, there are some significant differences within the regions. This has been the case in the recent decades in the regions and as a result of their developmental path, see further chapter. Looking back in the past few decades, overly in Hungary, relative positive trends were typical in employment between 1996 and 2000, which positive process was reversed in 2004 and then further deepened by the hit of the crisis in 2008 (Dusek, Lukács, and Rácz, 2014). The unemployment rate peaked at 11.9% as a result of the crisis in the first quarter of 2010 and remained above 10.5% for almost two and a half years. Unemployment began to rise again during the 2012 recession in Hungary and reached 11.8 per cent in the first quarter of 2013 (Bakó, 2013, pp.22) (Figure 4).

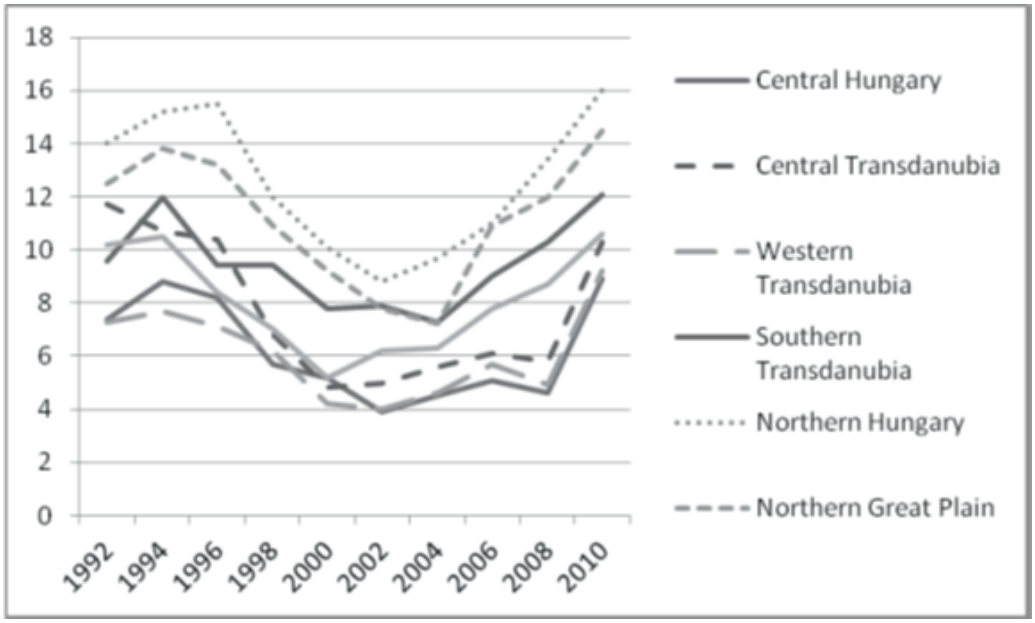


Figure 4: Changes in unemployment rate since the 90's
Source: Dusek, Lukács and Rácz, 2014.

According to the second quarterly data of 2018 of KSH, now the following unemployment rates apply to the regions: North Great Plain is the most disadvantaged

[9] http://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_wnt001b.html

(6.4%), followed by South Transdanubia (5.8 percent), Northern Hungary (4.7%), South Great Plain (3%), whilst in the best positions are Central Hungary with 2.5%, Central Transdanubia with 2.3%, and Western Transdanubia with 1.6%. However, earlier there were criticisms expressed about improving employment indicators, in the European Semester 2015 Country Report, drawing attention to the indicator-improving effect of public employment[10]. Alpek and colleagues also claimed that these indicators have modifying effect on spatial structure, and that 'the more disadvantaged the region is, the higher its public work rate gets' (Alpek et al., 2016, pp.65). In their opinion, public work cannot significantly improve employment, without the opportunity of productivity centred occupations (Alpek et al. 2016). In the field of labour market qualification indicators of the country, the capital city stands out in the nation, but in addition to this, the regional differences in this matter are mostly between urban and rural areas[11]. Higher education system in Hungary has a reputation of excellent quality, but there has also been critics declaring that Hungary's education system leaves many graduates '*leaving without the needed skills and unprepared to apply knowledge in novel and unfamiliar settings*'[12]. Also, the proportion of people with higher education graduation (16.2%) is not satisfactory according to EU preferences, and well below the EU average[13].

3.1.4 Economy

'The post-socialist transformation created some challenges in Hungary that had never been anticipated before. Functions had suddenly become obsolete after decades of expansion. This was due to the structural transformation of economy and the demilitarisation of spacious areas of thousands of square kilometres. Brownfield[14] was an unexpected and literally unknown category in the country: ideologically determined continuous economic growth excluded the possibility of recession, and the overall shortage of fixed capital made abandoning of industrial sites highly improbable' (Dannert and Pirisi, 2017, pp. 5). After the transformation several attempts were made to identify and assess the extension of brownfield in Hungary (Figure 5), and based on these characters several redevelopment and rehabilitation programmes were launched (mainly using pre-accession funds of the EU, such as PHARE or ISPA programmes).

[10] http://www.parlament.hu/documents/10181/303867/2015_11_kozfoglalkoztatas/1d9a7b57-65b1-4886-98c3-fff7cdfc29a1

[11] http://gvi.hu/files/researches/122/regio_2012_tanulmany_131028.pdf

[12] https://www.oecd.org/eco/surveys/Hungary-2016-OECD-economic-survey-flyer-EN-lang.pdf

[13] https://ec.europa.eu/eurostat/statistics-explained/index.php/Tertiary_education_statistics

[14] Brownfield is terminology mostly used for wasted landscape. The notion referred to the area that had been developed for industrial purposes, polluted, and then abandoned, since similar to the wastescape concept used in the REPAiR project, however, the latter includes more types of areas. (Details in the D 3.2)

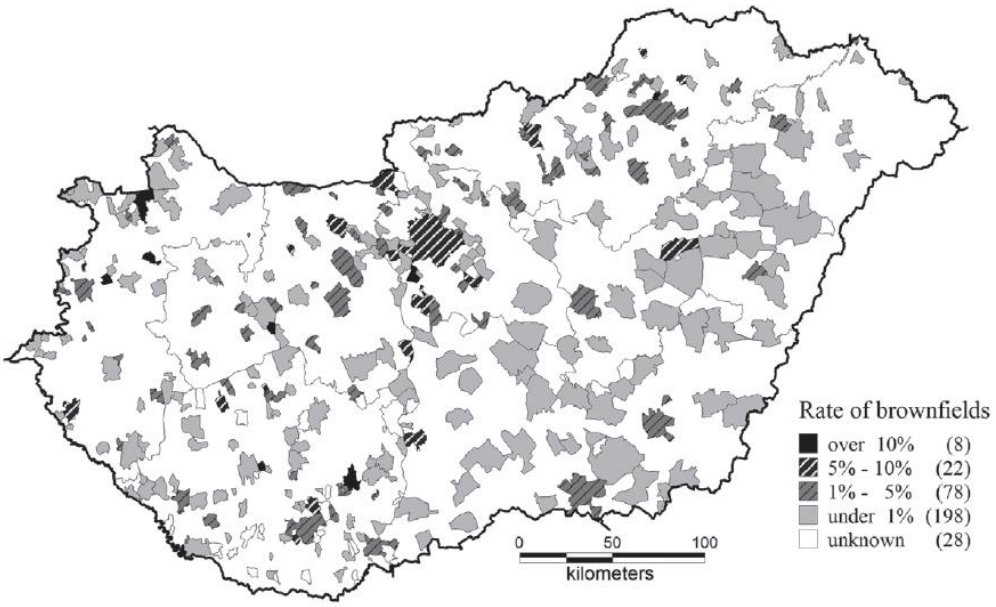


Figure 5: The rate of brownfields in the administration area of settlements in Hungary
Source: Dannert and Pirisi 2013, p. 13.

Measuring the territorial economic development is rather multidimensional (Dusek, Lukács, and Rácz, 2014). According to Csete and Szabó (2014) the regional differences within the Hungarian economy are largely due to export activity, creating both GDP per capita and the gross added value throughout the biggest companies. Therefore regional inequalities are parallel to the location of the largest companies and their export activity (Csete and Szabó, 2014). Considering the most common performance indicator, GDP per capita, Central Hungary is the most advanced region of Hungary, followed by West Transdanubia and Central Transdanubia. After them, fallen behind average, South Transdanubia (the macro region of our case area), South Great Plains, North Great Plains and Northern Hungary can be found (Dusek, Lukács and Rácz, 2014, pp. 12.) The picture of gross added value mainly reflects this, in which it is worth noting that among these lagging regions both South Transdanubia and North Hungary hold a strong R&D infrastructure, and therefore innovation capacity, but this is hindered by market underdevelopment and more complex collaboration problems[15],[16] (Farkas, 2015). The *West Transdanubia-Central Transdanubia--Central Hungary* corridor embraces the so-called Vienna-Budapest innovation axis, that was the most rapidly changing area right after the change of regime (in 1989) already, due to the rapid flow of foreign direct investments (FDIs). The most industrialised regions are ever since Central Transdanubia and Western Transdanubia, which also led – due to their sensitive sectors such as car

[15] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/northern-hungary
[16] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/south-transdanubia-0

industry – to the decline in the time of the recession in 2008 when their economic performance was highly affected[17].

In the present – post crisis recovery – decade, the following indicators can be said about the Hungarian economy: In the last four years, GDP per capita has been continuously rising (annual growth was 4.1% last year), trade balance grew (though in 2017 was lower than the year before), whilst inflation rate (CPI) went from 0.4% (2013) up to 2.1% (2017)[18]. Income levels in the country are still well below than in advanced economies. Similarly, the operation of the business sector – which can mainly be characterised with FDI and EU structural funds – is not satisfactory[19].

3.1.5 Transportation

Hungary, that is one of the Eastern European traffic juncture areas, is characterised by an expressly monocentric transport network. Both the railway and the main road network are Budapest-centric – further enhanced by the EU's Trans-European corridors –, which causes problems connecting the Eastern and Western parts of the country. Another problem is the lack of bypass roads leading to the overloading of main roads crossing many cities and causing traffic and environment problems for certain settlements. In some counties – like in Baranya (our focus region in this project) and Nógrád – the ratio of access roads is high (35-45%). In terms of car supply (number of cars per thousand inhabitants) Central Hungary, Central and West Transdanubia are in better position than South Transdanubia, whilst North Hungary, North Great Plain and South Great Plain are the most disadvantaged in this term, basically reflecting the income differences among the regions across the country[20]. The total motorway length is 1,099 km long, connecting through M1-M7 motorways all the regional centres to the capital. Road density is the third 3rd highest in the European Union (km/1000 km^2) therefore much of the freight transportation relies heavily on this. Railway network is 7,729 km, from which electrified railway network is 2,628 km (34%), in several rail lines Hungary is connected to Western Europe through this network. Water transport is also considerable, thanks to its large Rivers (Duna and Tisza), and the air transport infrastructure is secured with the nation's international airports in Budapest, Győr, Pécs, Hévíz, and Debrecen[21][22]. (Among them Budapest has the highest roles, Debrecen is increasing in the number of passengers, while Győr, Pécs and recently Hévíz are providing facilities to charter flights only.)

[17] https://www.ksh.hu/docs/hun/xftp/idoszaki/pdf/valsagmunkaeropiacra.pdf
[18] https://www.focus-economics.com/countries/hungary
[19] http://www.oecd.org/hungary/economic-survey-hungary.htm
[20] www.mtafki.hu/konyvtar/Magyarorszag/Magyarorszag_terkepekben_Kozlekedes.pdf
[21] http://eugo.gov.hu/key-facts-about-hungary/infrastructure
[22] www.mtafki.hu/konyvtar/Magyarorszag/Magyarorszag_terkepekben_Kozlekedes.pdf

3.1.6 Environmental management towards circularity

3.1.6.1 The findings of OECD

OECD (and its Environmental Committee) as a metagoverning organisation is trying to help governments to improve the state of their environment (with suggestions) and also makes report to reveal and to indicate the backwards of the progress. Following the previous reviews in 2000 and 2008, the third EPR of Hungary was published in 2018, providing related recommendations to improve the overall environmental management of the country.

Energy, climate, air and water

As regards energy consumption, the country's reliance on coal and natural gas in favour of low-carbon energy sources has been reducing and renewable energy took up 14.5% of gross final energy consumption in 2015, which was a threefold increase compared to the 2000's. However, as of 2016, fossil fuels still make up two-thirds of the country's energy supply and air pollution exposure and its costs are still among the highest in the OECD. Intensive industrial and agricultural activities and growing road traffic is escalating the already visible environmental challenges. As a result of the EU-funded investment in new water treatment facilities, the share of the population connected to wastewater treatment reached 78% in 2015, which is about 32% increase from the share of year 2000. However, this result still remains one of the lowest in OECD and almost 40% of the population receives drinking water of unsatisfactory quality.

OECD concluded that Hungary had been making significant progress in many important sectors including reduction in reliance on coal and natural gas and new water treatment facilities. However, energy supply, air pollution and water quality are still defined as the main challenges. Further recommendations include developing more challenging targets for reducing GHG emissions by analysing economic, environmental and social impacts, promoting sustainable use of fertilisers to reduce diffuse water pollution from agriculture and continuing to increase the share of population connected to the sanitation infrastructure.

Environmental governance

The main challenges concerning environmental governance and management is the limited role of the private sector and shortage of local capacity which is partly caused by the increased management role of central government and environmental responsibilities at the central level. As a result, public involvement on draft environmental legislation and public's environmental awareness are limited. Even though the number of inspections and detection of violations are declining over the past years as a result of strengthened environmental laws and regulations, regulatory non-compliance is high, particularly in water and nature protection. OECD's recommendation contains introducing sector-specific regulations, strengthening the

implementation of strategic environmental assessment (SEA), promoting green business practices and encouraging public participation.

Green growth

Environmental tax revenue of Hungary is 7% of total tax revenue and about 3% of GDP, which is relatively high compared to other countries. The country has allocated significantly larger amount of funding to wastewater management and waste management compared to air pollution abatement, biodiversity protection, R&D and others.

Several improvements in regards to green investment and eco-innovation can be found including implementation of a renewable energy support scheme (METAR), increased focus on eco-innovation and growing amount of revenue from environmental goods. On the other hand, Hungary's declining business environmental investment, decreasing employment and spending only 5% of its government research and development budget on environment and energy related research could also decelerate the country's ongoing transition to greener economy. OECD suggestions on green growth incorporates improving the design of environmental taxes, reconsidering cost-effectiveness of national public spending on environment related infrastructure, moderating energy prices and increasing public R&D funding.

Waste, material management and circular economy

With comparatively low material productivity, there are possibilities for efficient use of resources to produce wealth. *Hungary's municipal waste generation and its share of landfilling have decreased significantly.* Separate collection, recycling and recovery of municipal waste still remains as big challenges in many areas even after the mandatory separation of paper, plastic and metal municipal waste introduced in 2015. The review covered strengthening the involvement of municipalities in waste management planning, improving the ongoing separate waste collection and introducing specific measures for glass recycling as possible recommendations.

The rate of the landfill tax introduced in 2013 is frozen at 2014 levels which is allowing the limitation on the market signal to further divert waste from landfills. National waste management tariff for households were reduced in 2013, which could lead to potential long-term financial difficulties for both municipal waste management and waste businesses. Increasing the tax to encourage waste recovery and recycling is recommended.

Although there are many remarkable achievements in regards to decreasing waste generation, improving the waste management infrastructure and promoting recycling, Hungary lacks an institutional co-ordination at the national level as there are only several voluntary circular economy initiatives and projects in the private sector. The National Environmental Technology Innovation Strategy includes 2020 targets for sustainable resource management, but they are not integrated with policy measures in

different sectors. A whole-of-government approach is needed to accelerate towards circular economy.

Since the last review made in 2008, the country has seen significant improvements in areas of concern and at the same time there are many areas that could be improved.

3.1.6.2 (Continuously) altering waste management in Hungary

In Hungary the waste management questions are managed by different sectoral ministries (it belongs partly to environmental, partly to public service and partly to regional development issues). The main effects on the waste management can be traced back to the year 1995, when the first environmental law was accepted. By this law the local governments got the responsibility of collection and treatment of locally generated waste (MSW). It resulted in a very fragmented waste management system in Hungary, because of the high number of local governmental units (i.e. more than 3200).

In the Hungarian governmental system the NUTS 2 regions do not have governing positions; they are functioning as statistical-planning units (for receiving EU funds) only. At NUTS3 level we can find counties as public administration units, but they didn't (and don't) have real intervention role in the waste management. They had development and spatial (physical) planning roles. Consequently, the Hungarian waste management system lacked the co-ordinator and integrator functions for a long time.

Due to the new European waste directives, the Hungarian central government accepted the new Waste Act in 2012[23], which fixed the definitions of waste types and introduced the waste hierarchy (the first step is the prevention that is followed by the preparation for reuse; the recycling; the other forms of reuse (energy production) and at the end of the hierarchy is the disposal).

In the background, from 2010 there was a very strong centralisation process within the total governmental area (only few functions/tasks have remained at local governments), which reaches the waste management sector, too. A new coordination organisation, the NHKV Plc. (the National Coordination of Waste Management and Asset Management Plc.) was founded in 2016 to rescale the total waste management system. In 2016 the NHKV Plc. accepted a new regional optimisation plan (OHKT 2016) for the waste management public service provision. The most important effects came from the new Hungarian Waste Management Public Service Plan that is the top-down regionalisation ('integration') of the public service providers in Hungary. There were more than 110 organisations in 2016, while the targeted number is only 20-22 units. The another main aim of the NHKV was the introduction of the new, integrated, standard invoicing system for waste public service, which has been fighting ongoing operational problems since that time.

[23] The Act CLXXXV of year 2012 on wastes.

However, on the other hand, in Hungary, the local municipalities have the right to make contracts with the waste management public service providers. From 2013 this contractual freedom of local governments has been limited. From this time they can make just one, integrated contract for the waste collection and the waste management. At the same time, from the waste treatment side NHKV Plc. could limit (to 20-22 actors) the number of accepted, accredited, potential contractors (as public service providers) of the local governments.

From 2017, the secondary raw materials and residue-derived fuels (RDF) collected (and selected on site or afterwards) by the household sector are owned by the state (NHKV Plc.) and not the local/regional public service providers. (Secondary raw materials collected from private sector are still under market conditions). Nowadays, as a result of the new legislation, the local governments have the responsibility of waste management at local level, but they cannot manage the local waste alone. These conditions don't help the spreading of circular concept at local level. However, many of the major companies, which use the secondary raw materials as resources, can buy large amounts from these materials from the NHKV (via public procurement procedure), and they do not depend on the limits of the regional waste market any more. From one point of view of the main local actors, the city and the public service provider lost their economic interest in the area of better selective collection or secondary raw materials. Without this interest, and without local companies which have own interest to reuse, recycle or minimise the waste there is no possibility to introduce the circular economy concept at local level. On the other hand, having regarded the spatial development strategies, main local/regional governments aim at the following: less waste, higher recycling rate, better pro-environmental attitudes of households and good quality of public services. For these goals we can find a good infrastructural background (thanks to the EU-financed hard infrastructure development projects of the sector), however, there is an unclear financial responsibility for the renewal of this hard infrastructure.

The main waste management goals come from the national sectoral strategic documents such as the National Waste Management Public Service Plans (OHKT 2016, 2017), where the economic sustainability, the profitability of the sector and the centralisation and the integration of the management are defined.

The priorities of the Hungarian Waste Management Public Service Plan were (OHKT 2016):

Preserve the achievements of the cost reduction programme of the state (household tariffs).

1. Ensure a uniform quality of waste service in each region.
2. Regional equalisation at the public service provision level.
3. Sustainable finance of the waste management public service provision.

The targeted selective proportion within the total MSW was defined at 28.95% level by the Waste Management Public Service Plan for 2017 (OHKT 2017, pp. 42). The current Hungarian average is very far from this level with the level at 13.81% in 2016, but in Pécs this proportion reached the 18.9 percentage in the reference year (KSH 2018).

Other indicators defined by the Waste Management Public Service Plans (OHKT 2016, 2017) are as follows:

- the minimum level of reused or recycled part of packaging materials (glass, plastic, paper, metal) of households is 50%;
- the minimum level of the reused, or recycled, or recovered part of the (non-dangerous) demolition waste is 70%;
- the maximum level of landfilled biodegradable waste proportion is 35%;
- all of the households must be reached with the selective collection opportunities until 2015 either using door to door method or big communal containers.

3.1.6.3 Food waste management in Hungary[24]

Waste management around the food industry in Hungary focuses to implement change through two current strategies: namely the "Food Chain Safety Strategy 2013 - 2022" and "The national waste management plan 2014-2020".

The first one aims indirectly to contribute for a more conscious food-waste management; it is centred on those activities that generate the waste and, involving all the actors of society, the focus effort is to enhance their responsibility, behaviour, and awareness. One key is to preserve food quality, so therefore the strategy pays increased attention to the production process, to the operation of the monitoring system, to efficient communication between actors. The logic behind it is that better quality of food would mean less food waste.

"The national waste management plan 2014-2020" draws up the objectives with regard to comprehensive waste management for the given period. Importantly, it makes a distinction between "by-products" and "waste". Special attention is given to make the corporate practices more sustainable. Among others, this plan favours enterprises that are using Environmental Management System, supports R&D sector to promote waste prevention, and strongly orientates them towards charity purposes to eliminate waste.

Two market based instruments, the "corporate tax benefits for donations" and the "exclusions of the value added tax from donations" have major effects on food waste. Both of these have helped to improve the use of food surpluses in charity purposes. There are on the other side, legal regulations to be mentioned that might not exclusively have positive effects. The "Regulation of food hygiene requirements for public catering

[24] Based on http://www.reducefoodwaste.eu/situation-on-food-waste-in-hungary.html

(37/2014 (IV.30)" can cause some waste creation through its "minimal portion size" regulation. Also the "Act on the food chain and its regulatory supervision and monitoring" (National Act n° XLVI/2008) might result in food waste, as it claims that the manufacturer is responsible to determine properly the indicated "best before" and "use before" dates on the product that does not always work out properly. "Regulation on the usage of food-waste for feeding animals (Regulation 75/2002) (VIII.16.)" forbids animal feeding with food waste. The last to mention is the "Hungarian Food Book (Codex Alimentarius Hungaricus)" that basically prescribes the appropriate food quality within the whole supply chain. Although many institutional initiatives support waste reduction, at the moment "*In Hungary, there is no legislation specifically addressing food waste reduction"*. Food Bank does operate within the nation, through which charity purposes are feasible.

3.1.7 Waste sensitivity

3.1.7.1 Household sector

In Deliverable 3.2 (Grünhut et al., 2017) we outlined SSCA-1 (the first phase of the Secondary Socio-cultural Analysis) based on data obtained from Flash Eurobarometer 388. The elaborated composite index of Waste-conscious Behaviour (WCB) comprised an 11-item variable about various waste-related individual perceptions and attitudes. Accordingly, the WCB index used individual responses which were later aggregated at national level (for details, please, see: Deliverable 3.2 of the REPAiR project). In the WCB-rank of the EU member states Hungary's score (5.90 from the 0–11 scale) was much below the EU mean value (6.89); it was the lowest among the case studies' scores. SSCA-1 then examined the WCB mean values also at regional level in order to find out if there are relevant spatial differences. In the case of Hungary, the inquiry presented that there are no significant regional differences at NUTS-2 level (Figure 6).

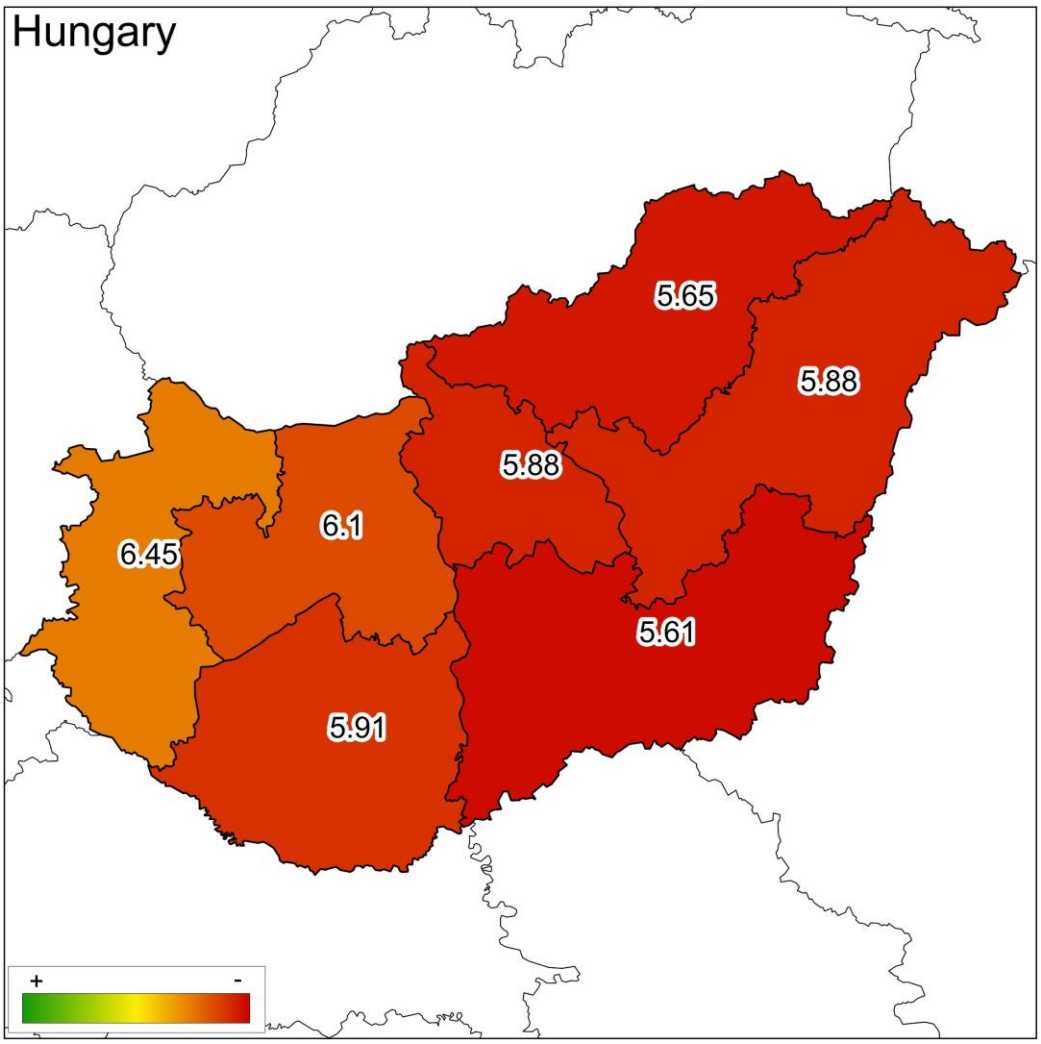


Figure 6: WCB indices in Hungary at NUTS2 level
Source: Our calculation based on Flash Eurobarometer 388 data

3.1.7.2 Corporate sector

As it is described in the Deliverable No.3.2 of the REPAiR project, corporate environmentalism refers to the recognition and integration of environmental concerns into a firm's decision-making process, and it is one way how a business entity can address environmental issues (Banerjee 2002). Firms' pro-environmental behaviours can be twofold. One of them is 'externally' regulated (by a meta-governmental, governmental, local governmental organisation). The other one – that is more important from the point of view of environmental consciousness – is self-regulatory mechanism. It is attributed to a variety of different motives (and as an interdependent phenomenon, 'understanding what really motivates corporate environmentalism is important for policymakers, since the effectiveness of government environmental policies depends in large part on how corporations will respond to them' (Lyon and Maxwell, 2004, pp. 16). The latter approach (self-regulatory mechanism) is usually manifested in the use of environmental management systems such as the EU's Eco-Management and Audit Scheme (EMAS) and the International Organization for Standardization's ISO 14001 quality management system (Hillarya and Thorsenb, 1999; Neugebauer, 2012). The first

version of EMAS was issued in 1993 while the first version of ISO 14001 was launched in 1996.

'ISO 14001:2004 specifies requirements for an environmental management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects.' ISO 14001:2015 revised this management system including more strict regulations for firms applying for the certification[25].

Concerning the ISO database in 2016 Hungary had 1,969 ISO 14001:2004 certificates and 264 ISO 14001:2015 certificates. The number of firms (2,233) with (both type of) ISO 14001 certificate means that almost 1.8% of the ISO 14001 certificates can be found in Hungary from Europe. The trend in these certificates shows an increase (Figure 7).

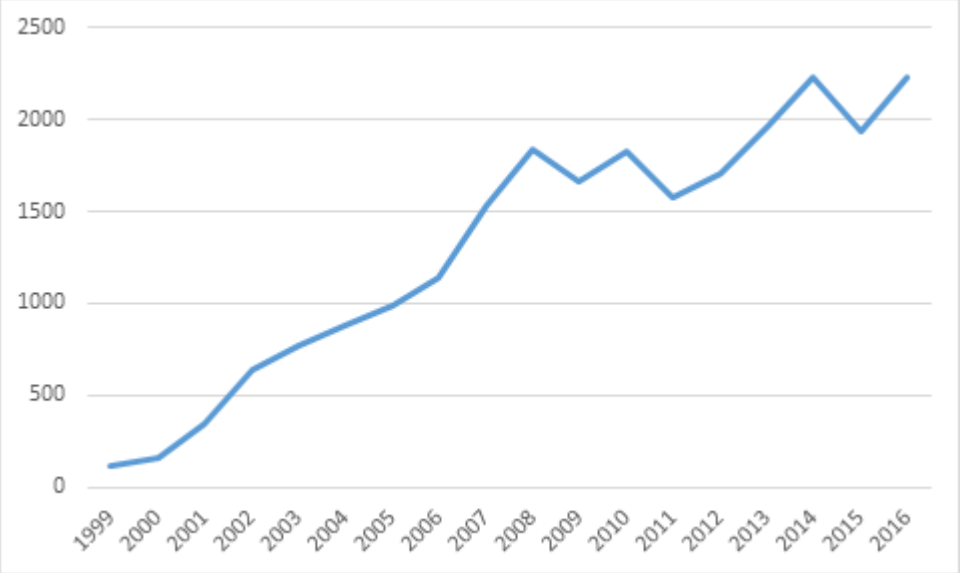


Figure 7: ISO 14001 in Hungary (1999-2016)
Source: https://www.iso.org/the-iso-survey.html

Having regarded the EMAS database, 12 certifications are reported at the first quarter in 2017 for Hungary in the EMAS central database. Recently (in December 2018) the EU EMAS webpage[26] is reporting about 48 sites and 25 organisations bearing EMAS certificates, while the Hungarian EMAS webpage shows[27] 30 certification holders. Irrespectively of the real number, it can be said that the number of EMAS certifications in Hungary is significantly low. Concerning Herner (2018) the main reason is that bearing EMAS has no benefits for the companies either in tendering procedure or in market competition, or in case of control by any authority. Parallel with this the reputation of EMAS is far low comparing to ISO 14001 (Herner, 2018).

[25] www.iso.org
[26] http://ec.europa.eu/environment/emas/register/reports/reports.do
[27] http://emas.kvvm.hu/company.php?l=

Concerning a survey in 1998-99, Hungarian companies were already committed to environmental management in that early phase of environmental certifying processes. One of the reasons (but not solely) was the high rate of investments of Western European companies (from the end of 1960's) and they brought their 'environmental-conscious culture' (Málovics et al., 2007). It also means – according to another examination – that big multinational (and national) companies were in the forefront of certifying processes, and on the other hand, international standards in connection with sustainability were relatively less widespread in Hungary (Ransburg and Vágási, 2007). Besides, they also viewed economic factors as motivators for the introduction of an environmental management scheme, including the positive effect on corporate image. On the other hand, environmental sustainability or protection appeared as a low level factor in motivations (Málovics et al., 2007). Besides that, another survey revealed that medium-sized and small businesses considered the costs of acquiring certification and of the application of the standards too high. Furthermore, the lack of state regulation (including financial incentives) cannot support the increase of environmental management scheme adoption in Hungary (Ransburg and Vágási, 2007). Csutora and colleagues' (2014) examination revisited the issue of the motivation factors of corporate environmentalism (via certification) later on. Their results showed that Hungarian companies were more sceptical towards the benefits of the implementation of corporate sustainability/introduction of environmental schemes. This is especially true with regard to the prospective positive impacts on cost reduction, innovation, employee motivation as well as enhancing and safeguarding corporate reputation (Csutora et al., 2014, pp. 105).

3.2 Spatial and socio-economic analysis – Pécs and the surrounding region

In our analysis the county of Baranya (NUTS3 level) is the 'region'. It is the frame, the compact entity that surrounds the city of Pécs and its agglomeration (focus area) and they have interrelation in spatial development. Baranya county has also spatial development plan (and decision-making power in development) while the upper level of NUTS (2 – South Transdanubia) is only a statistical region without decision-making power or self-governance.

In this chapter we are analysing the city of Pécs and its agglomeration as the focus area, however, sometimes – because of the availability of data and for a deeper understanding of flows – we are focusing on Pécs as a sample area. Once we are talking about agglomeration, we use the delineation of the Hungarian Statistical Office in 2014[28].

[28] http://www.ksh.hu/docs/hun/xftp/idoszaki/mo_telepuleshalozata/agglomeracio.pdf

3.2.1 Geographical situation and the natural environment

Baranya county is situated in the so-called South Transdanubian region of Hungary. It is bordered by Somogy, Tolna and Bács-Kiskun counties, and the southern border which is also the Dráva river.

Historical changes, hand in hand with environmental factors, have played an important role in the recent socio-economic situation of the county of Baranya. In the Roman times, Danube River was a military objective (parts of the limes-system had been built alongside the river) with settlements with military function. Later on, the Hungarian conquest led to prosperous agriculture and increasing population. The first significant depopulation started due to outer causes – after the conquest by the Ottoman Empire, these settlements were destroyed and their infrastructure was demolished. In these times, the area was a border region between two large empires. Later, in the 17th century, immigration had started so a huge number of Swabian people arrived at Baranya county, which contributed to the multi-ethnic character of the area. In the middle of the 19th century, the rail network took over the role of the rivers as it had become the primary and most effective way of transportation, which also affects the settlement system. After 1920, there was a large change of the development of the area – the Austro-Hungarian Monarchy collapsed and the former Baranya county split up into two parts: Baranya on the Hungarian side and Osijek-Baranja on the other. After the Second World War, both sides of the border were part of communist systems but with differences (Bálint et al., 2018, pp. 14).

In order to understand the recent socio-economic and environmental situation, it is essential to extend the focus and take into consideration the borderline position of Baranya county and describe the cross-border situation/history in a nutshell. (Pécs is situated only 30 km from the Croatian border.)

Being a border river, the Dráva cuts the cross-border area (that is called Baranya county on both sides) into a Hungarian and a Croatian part. Along the Dráva River, both sides of the border area are historically peripheral, characterised by poor economic performance. Between 1920 and the end of the 1980's the Dráva-region was almost perfectly closed. During the Soviet era both countries were subject to socialist ideology, however, former Yugoslavia was not part of the Soviet ascendancy area. Because of the very strict border guarding only local citizens or a person with permission could approach the border area, including villages nearby the border. The whole area had a very unfavourable position in terms of investments due to the geopolitical risks on the Hungarian side and the Yugoslavian civil war in the 1990's. In the past 25 years the trajectory of the development of this cross-border area differed from other parts of "the mother-countries" (Rácz, 2016; Varjú (ed.)., 2014, Varjú 2016, pp. 86).

The concept of Dráva, as energy resource, appeared during the 19th century already, during the era of the Austria-Hungary Monarchy. There were several concepts to build a hydroelectric station in the border region of Hungary and Yugoslavia (Croatian part),

however an intergovernmental negotiation was achieved only at the end of the socialist era (in 1988). After the (Hungarian) systemic change (1989) Hungary turned towards an environmental related direction. Due to this turn, Croatia decided to build a power plant at a farther point of the border. The negotiation and debate between the two countries (hydroelectric power station vs. nature protection and environmental interests) took until the middle of 2000's, once Croatia turned towards the EU. From the 1990s high attention has been drawn to natural protection in this area. The Danube- Dráva National Park (and Directorate in Pécs) was established in 1996 in order to pay high attention to the natural heritage (Figure 8 and 9).

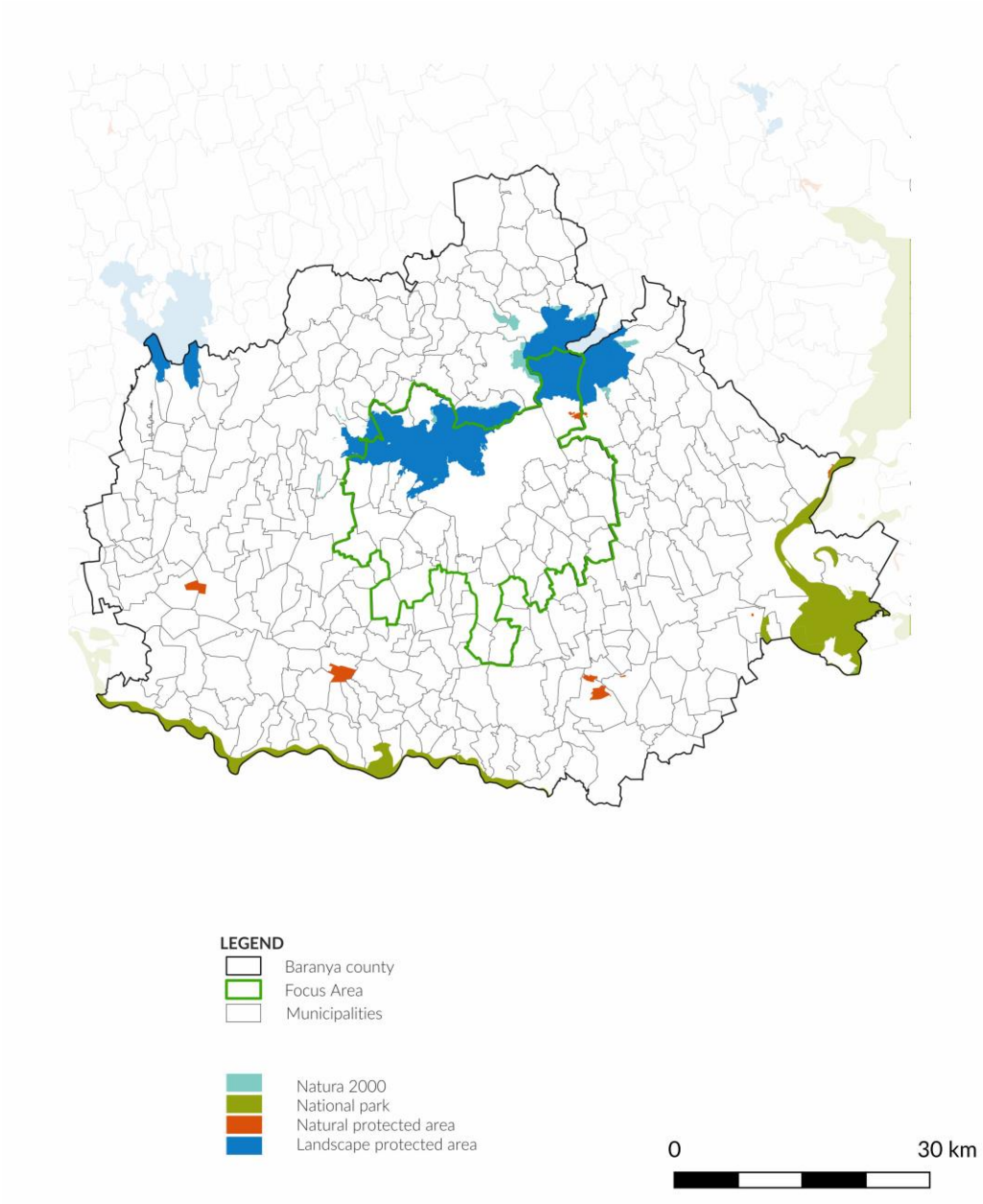


Figure 8: Natura 2000 and nationally protected areas in Baranya county. Source: Natura 2000 and Hungarian nature protection databases

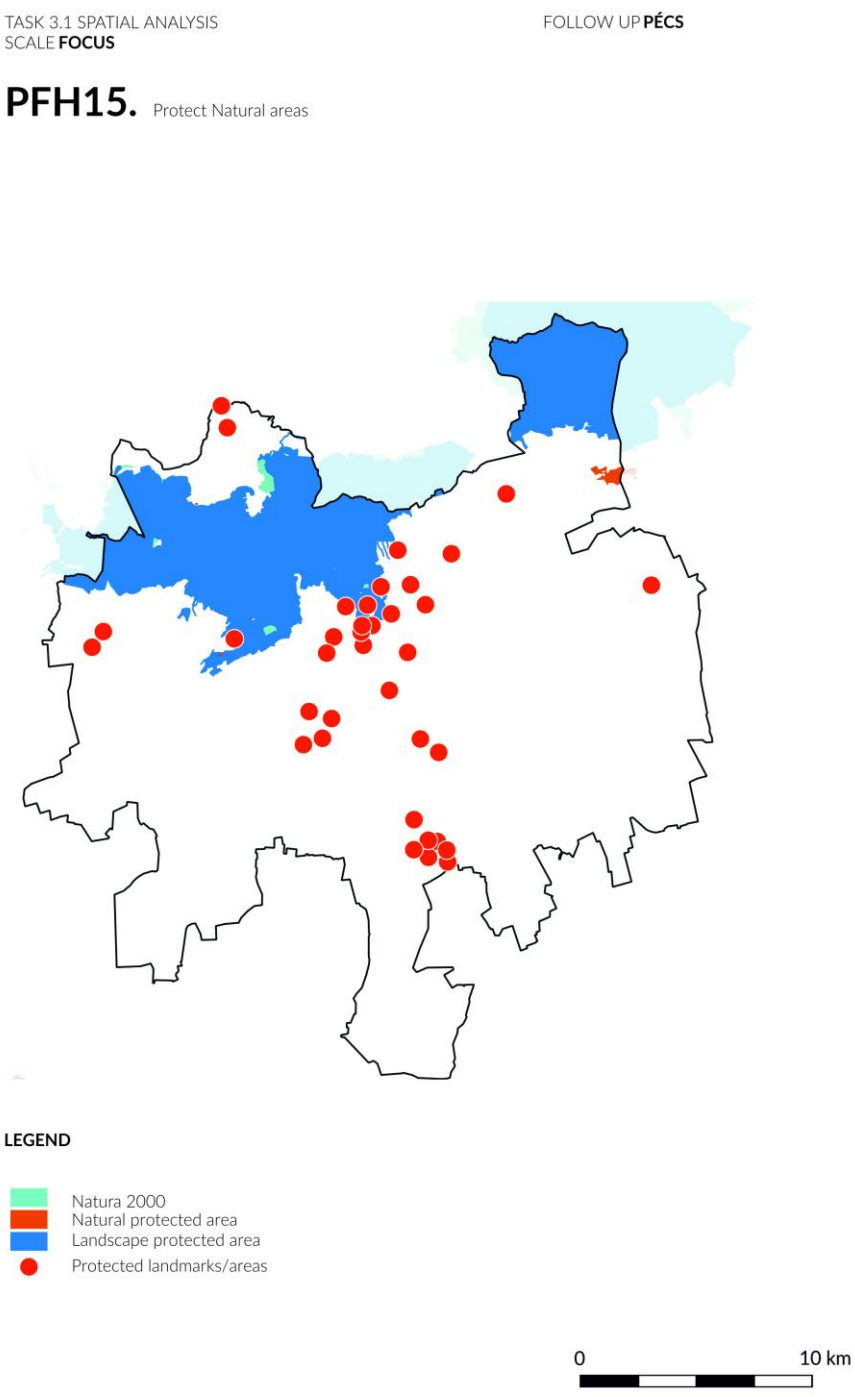


Figure 9: Nature protection sites in the Pécs agglomeration (2017)
Source: Natura 2000 and Hungarian nature protection databases

Almost 20% of the county is Natura 2000 area (Figure 10) and 7.7% is under high national nature protection. With 66 sites, 0.5% of the county has local (natural or cultural) protection (Varjú (ed.), 2014, Varjú, 2016, pp. 86-87).

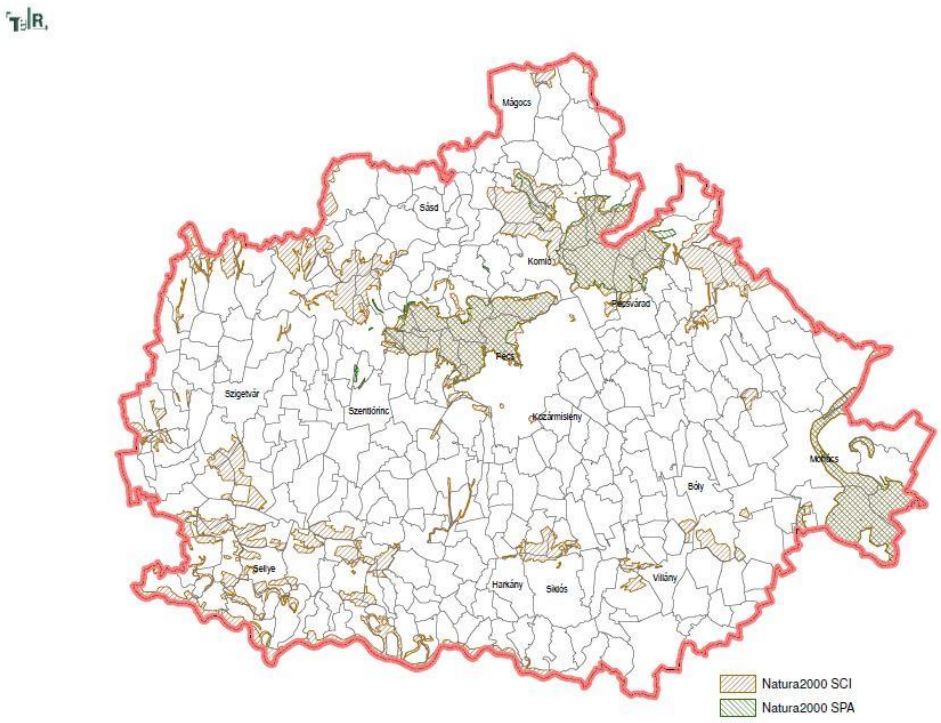


Figure 10: Natura 2000 areas in Baranya county (2017)
Source: TeIR

The county has 10 smaller administrative units (Mohács, Pécs, Pécsvárad, Sellye, Siklós, Szentlőrinc, Szigetvár, Bóly, Hegyhát, Komló LAU1 units), and altogether 391,455 inhabitants. It is a geographically diverse area, and – similar to the county – the northern part – of the county and of the Pécs agglomeration too – is dominated by higher elevation (with the highest peak of Mecsek, 682m), whilst the southern part by plain (Figure 11, 12).

Figure 11: The natural environment of the county.
Source: Corine2012, SRTM90 http://srtm.csi.cgiar.org/srtmdata/

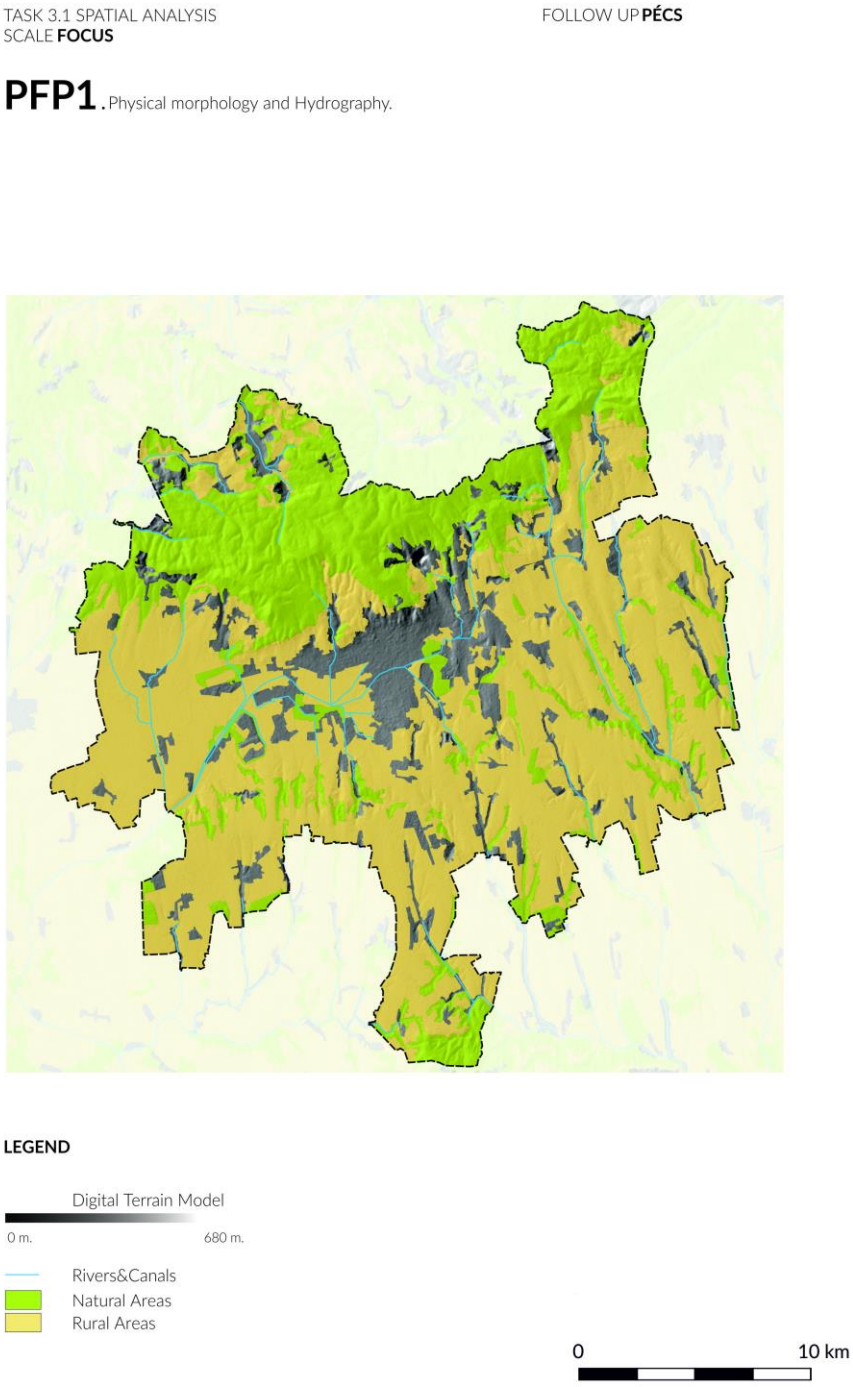


Figure 12: Morphology of the Pécs agglomeration
Source: Corine2012, SRTM90 http://srtm.csi.cgiar.org/srtmdata/ EU-Hydro River Network, 2016 https://land.copernicus.eu/imagery-in-situ/eu-hydro/eu-hydro-public-beta/eu-hydro-river-network

The county is considered as periphery and disadvantaged in social and income aspects (Pénzes, 2014), with its centre Pécs that is having disproportionate role in the employment of Baranya. The overwhelming role of employment of Pécs means ca. 15,000 commuters daily (Keresztes and Tésits, 2008, pp. 111). The population of the county is constantly falling from the 1990s, largely down to the outward migration[29]. It has 'inner peripheries' as well. The settlements of the county, and especially its small villages near the border, are one of the most disadvantaged areas of the country (Alpek and Tésits, 2014). Taking into account the dependency ratio it can be seen that moving away from the city (in the agglomeration), the ratio is increasing (Figure 13).

[29] http://www.ksh.hu/docs/hun/xftp/idoszaki/nepsz2011/nepsz_03_03_2011.pdf http://www.terport.hu/webfm_send/4171

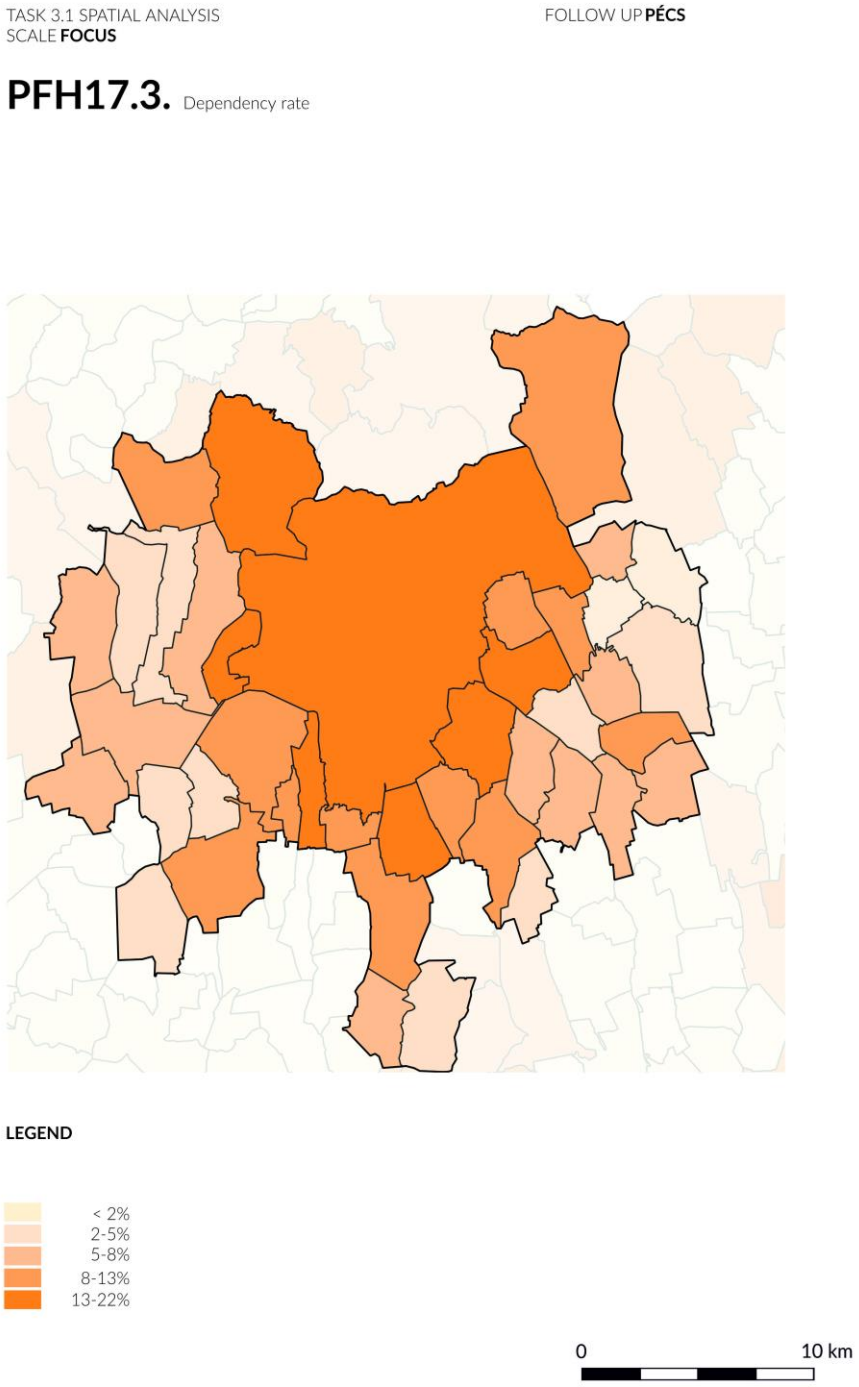


Figure 13: The dependency ratio in the Pécs agglomeration (2011)
Source: KSH TeIR, 2011

Mining began in the region since Roman times. But this time it meant the mining of quarrying for the construction works. These were typically local interventions. The coal mining of Pécs started in the 18th century. In the beginning of the 20th century larger

volumes, deep cultivation and intensive coal production started (Faragó et al., 1997). Since, the turning point for Pécs, to transform it into a big city that plays a dominant role, took place in the beginning of 20th century, with the step that it became the organisational and production centre of the black coal found in Mecsek mountain. This move, however, went well beyond economic restructuring; as it "greatly affected the city's traffic, its society, its built environment, general economic development, cultural and spiritual life" (Pirisi et al, 2009, pp. 3). From the second half of the twentieth century, besides coal, mining the uranium ore also contributed the city's dynamic growth. However, the process of the decadence in mining was unavoidable, due to the decline in the role of coal as the consequence of post-industrial era, and environmental consciousness that came with it. This process was quite progressive though, it started in 1991 and the last quarry was closed in 2004. The remaining elements of the mining heritage that should be addressed by the city planners are the brownfields, land eroded mining town housing estates (*c.f. wastescapes in D3.3)* that the industry left behind (Pirisi et al., 2009) (Figure 14, 15).

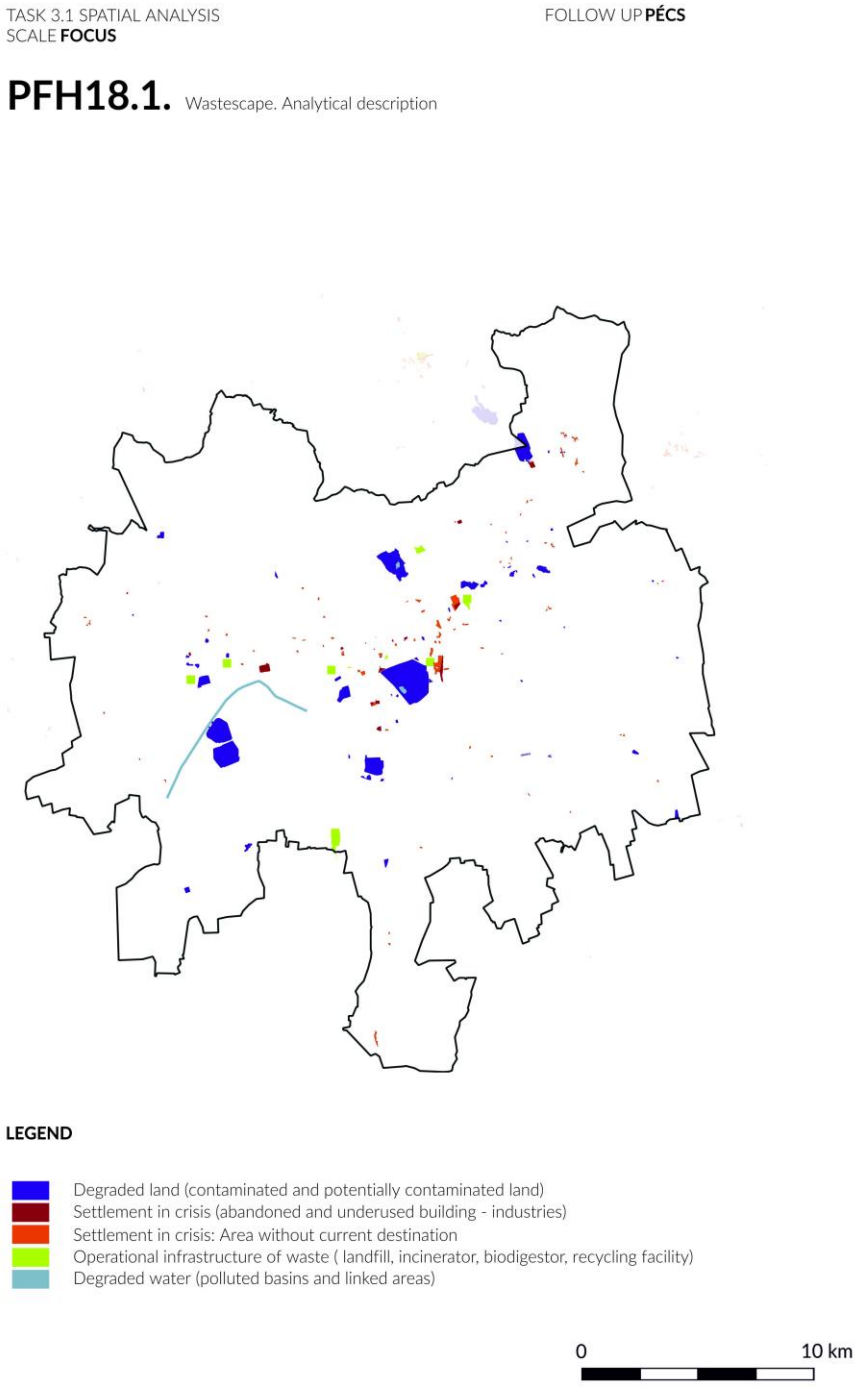


Figure 14: Wastescapes. Analytical description (Focus area); (2018)
Source: Own contribution based on PULL meeting

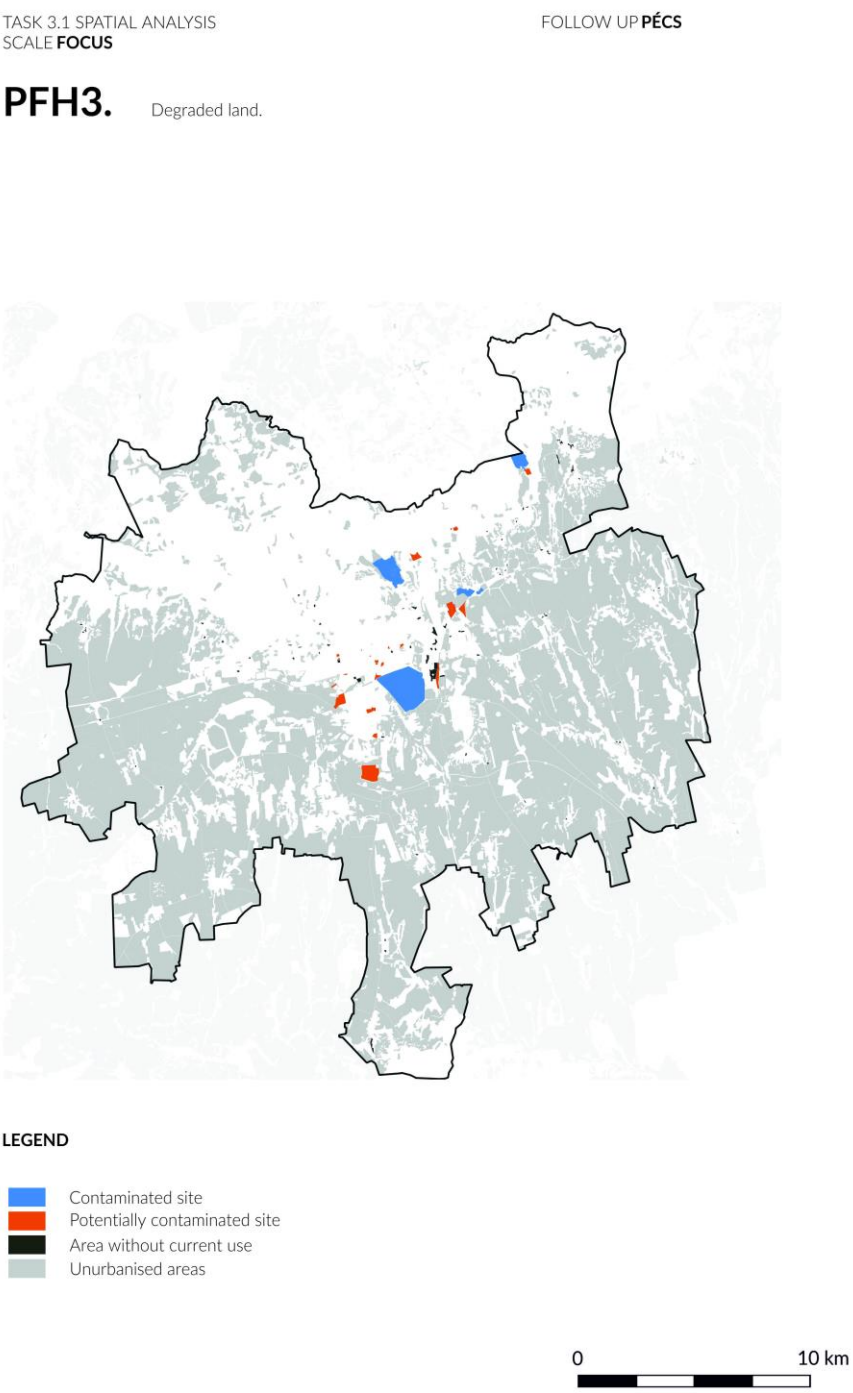


Figure 15: Degraded lands in the Pécs agglomeration (2012)
Source: Corine2012, UrbanAtlas2012, SRTM90 http://srtm.csi.cgiar.org/srtmdata/

The quite particular microclimate is worth mentioning as Baranya is the only area in Hungary that has climatic conditions with sub-Mediterranean character. The amount of

the annual sunshine hours varies between 1,800 and 2,000. The annual average temperature is 10-11°C, which varies according to the elevation. The annual precipitation is between 600-700 mm but it has annual changes. North Baranya has the highest amount of the precipitation – 750-800 mm. Convective precipitation in late spring-early summer can lead to flash floods in the mountainous areas, especially in the Mecsek Mountains (Bálint et al., 2018).

Location, climate and the basic effect determine the drainage system as well; the whole area belongs to the Danube's catchment area (Figure 16). In hillier places, like Mecsek, brown forest soils can be found. These humid places with lower temperature created medium quality soils. The most fertile ones are located in the south part of the county.

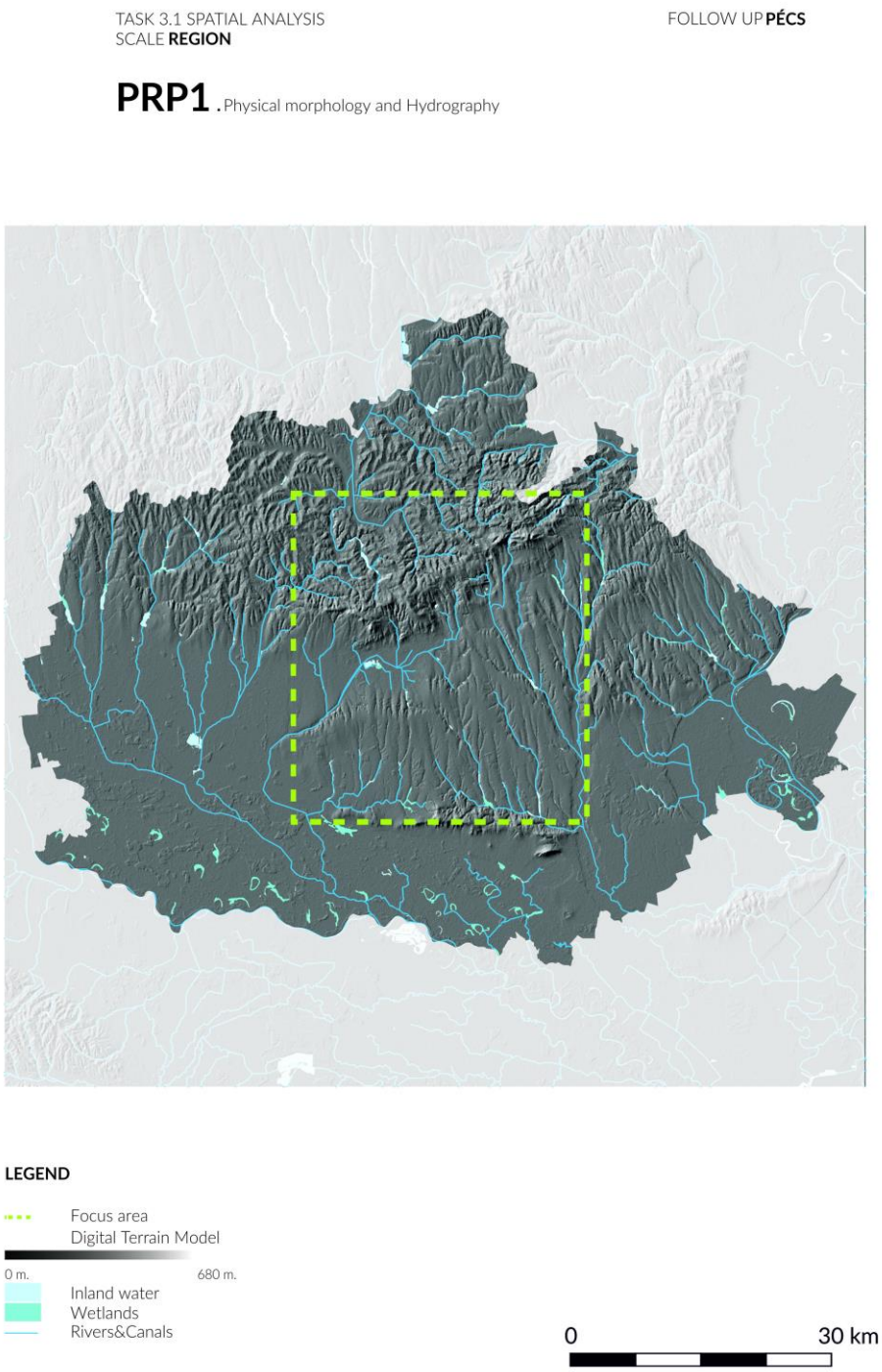


Figure16: Physical morphology and hydrography of Baranya county.
Source: Corine2012, SRTM90 http://srtm.csi.cgiar.org/srtmdata/ EU-Hydro River Network, 2016 https://land.copernicus.eu/imagery-in-situ/eu-hydro/eu-hydro-public-beta/eu-hydro-river-network

The county centre and regional hub Pécs is settled dominantly on Southern exposed slopes, taking advantage of its advantageous features (Gyenizse et al., 2008, pp. 24), located on the foothills of Mecsek, with its historical centre developed on the fluvial deposits of streams (Trócsányi, 2011, pp. 270). In aspects of the green areas per inhabitant, Pécs outperforms the quantity of Hungarian cities of similar size (Miskolc, Szeged, Székesfehérvár) which number is, however, significantly influenced by the Mecsek forests that are outside of the inner border, whilst there is a lack of green surface in the downtown areas, whereas the possibility to increase them – due to the monumental buildings – is very limited (Schmeller, 2018) (Figure 17, 18). Typically, the city has been expanding East-West way, whilst considering current trends major investment such as hypermarkets were built mostly in the southeast and western areas, in order to select their most advantageous location in favour of poolside, near flat surfaces (Gyenizse et al., 2008).

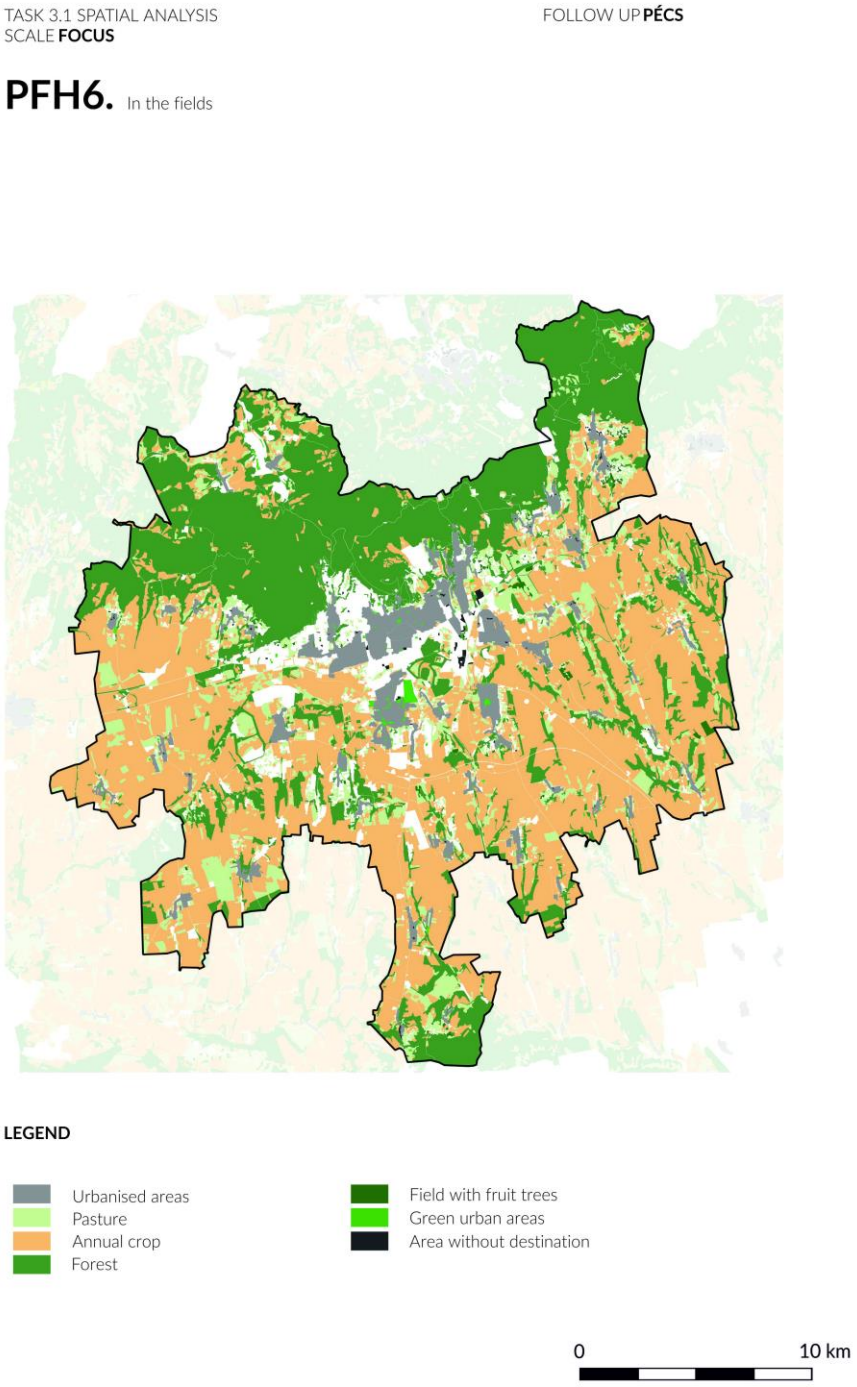


Figure 17: Land use in Pécs agglomeration
Source: Corine2012

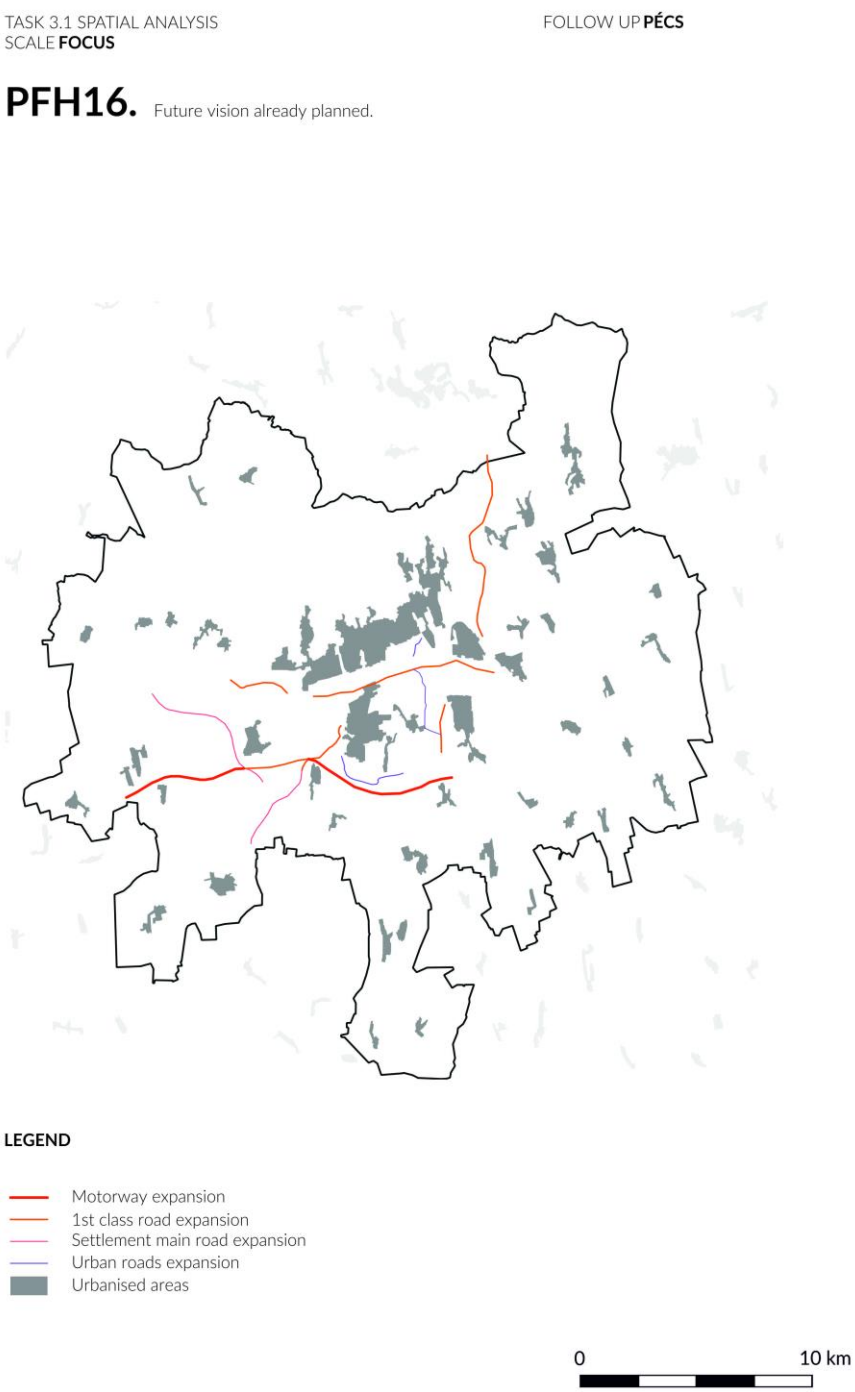


Figure 18: Future vision already planned in the Pécs agglomeration
Source: Corine2012, Physical Development Plan of Pécs 2018

3.2.2 Demography

Baranya shows significant demographic erosion continuously since the 1990's, mostly because of the outward migration tendency, combined with decreasing number of live births (which is reduced by approximately one hundred per year from year to year, and was 3,144 in 2016)[30]. These two factors result in such a loss of population that is even more intense than the demographic erosion of the national level. Even more so, the small village settlement structure – that is a characteristic of the county (Figure 19) – makes it even harder to stop the disadvantageous process. In this respect, the Sellye and Sásd micro-regions are experiencing the highest tendency of population shrinking. Aging is also very characteristic in the county (Figure 20). From the presence of nationalities and ethnics in Baranya the German, Croatian and Roma should be highlighted[31]. The median age of population is 43.8, the population density is 83.7 inhabitants/km^2 within Baranya[32]. Apart from the abandoned villages, those exceptional settlements that are characterised by population growth in Baranya are mainly situated 20-25 km from Pécs. The largest population growth happened in Keszü, Cserkút, Nagykozár, Bogád, where clearly the proximity of the metropolis could have been the trigger (Molnár, 2007). Apart from them, in the territory of Baranya county, the small village structure and population density that is way below national average dominates overly, as shown in Figure 21.

[30] http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do
[31] http://www.terport.hu/webfm_send/4171
[32] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=demo_r_d3dens&lang=en

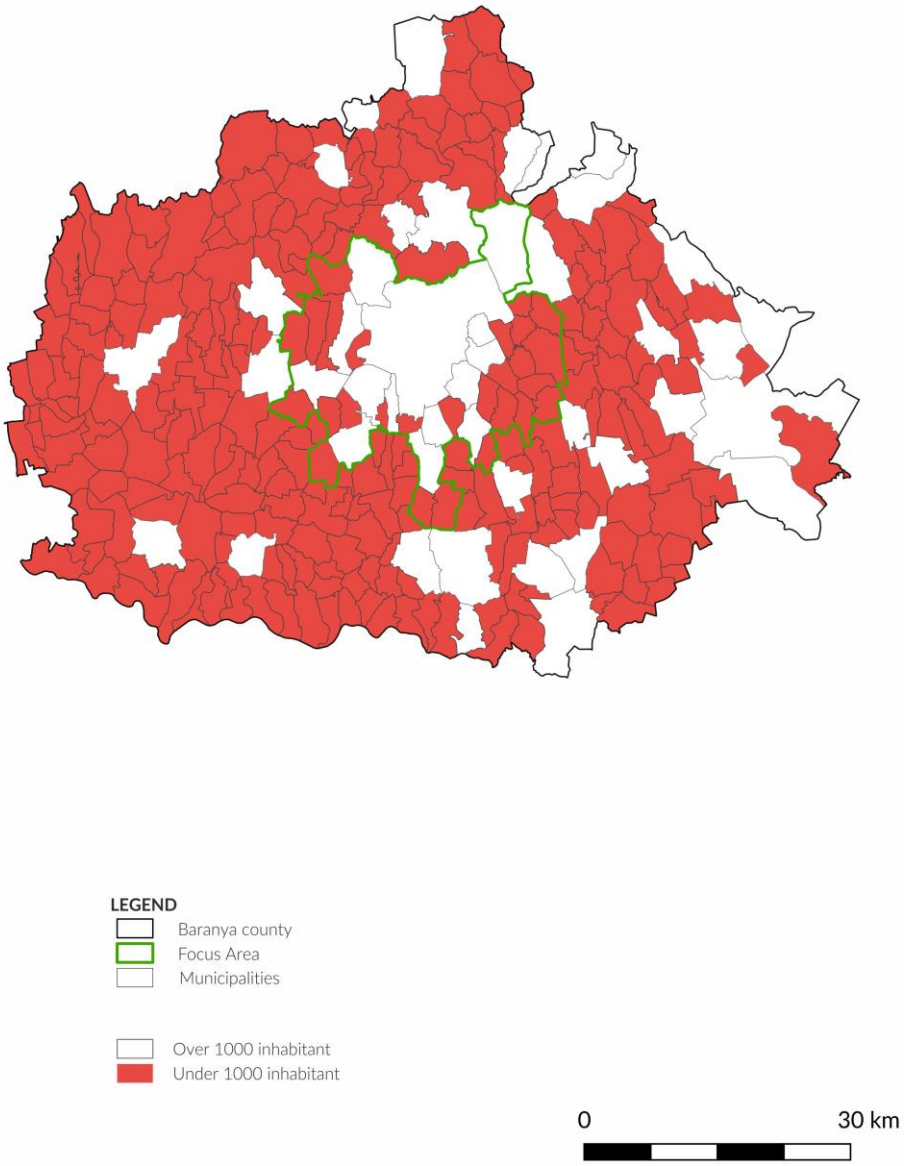


Figure 19: The distribution of small settlements in Baranya (2017)
Source: KSH TeIR, 2017

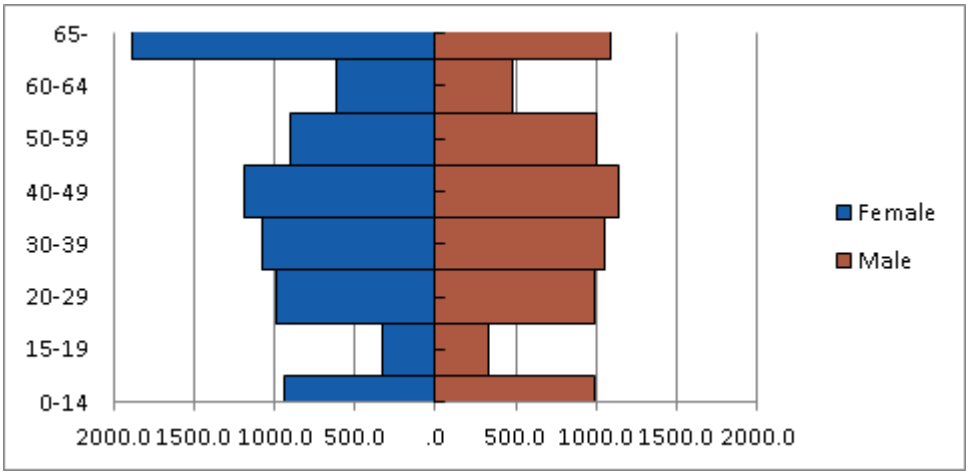


Figure 20: Pécs's population by age composition (2017)
Source: Own edition based on TeIR, KSH-TSTAR data
Note: The unusual partition of the figure intends to convey equality values

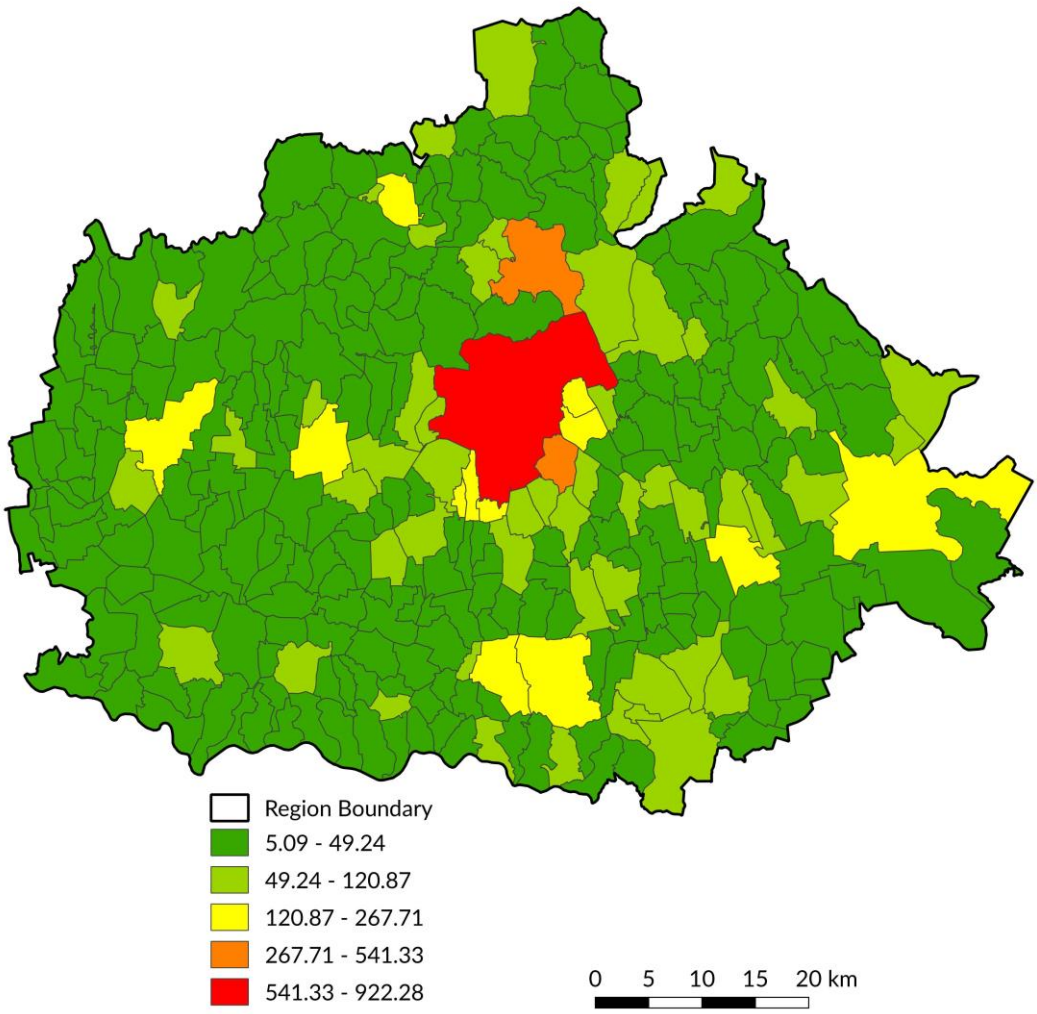


Figure 21: Population density in Baranya county/region (inhabitants/km^2) (2016)
Source: TeIR

There are significant differences in the number of permanent and temporary residents in Pécs, as during the autumn and spring semesters thousands of students dwell in the city. 'In Pécs and its area, for nearly two decades, the university is the largest employer and has about 25,000 students, of whom 17,235 students (PTE 2012, pp. 1) study day-to-day, so live their everyday lives (mostly in the period of study) in this city' (Gyüre et al., 2013, pp.1). The number of registered temporary residents isn't totally reliable, either, as students are not required to register their temporary address when they arrive at Pécs, so they do not do it in every case (Trócsányi, ex verb, 2015). The number of live births in Pécs was 1,091 in 2016, which indicator shows continuous decrease, in line with the national phenomenon. The economically active population means 69,042 people total, with slight male surplus (34,686) against 34,356 women (Eurostat).

3.2.3 Labour force

Since the unemployment crisis in the 1990s widened the gap among regions at different levels of development, the issue of jobless people has become a permanent problem in the rural areas of South Transdanubia (and in North Hungary), including Baranya county. The high share of involuntary entrepreneurship born in dissatisfaction was typical in the

area due to unfavourable economic and social trends during the 1990s (Tésits, 2004, pp.40). As for Baranya in the present, both the employment and economic activity rate lag behind the national average, and this tendency can be further enhanced by the process of shrinking in the number of its inhabitants[33]. Despite the negative effect of demographic erosion, the level of education among the population of Baranya shows positive tendency, the share of those holding higher education certificate (years 25 and above) increased to 17% since the last census (when it was 11%)[34]. Unemployment, at the very least, showed some decrease since the post-crisis peak in 2010 (10.4%) but stands currently with the highest (7.3%) rate in national comparison[35] (Figure 22, 23).

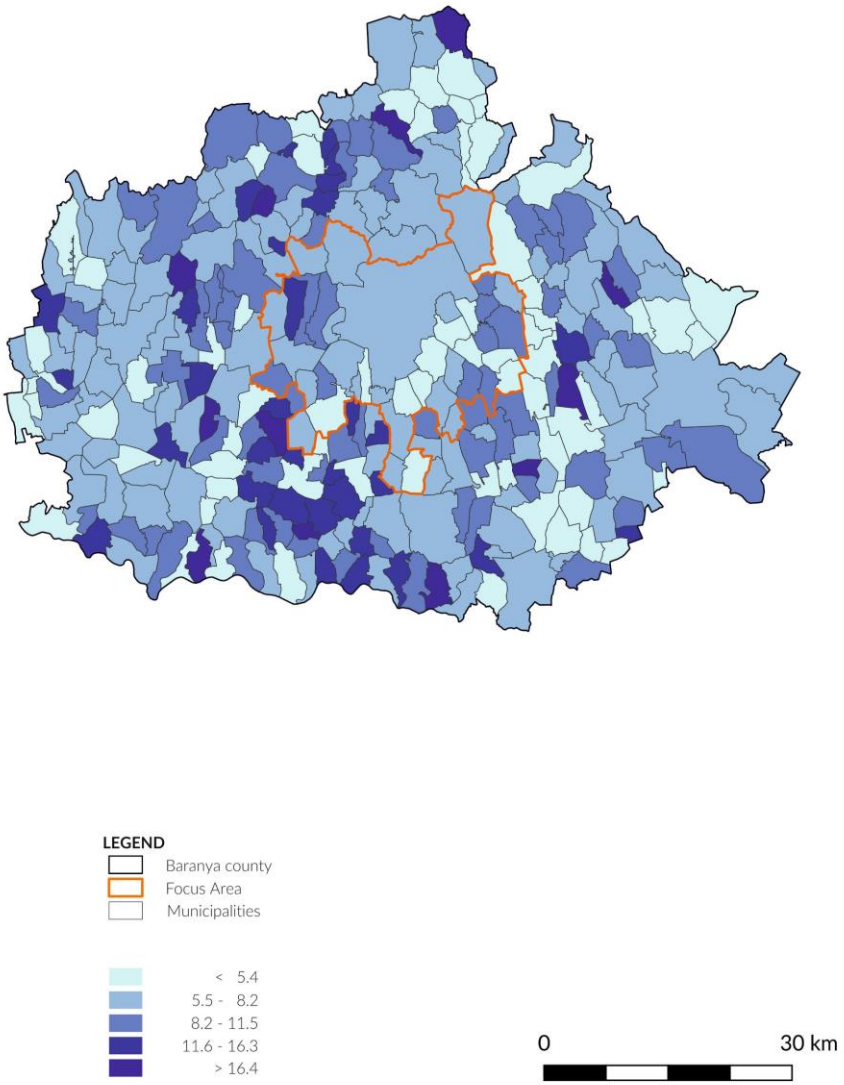


Figure 22: Unemployment rate in Baranya county (2016)
Source: Hungarian Statistical Office

[33] http://www.terport.hu/webfm_send/4171
[34] http://www.ksh.hu/docs/hun/xftp/idoszaki/regiok/mesz/02_ba.pdf
[35] ksh.hu

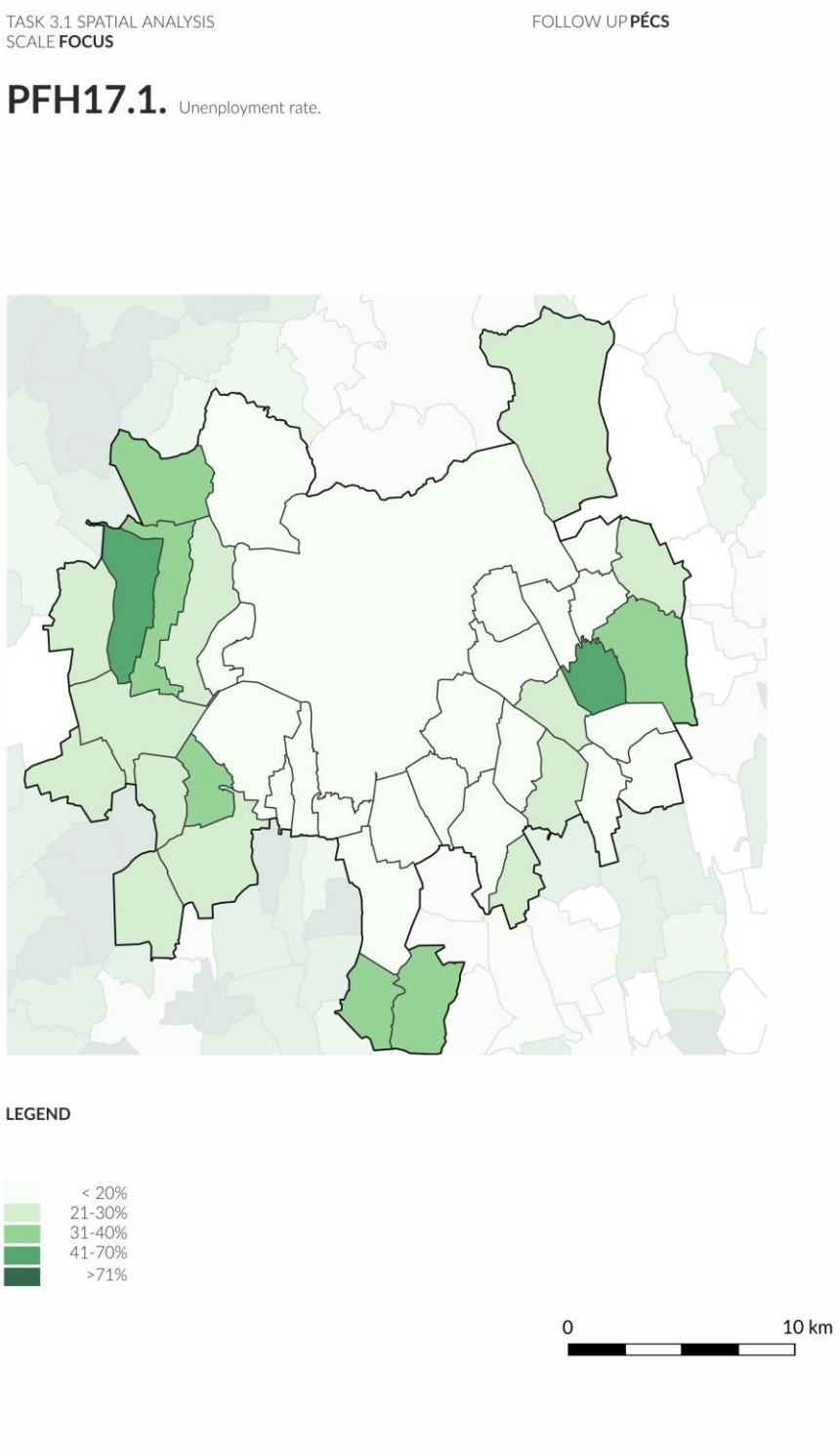


Figure 23: Unemployment rate in Pécs agglomeration (2016)
Source: Hungarian Statistical Office

The labour market participation per sector, when looking at Pécs – the centre of South Transdanubia and the capital of Baranya – along with the qualification indicators reflects a services-dominant employee demand and that the society and the economy shows a

movement towards services and knowledge based sectors[36]. Agriculture is dominating in the rural area around Pécs that is an opportunity (and partly existing phenomenon) to provide local food (and make the value chain short) for the urbanised city (Figure 24).

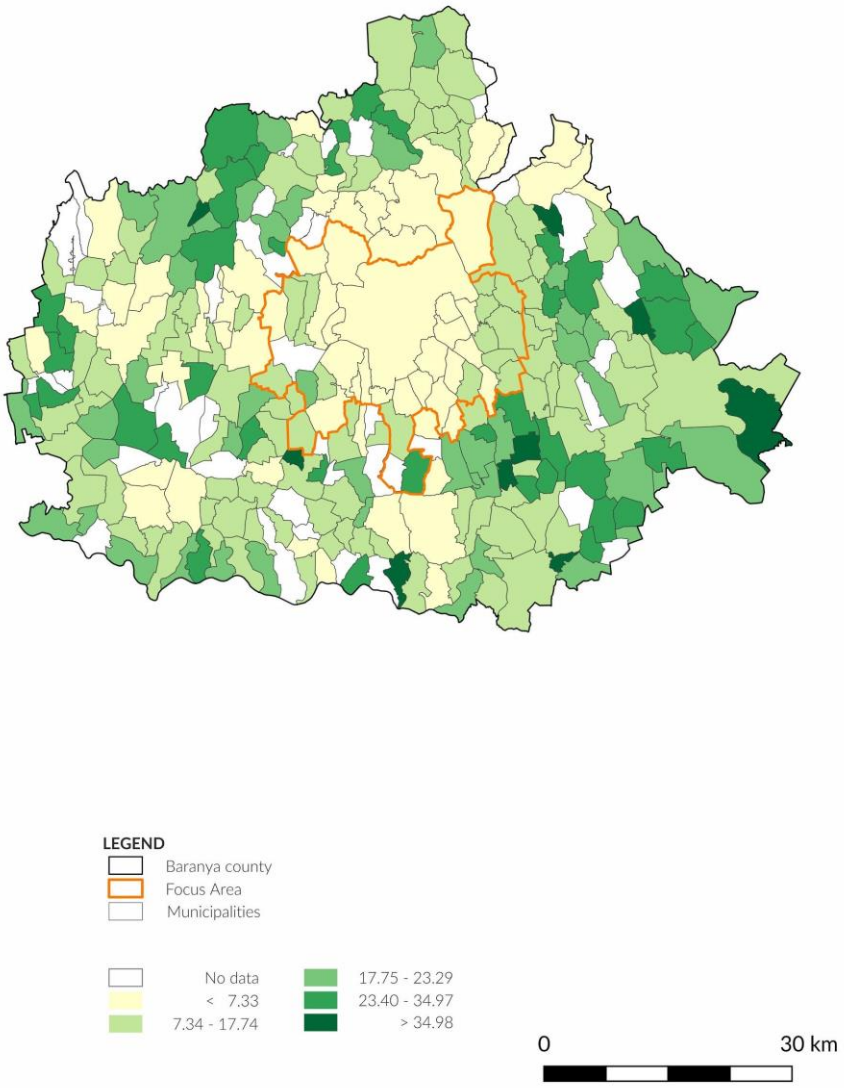


Figure 24: Employment rate in agriculture in the settlements of Baranya county (2016)
Source: KSH

In the city 78% of the employees work in services, 21% in industry and construction, and only 1% in the primary sector[37]. The overwhelming role of employment of Pécs means ca. 15,000 commuters daily (Keresztes and Tésits, 2008, pp.111). This over-representation is well illustrated in the following employment density map (Figure 25).

[36] http://www.ksh.hu/docs/hun/xftp/idoszaki/regiok/mesz/02_ba.pdf
[37] https://www.teir.hu/

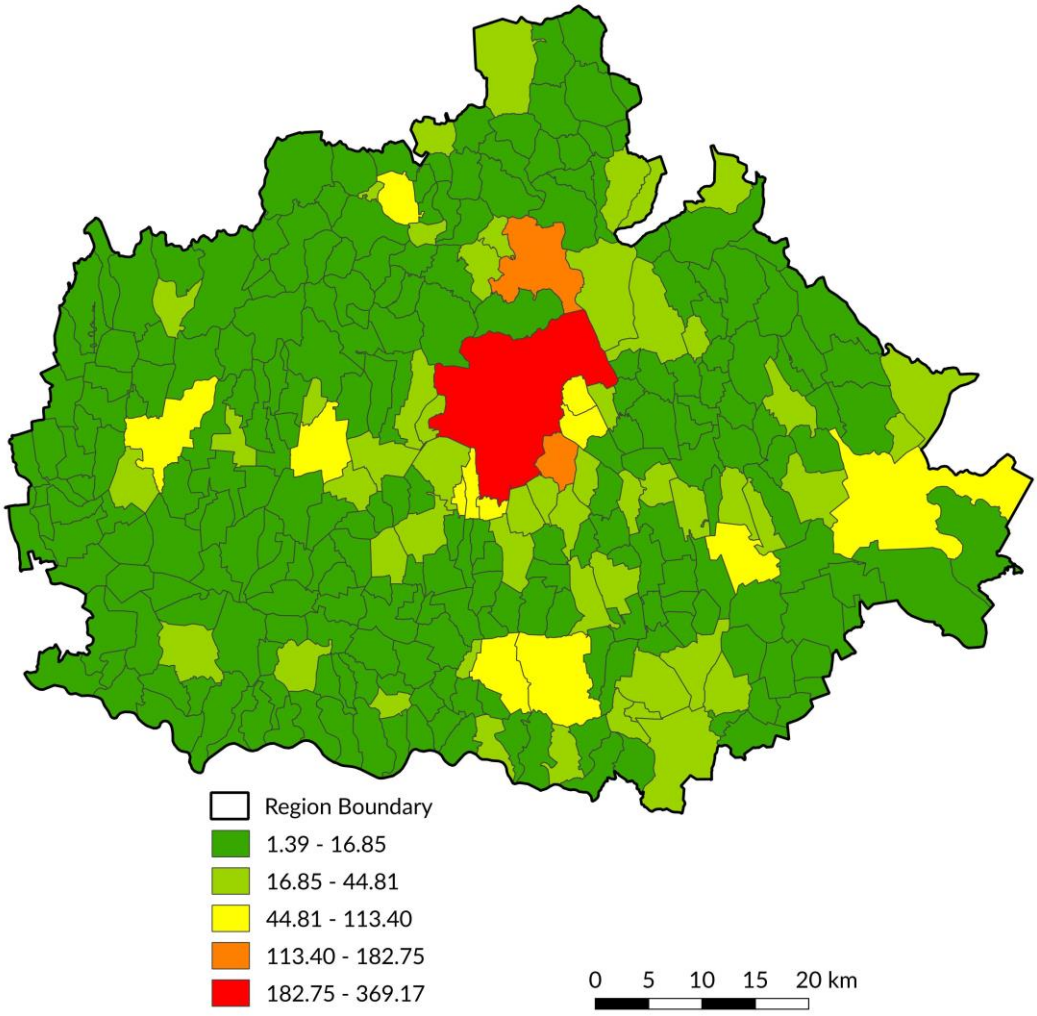


Figure 25: Employment density in Baranya county (employee/km^2) (2011)
Source: KSH Census

When looking at the education level of people aged between 25-65 in the Metropolitan area of Pécs, inhabitants with tertiary education represent 21.3% – which is higher than for Miskolc and Debrecen, both being regional capitals, same as Pécs – whilst the less than primary, primary, and lower secondary rate is 19%, and upper secondary, post-secondary non-tertiary 59.7% (Eurostat data). This rate seems high, especially in national comparison, but of those receiving higher education in technical and natural sciences is not satisfactory, neither is the share of skilled workers (Pais, 2009, in Lux, 2013). Therefore the opinion is that Pécs's innovative capabilities are good, but this capability is untapped. '*The partly conscious, partly spontaneous restructuring based on services and culture can be seen more as a path-dependent phenomenon and drift rather than guided strategy' (*Lux, 2013, pp.1). At county level, the lack of language skills is also a usual problem among the job seekers. The central ideas of county leadership do not fit the needs of a competitive economy, they prefer professions in the development of professional structure that enhance further economic peripheralisation, such as social

nurses and nursing (Lux, 2013). The most problematic area in the county is the so-called 'Dráva region', including the Sellye and Siklós units, right at the southern border with Croatia. This area is '*separated from the prosperous areas of the country by almost an insuperable gap*'. (Tésits and Alpek, 2013, pp. 7). Employment rate among working age demonstrated the depressed position of the region; it was 45.3%, in Sellye – making it the most disadvantaged micro-region on the Hungarian side – 49.2%. These areas struggle multi-factor renewal inability including the peripheral location, lack of sufficient infrastructure, social capital, education qualifications (Tésits and Alpek, 2013).

Unemployment in the Metropolitan area of Pécs means 11,800 people between the ages 20-64 years old. Narrowing for Pécs, the total number of registered unemployed were 3,598 people in April 2018[38]. Among them, the share of those with primary and secondary school education is the most significant. According to TeIR[39], the latest census demonstrates 12,851 people working in industry and construction, 691 in agriculture and forestry, 46,518 in services.

3.2.4 Economy

Within industry, the extractive industry had a peculiar importance in Pécs in the second half of the 20th century, but in the second half of the 1970s, the need for structural change was formulated. At the end of the 1980s, the local economy was characterised by the overwhelming role of the extractive industry and on the other hand by the labile light and food industry, and the building materials industry was equally dominant. Although mining difficulties occurred in the 1980s, the economic structure did not change much in the decade. The only positive trend was the gradual advance of the tertiary sphere, which partly depended on the emergence of modern business services (Faragó et al., 1997). In 1987, 36% of the city's industrial employees worked in mining, more than 20% in the light industry, more than 16% in the food industry, more than 10% in the engineering industry[40].

In Pécs, following the change of (socialist) regime (1989 in Hungary), the most significant change was due to industrial restructuring, which affected the northern areas of the city taking into account the physical geographic conditions. First, after the mining of the deep-mills and then at the millennium, the closure of the remaining excavations did not only result in a large reduction in the number of employees (the tens of thousands of people in the 1980s dropped to 199 in 2001[41]), but led to the emergence of large brownfield areas. (For instance, in the northern periphery of the city, active mining was taking place for more than three decades, between 1968 and 2004, and there was a time when more than 400,000 tons of coal were produced annually. As a

[38] https://www.teir.hu/
[39] https://www.teir.hu/
[40] Statistical yearbook of Baranya county, 1987
[41] Népszámlálás 2001. Területi adatok – Baranya megye, 2003.

result, a massive 80 m deep mining fountain was built, at the bottom of which, as a result of rainwater, a 28-meter deep lake was formed.)

As a result of the structural transformations following the end of the socialist era, due to the setback of mining industry, the city of Pécs – as well as its "hinterland", the South Transdanubian region and the county of Baranya – found itself in economic crisis. This crisis is, even currently, decisive for the whole region, as it struggles with catching up in several aspects (Trócsányi, 2011). There is a sharp contrast between Baranya's underdeveloped subregions and inner peripheries and its city areas, especially concerning Pécs. Eight of Baranya's micro-regions are disadvantaged*, of which 3 belong to the most disadvantaged group. This means that, apart from the Pécs micro-region, the county's population lives in a disadvantaged area (that means 52% of the county)*[42].

Despite its size and potential, and the renewal of relationships after the end of the socialist era, the presence of Pécs can hardly be measured on the world markets, large companies are barely present (Rácz, 2008). In order to understand its current economic characteristics, it is important to look at the concepts "transitional economies" and "under-urbanisation". As for Pécs, the sudden changes in economic position, the lack of practicable strategies and renewed infrastructure made the city *under-urbanised (Sailer and Fliege, 1999); 'urban in its traditions and present size, functions, but with explicit signs of distorted socialist development" (*Trócsányi, 2011, pp.2.). For Pécs, the intention to tertiarise and to renew its economic significance, formulated through the idea of emphasising "cultural economy", taking advantage of its massive cultural background and potential, offered by its bishopric university, cultural infrastructure and heritage. This intention was put within the so-called "Pole Programme" in 2005, in which, besides cultural economy, the emerge of health and environmental industry were also envisioned. This aim, however, *was somewhat shaded out by the European Capital of Culture 2010 project, partly because resources for the former were re-allocated (T*rócsányi, 2011, pp. 10*),* they earned some improvement for the economy. Accompanied with winning title of European Capital of Culture in 2010, these programmes achieved the base for a potential supply chain through upgrading the cultural functions in revitalisation of the city, but, these actions did not fulfil yet a sufficient level of restructuring neither the regain in economic significance. In addition, the renewal was mainly implemented in the northern part of the historic centre, whilst the southern expansion of the revival did not take place yet (Trócsányi, 2011). Partly because of *reconstruction towards that direction failed due to missing resources (*Trócsányi, 2011, pp. 22), even at the current stage*, Pécs is full of problems to be solved* (Trócsányi, 2011, pp.23*.).* However, as we can see, the development strategy Pécs has chosen is definitely based on endogenous resources, something that is considered more adaptive (as it provides resilience) than the involvement of external capital (Martin and Simmie, 2010), which makes a debate about resilience and adaptive circles of the city. *The county is*

[42] http://www.terport.hu/webfm_send/4171 p.12

currently in the middle in national comparison in guest turnover per thousand inhabitants [43].

The GDP/capita for Baranya county was 12,471 in purchasing power standards (PPS) (2015) that was 43.2% of the EU28 average. This GDP value was similar to the NUTS 2 South Transdanubian region (12,785 in 2015) and it was far from the Hungarian average (that was 19,744, 68% of the EU average in 2015).

The engagement of R&D sector is somewhat controversial; whilst the region is first in the number of publications per researcher – thanks to the high-quality University of Pécs –, in R&D expenditures the region is in the last position at national level; the latter can be explained by the *lack of networking, networking with the corporate sphere, and developing entrepreneurial competence (*Farkas et al., 2015, pp. 71). *No strong relationships have been established with the local economy, innovation transfer lags behind the sufficient level. In the framework of the OTKA research of the MTA RKK 2010-2012, K81789 (*Somlyódiné, 2012*),* it is clarified that *the University of Pécs has not been able to undertake effective innovation transfer due to its disciplinary structure or organisational closedness (*Lux, 2013, pp. 2). The significance of the university is touchable in other ways within the economy; as Heindl (2014) argues, the University of Pécs *dispenses more money than the local government itself,* and the fact that *the presence of university students and their consumption create jobs for nearly 1,600 people, and 3% of Pécs's gross added value is due to this.* It tells a lot about the economic situation of Pécs (Heindl, 2014, pp.50, 59).

3.2.5 Transportation

Baranya is situated at the periphery in Hungary, therefore, the lack of sufficient transport network has long been a major obstacle in its economic development. Despite the fact that the road network of the county is above the population ratio, *the traffic conditions of the small village settlement structure are particularly unfavourable* (Lux, 2013, pp. 6). Earlier, there was a lack of connection to the motorway network, which was partly the cause of many problems for Baranya, such as isolation from foreign capital inflow, which enhanced its peripheral nature. The M6 motorway was built in 2010, but it is still deficient in some parts close to the border, and according to the prognosis, the continuation from Bóly to the southern border crossing will not take place until the 2020's. Within the county, transportation of the industrial parks dominantly occurs on public roads; which is due to the overrepresentation of small and medium size enterprises in Baranya that are specialised for small weight freight and where mostly door to door delivery is required. While domestic businesses use local rent transportation, the few foreign companies that are present in Baranya are more likely to use a larger transport company from beyond the county boundaries. The effect of the highway trail is ambivalent: it improves the connection between Pécs and Baranya to the capital city, but it does not reach the optimal route to the western and eastern

[43] http://www.ksh.hu/docs/hun/xftp/idoszaki/regiok/mesz/02_ba.pdf, p.39

outbound markets, there is no link to Austria and North Italy/Croatia. Until now, there is no concrete positive effect on the 'attraction of capital' by the motorway, although, the gradual nature of investment decisions and the effects of the crisis must be taken into account here (Lux, 2013, pp.9). Baranya has an airport in the borders of Pécs-Pogány, one that has received international scheduled flights since 2006, however, due to poor utilisation, since 2008 the number of these have gradually declined and almost completely disappeared. The problem with Pécs-Pogány Airport is that it *could only operate with too little utilisation or extremely low frequency, which does not make it economically sustainable in the long run,* it is because Pécs and its agglomeration does not have the "critical mass" that would allow the economical operation of international traffic *(*Mernyei, 2015, pp.24). In the absence of this, critical mass could be increased by the availability of a larger distance through the development of the aforementioned related traffic paths (highways, railway) (Bali and Szalai, 2013). Baranya's transportation infrastructure includes a 381 km length of railway lines, from which 22% are electrified, 1,717 km length of roads, from which motorways and highways are 3%, main roads make 15%, and other national roads 82% of the whole (Lux, 2013, based on the Territorial Statistical Yearbook 2010 data) (Figure 26, 27).

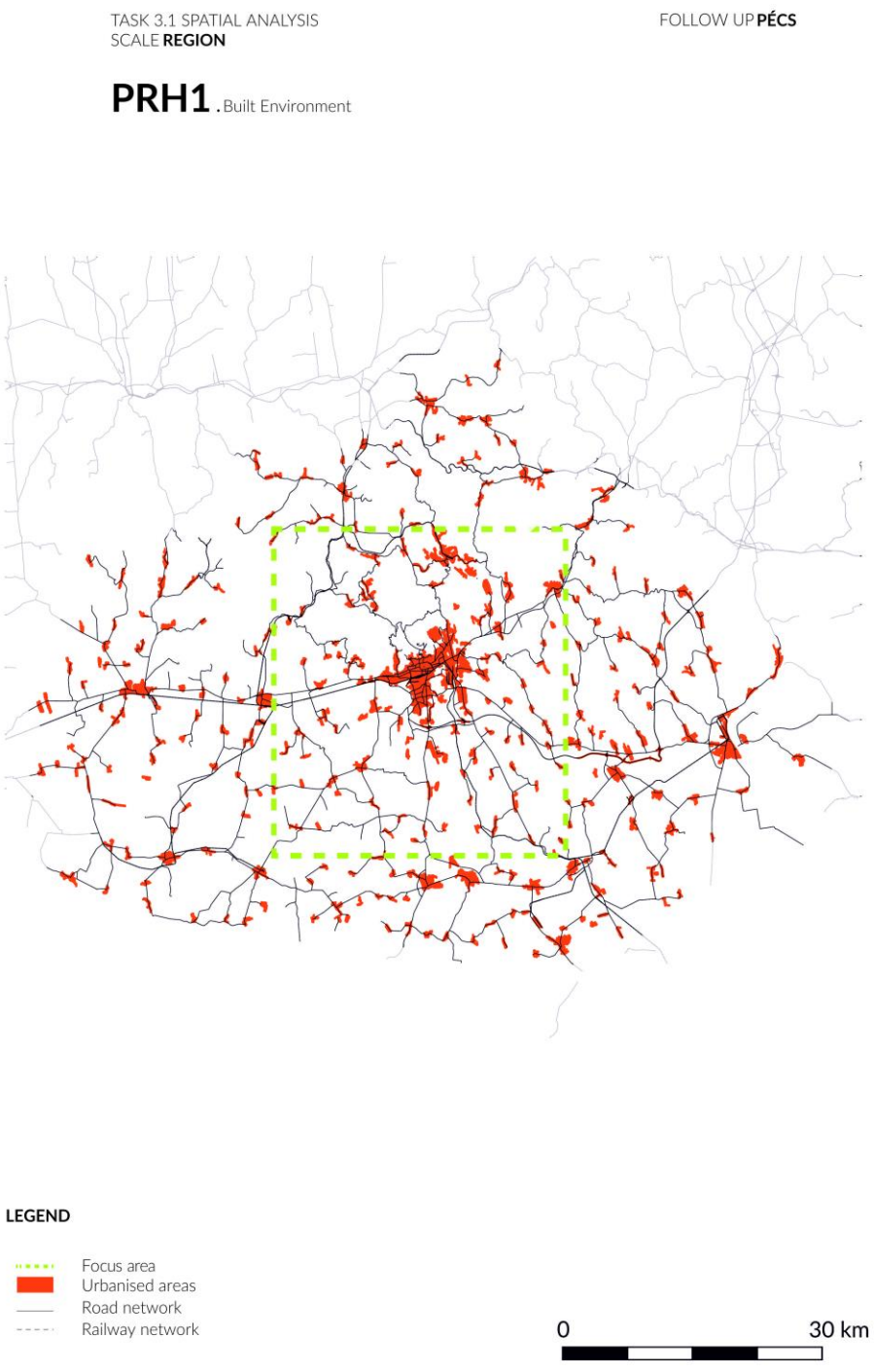


Figure 26: Road and railways network system in Baranya county (2012)
Source: OpenStreetMap, Corine Landcover 2012

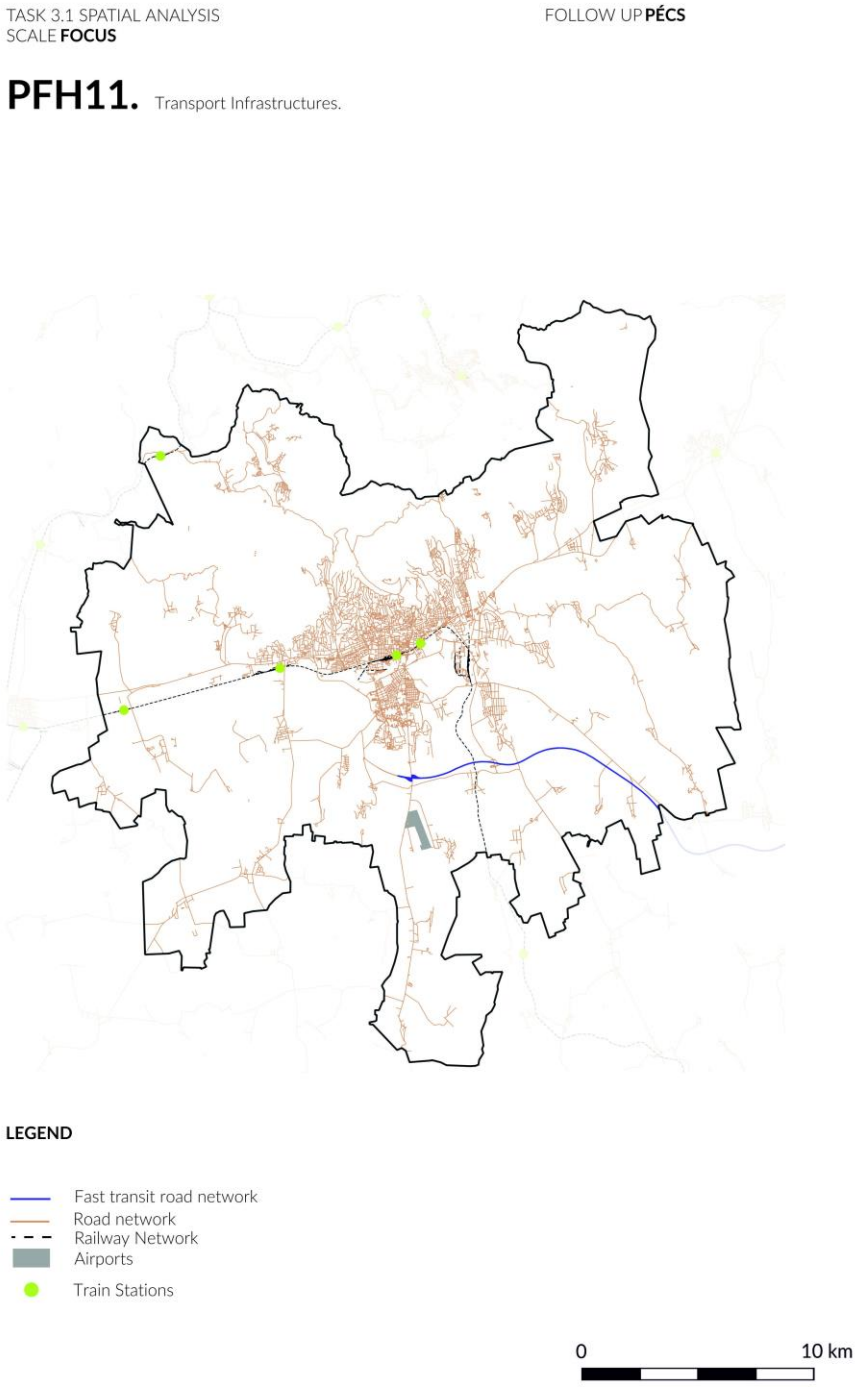


Figure 27: Road and railways network system in Pécs agglomeration (2012)
Source: OpenStreetMap, Corine Landcover 2012

3.2.6 Wastescapes

In the case of the Pécs agglomeration (as well), the generation of wastescapes are related to the main development trajectory of Pécs. The three main group of challenges were

1) the closed mining sites and their deposition areas;
2) the leftover military sites;
3) and the abandoned industrial areas.

Approximately three-quarters of the brownfield (wasted landscape) zones in Pécs in the early 1990s were somehow linked to coal mining. The territorial manifestation of the sector appears in the northern and eastern parts of the city, not only in the form of brownfields/wasted landscapes, but also in the image of residential areas in need of rehabilitation, which has a stochastic connection with the decline of the sector, providing a complex problem for the city.

Although the mining of uranium – after 40 years of extraction – stopped in 1997, the revitalisation of the dumping areas, especially the slop reservoir (Figure 28, site No1) is still a crucial issue with their effect through the water base. In order to secure a safe environment, the city has installed new monitoring wells for ISPA within two dozen points of the city.

The contamination of wasters (based on the Pécs Environmental Protection Programme 2011-2016, using the monitoring scheme of EU Water Framework Directive – 2000/60/EC) was an issue until the near past. Concerning this document, Pécsi-stream (Figure 28 – No2.) has 4 contamination points in the city, where cleaned wastewater falls into the stream.

The revitalisation of Carolina coal openwork (Figure 28 - site No3.) – closed in 2004 – has been a crucial issue until now. The revitalisation of the site started in March 2018, after a long negotiation and debate between the state and the main owner (of Veolia), as the landscape revitalisation is a common obligation of the Pannon Hőerőmű Co. (recently VEOLIA) and Hungarian state, which (both) captured the mine after the change of regime. (The magnitude of the work is indicated by the fact that a total of 9.6 million cubic meters of previously extracted waste material should be placed in a mining quarry. In addition, during the works, the drainage of the mining water and the filling of the pit should be ensured, and the entire area should be covered with soil of 40 centimetres thick and planted with plants.)[44] The revitalisation of the site would take 3 to 4 years.

[44] https://www.veolia.hu/hu/media/hirek-0/megkezdodott-tajrendezes-pecsi-karolina-kulfejtes-teruleten

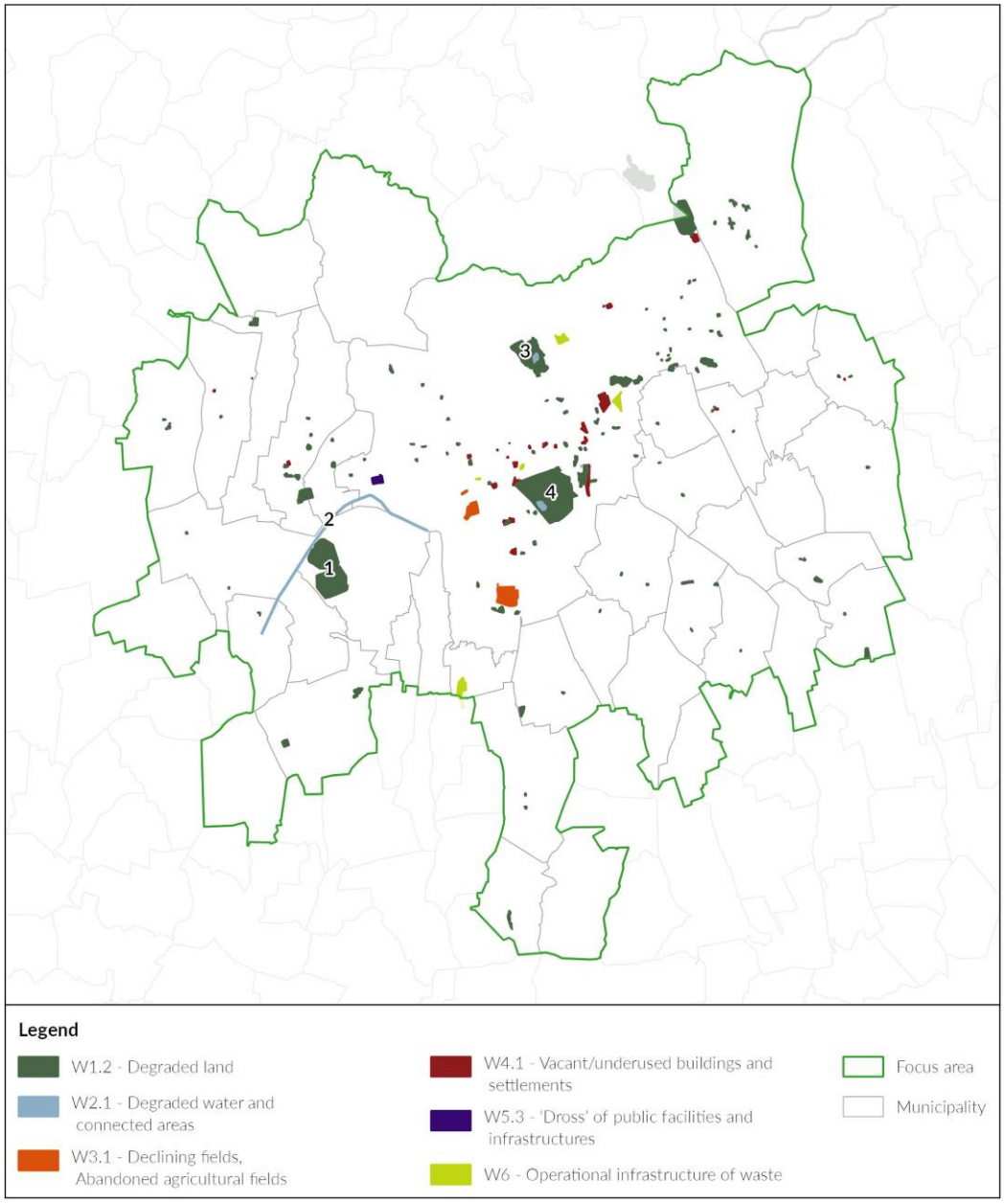


Figure 28: Wastescapes in the Pécs agglomeration (2018)
Note: 1) Slop reservoir for the former uranium mining; 2) Pécsi-stream; 3) Carolina openwork; 4) Tüskésrét

In the past decades several attempts were made for revitalising the above-mentioned and the mapped (Figure 28) abandoned areas (that also partly caused the

contamination of Pécsi-stream). Firstly, several of them were used for other purposes, mainly accompanied by foreign direct investments. Another part was regenerated by local governments and by the state using different development funds (e.g. PHARE or ISPA). However, Dannert and Pirisi (2017) argue that the regeneration projects implemented so far cannot generally be considered a success. Sustainability was not the main focus, the future of the areas was dominated by short-term interests. The result of the failed conversion can be observed in the reproduction and the emergence of second generation brownfields (Dannert and Pirisi, 2017, pp. 21), although there are good examples of revitalisation in Pécs as well.

The power plant and its depositing area

Along with the collapse of coal mining, something had to start with abandoned areas. In 1991, the elimination of the coal mines in Pécs started. The tasks involved not only the recultivation of buildings, but also the recycling of waste dumps. The reconstruction of a former (Pécsújhegy) dredger and its related areas played a major role in the establishment of the Pécs Industrial Park.

After the closing of the last coal mining site the local power plant changed their fuel, firstly to gas and arboreal biomass (in 2004), then a new (non-arboreal) block (with 35 MWp electricity capacity) was built (in 2013). However, a huge area – nearby the power plant – remains waiting for revitalisation. The revitalisation of some parts of the rubbish areas was started in 1974. With the implementation the Power Station entrusted the local forestry company. The goal was clearly to create a coherent green area, and not the production of wood. The question of the functional utilisation of the area was raised in the late 1970s. The primary goal was recreation, so the decorative tree species were planted during the revitalisation. The size of the forested area reached 150 hectares by the beginning of the 1990s (Papp, 1992). Besides these areas, in the 200 hectares sized landfill of Tüskésrét (Figure 28 - site No.4) almost 30 million tons of slurry consisting of slag from the bottom of the boilers and flue gas fly ash separated by the electro filters was deposited in cells during the roughly 50-year long coal firing period. After conversion to biomass and natural gas combustion the cells were not needed for depositing the by-products of coal firing any more. In the first stage, the power plant covered the slurry cells with ten centimetre deep topsoil, with this, however, rehabilitation was not completed, since the environmental authority required one metre deep topsoil. As the area is owned partly by the power plant, partly by the Municipality of Pécs, a written agreement describes the rehabilitation tasks to be performed. Under the agreement the 51 hectare slurry cell covered partially, i.e. with thinner layer than required, shall be rehabilitated with topsoil extracted from the enlargement of the existing groundwater lake. In the course of the project 850 thousand cubic meter earth was moved, which increased the barely five-hectare water surface of the lake more than four times. This made it possible for the municipality of Pécs to establish a city park for recreational purposes with a more than twenty-hectare water surface next to the city centre. Using EU Funds, the South Transdanubian Environment Protection and Water

Management Directorate has successfully submitted a tender for the support of the SUFALNET4EU, the main purpose of which programme is to establish the context for the sustainable re-development of the closed landfills. The physical land rehabilitation was financed by Pannon Hőerőmű Zrt. committed to environmental protection. In the city centre, only at a few hundred meter distance from Siklósi Road, a vast green area was opened, where a recreation park was established to provide entertainment facilities for water lovers, runners and families (Picture 1 and 2).

Picture 1: Wakeboard site at Tüskésrét (2014)
Source: Former website of Pannonpower Power Plant

Picture 2: Children playground at Tüskésrét (2015)
Source: Former website of Pannonpower Power Plant

Another 10 hectares deposit area was used for creating a 10 MWp capacity photovoltaic power plant right next to the recent working power plant. The 38 000 photovoltaic module can provide electricity for 3300 families and reduce the CO_2 pollution by 15,000 tonnes/year (Picture 3).

Picture 3: Photovoltaic power plant near the (recently) biomass based power plant (2015)
Source: Former website of Pannonpower Power Plant

Revitalisation with culture

The Zsolnay factory in Pécs was founded in 1853 by the Zsolnay family, and in particular Vilmos Zsolnay created the foundations for the development of the plant into the world-famous factory. Following some ups and downs, at the beginning of the socialist era (between 1948 and 1989) industrial porcelain was typically manufactured by the nationalised plant, and later the production of pottery and decorative porcelain was resumed. Its independence was restored in 1982, and since 1991 it has been operating as a joint stock company (Kovács and Markóné, 2005). The lack of use of some of the factory's buildings, as well as the decline in production and the decline in building stock in the 1990s, already called for renewal. After the turn of the millennium, especially in the spirit of the Zsolnay memorial year, these conceptual ideas were intensified. Already at that time, the maintenance of the rehabilitated areas for tourism purposes was maintained, with the partial operation of the factory. To this end, they tried to assign functions such as research and development, art-architectural higher education, museum-collection, hotel-hospitality. In relation to the possible functions, it was also necessary to create the financial resources of the operation during the continuation of the activity (Komor, 2005). During the preparation of the European Capital of Culture programme (which came true in 2010), participants in the preparational board met with European urban development strategies focusing on culture. Empty industrial buildings or entire factories have been revitalised through cultural and artistic activities. Since the

Zsolnay factory has obvious art history and cultural heritage value, it seemed obvious that the factory was to be revitalised. Thus, the plan of Zsolnay Cultural Quarter (Picture 4-5) was one of the five key projects in Pécs. The implementation of this huge project started in November 2009. As part of the Zsolnay Cultural Quarter, Zsolnay's porcelain factory, formerly used for most of the area, was relocated to the eastern part of the quarter. The vacant buildings were rebuilt, refurbished, the bad ones were demolished, and the factory was renovated with valuable monuments and vases. The Cultural Quarter was fully handed over in December 2011. Recently, Zsolnay Quarter has unique exhibitions featuring Zsolnay heritage. From his home in America, dr. László Gyugyi's collection came to the Quarter, an exhibition of nearly 700 ceramic objects estimated at two billion forints (approx. 6.2 million EUR) bearing the title Zsolnay's Golden Age. The earliest Zsolnay products are represented by the Pink Exhibition, about 1,200 pieces. These are complemented by the Family and Production History Exhibition. On the hill close to the Zsolnay Cultural Quarter, the Zsolnay Mausoleum, the Zsolnay family retreat, boasts 42 lions guarding the eosin secret. In addition to preserving the past, present-day presentations and contemporary art also play a major role, served by the M21 Gallery and the popular E78 Concert Hall where entertainers and theatre performers can entertain the audience. Visitors can choose from special local products at the Handicrafts Street. There is also a lot of interesting activities for children in the Quarter: outdoor playgrounds, Labour Interactive Magic Square, Planetarium, Wizard Clock (spectacular physical experiments), Bóbita Puppet Theatre and Herkules Workshop are waiting for young people[45].

Picture 4: Zsolnay Cultural Quarter (2014)
Source: https://www.zsolnaynegyed.hu/informacio

[45] https://www.zsolnaynegyed.hu/informacio/a-zsolnay-negyedrol

Picture 5: Renovated building in the Zsolnay Cultural Quarter (2014)
Source: https://www.zsolnaynegyed.hu/informacio

3.2.7 Development Strategy and waste sensitivity towards circularity

3.2.7.1 Environmental development

Although the city of Pécs does not have 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. After a few years of preparation, a new development concept was introduced: *Pécs Eco-City, Mecsek-Dráva Ecological Region Programme*. It meant that the city of Pécs, along with a number of settlements in the region, considered finding a more effective solution to the problems of environment protection and environment health as a high priority community task. The implementation of the ECO-CITY – ECO-REGION Programme was inspired by the wish to support the regional economic and social players as well as to develop an environment-conscious market and social approach. The essence of the ECO-CITY – ECO-REGION concept is that the elements of sustainable development become predominant in the course of regional, county and local development as well as city operation. Its goal is that the investments and development ideas already planned that originate from statutory obligations be implemented in a comprehensive manner, integrated into a single Programme, in order to mutually enhance each other's impact. The interpretation of ECO-CITY – ECO-REGION is that it is an area unit whose ecological footprint does not cross the boundaries of the available area, or if the ecological footprint of the area in question should exceed the available territory, then it does not secure sufficient supplies by raising its dimensions but by utilising methods that do not lead to increase its ecological footprint (Kiss, 2004).

Pécs doesn't have a sectoral plan for the waste management. The City of Pécs has not got Circular Economy concept just as the country has 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. However, Pécs makes a lot of projects and implements a lot of initiatives which could be considered as results of the Circular Economy or the Green City approach of the local decision-makers.

The issue of renewable energy and energy efficiency is not novel for Pécs. The fuel of the local power plant was changed from coal to arboreal biomass in 2004, and a new biomass block (burning straw) was built in 2013. The latest provide district heating for the city. The input material is coming from a 100 km circle, from the surrounding agricultural areas.

In June 2013 Pécs joined the initiative of the Covenant of Mayors, and with this the city leadership undertook that by 2020 the CO_2-emissions will be reduced at least by 20% in the area of Pécs, in addition, a Sustainable Energy Action Plan will be elaborated. This document's main goal is to provide a guideline for the energetic investments in Pécs and with this, give help to the work of local decision-makers. The action plan contains suggestions in terms of sustainable energy management to improve energy efficiency, also contains suggestions how to use the energy sources. Through the interventions of the proposed actions, the City of Pécs can reduce the energy consumption and the greenhouse gas emissions – focusing on the sectors that are in the competency of the Municipality. The action plan gives more chances to obtain the EU Funds in the term of 2014–2020, so the Municipality can implement useful and inhabitant-friendly developments by the EU subsidy. The actions of the plan are incorporating the energy issue of municipal buildings and facilities, residential buildings, public lighting, transportation, awareness-raising, and energy production (MANERGY, 2014).

Based on this action plan the city (in collaboration with the power plant) established a 10 MWp photovoltaic power plant on a former ash deposit area of the local power plant. Another important step towards circularity was that in 2015 the Biomű-Baranya company established a biogas plant on the wastewater treatment plant of the Tettye Forrásház to safely dispose of and to generate energy out of the anaerobe digestion of the pre-compressed sewage sludge generated on the plant and brought in from the regional wastewater treatment plants. From the locally generated and collected sewage sludge, approximately 2.33 million Nm^3/year biogas is produced. After the purification, thermal- and electric energy in two combined cycle-power stations, with each 375 kWh capacity, is generated. The biogas plant gives the exceeding part above the thermal energy for own use to the wastewater treatment plant in the quantity of 1.310 GJ/year, which is used for the heating of the offices and social building. The largest part of the gas usage is replaced in this way.

3.2.7.2 Stakeholder survey – The case of Pécs

One of the main tasks of 'WP3.3 – Social Analysis' is to develop a Primer Socio-cultural Analysis (PSCA) in order to inquire the possible impacts of socio-cultural context on waste and resource management. As all policies, among them waste and resource

management related policies, are embedded into a complex social and cultural environment [as these policy mechanisms are targeting and addressing certain smaller or more comprehensive groups of people, while these policies are also implemented by individuals (among them decision-makers, stakeholders, beneficiaries, etc.)], it would be a mistake to neglect the fact that the socio-cultural context might influence the sustainability (efficiency, progressivity, innovativeness etc.) of waste and resource management activities. SSCA-1 (the first phase of Secondary Socio-cultural Analysis) of WP3.3 actually found out that – at a macro-social level – there are relevant differences among the EU member states respective to waste-conscious behaviour (WCB) of individual subjects (see: Deliverable 3.2). SSCA-1 also presented that in the case of Hungary there are no significant regional differences respective to the WCB scores. In line with this, PSCA aims to map out relevant stakeholders' perceptions about the institutional conditions (financial, regulation-, infrastructure-, policy-, strategy-related aspects) and socio-cultural fundaments of sustainable waste and resource management. Although the comparative PSCA investigation embracing all case study areas will be published in Deliverable 3.8, it is interesting to draw up the first results of the stakeholder surveys by each case. In the following, the case of Pécs is summarised briefly. Some basic methodological information in advance: the relevant stakeholders were identified by the Hungarian consortium partner; they were interviewed in their first language via online by a closed, structured survey.

The institutional block of the Pécs stakeholder survey

The first block of the survey has 5 thematic scopes: financial issues, regulation and laws, implementation, infrastructure and technologies, and learning/knowledge-transfer. The general question posed to the interviewees was the following: "*On a 0 to 10 scale, where 0 is 'absolutely not important' and 10 is 'absolutely important', how would you perceive the relevance of the following factors for a sustainable waste/resource management?*"

Financial issues	**Mean v.**	**N=**
Stable financial background of the responsible provider to secure EU standard quality waste services for every customer	8.6	17
To continuously aim for additional financial resources (e.g. private investments, government subsidies etc.) for waste sector	7.2	17
To reduce the loss-making waste services and improve the profitable ones even if this intervention has social costs/potentially negative impacts	5.3	16

To reduce the loss-making waste services and improve the profitable ones even if this intervention has environmental costs/potentially negative impacts	2.8	16
To provide the same quality services for every customer even if securing accessibility is reducing profitability	6.2	17

T*able 1. 'Institutional block – Financial issues section' of the Pécs stakeholder survey*
Source: Authors' own elaboration based on primer survey data

Regulations and laws	**Mean v.**	**N=**
Comprehensive and executable regulations on waste/resource management	9.4	17
To explicitly formalise at different (national, regional, local, organisational etc.) level regulations all the waste/resource management-related issues and practices	7.6	17
To leave room for implementation based on the local context	9.1	17

Table 2. 'Institutional block – Regulation and laws section' of the Pécs stakeholder survey
Source: Authors' own elaboration based on primer survey data

Implementation	**Mean v.**	**N=**
To benchmark by a multi-level monitoring system waste/resource management service providers according to outputs/costs indicators	7.9	15
Strict fines on violating customers	7.8	17
To leave grace period before fines on violating customers become due	7.7	17
Promotion campaigns to encourage participation in and acceptance of waste/resource management	8.8	17

Table 3. 'Institutional block – Implementation section' of the Pécs stakeholder survey
Source: Authors' own elaboration based on primer survey data

Infrastructure and technologies	**Mean v.**	**N=**
Using eco-innovative and smart technologies to improve waste/resource management even if these developments are increasing the costs of services	8.2	17
Using eco-innovative and smart technologies to improve waste/resource management even if these developments are challenging the acceptability of services	4.9	16
Using eco-innovative and smart technologies to improve waste/resource management even if these developments are challenging the equal accessibility of services	4.4	16

Table 4. 'Institutional block – Infrastructure and technologies section' of the Pécs stakeholder survey

Source: Authors' own elaboration based on primer survey data

Learning/knowledge-transfer	**Mean v.**	**N=**
Waste/resource management service providers should continuously study best practices	9.0	16
Waste/resource management service providers should continuously learn from webinars (online presentations about best practices and innovative solutions)	7.9	17
Instead of developing local innovations, waste/resource management service providers should adapt an existing model of best practices if it seems to be a cheaper solution	7.4	16
Waste/resource management service providers should cooperate in developing and sharing eco-innovative solutions	9.2	18

Table 5. 'Institutional block – Learning/knowledge-transfer section' of the Pécs stakeholder survey
Source: Authors' own elaboration based on primer survey data

Regarding to the financial issues, Hungarian stakeholders consider stable financial background of the responsible provider as the most important condition to secure EU standard quality waste services. According to the respondents, profitability should not be among the main goals of service providers, especially if it increases (risks) social and/or environmental costs. However, stakeholders do not think that securing same quality services for all customers is a distinguished principle. As regards the regulations, respondents agree that both comprehensive legal frameworks and room for locally specialised rules/directives are equally important. Similarly, respondents understand standardised benchmarking and promotion campaigns as crucial tools in order to improve the quality and acceptability of services, and they generally agree that imposing fines on violating customers is indispensable, yet not without proposing a short grace period. While applying eco-innovations is favoured even if it increases service costs, yet in cases of growing challenges to service-accessibility or -acceptability stakeholders would not support these solutions. Both studying and sharing eco-innovations are considered as very important by the respondents.

The socio-cultural block of the Pécs stakeholder survey

The second block of the questionnaire aimed to inquire how the stakeholders perceive the relevancy of certain social and cultural features to waste and resource management. The question posed to the respondents was the following one: "*As some research highlights, the social and cultural milieu of a collective entity (society or smaller community, social group) – through the generally accepted and respected social values, norms and attitudes – could influence the effectiveness of public policies. Based on this argument, we are now interested in how you perceive the relevance of the following social and cultural features and attitudes for a sustainable waste/resource management. The*

scale refers to the same values: 0 to 10, where 0 is 'absolutely not important' and 10 is 'absolutely important'."

Social and cultural environment	**Mean v.**	**N=**
A collective feeling of unity arising from common responsibilities, interests and objectives	8.4	16
A bond of social togetherness based on an informal agreement that everybody should have the same opportunities	8.4	16
Social cohesion based on commonly respected principles that everybody is entitled to basic individual rights and needs	8.2	16
Social unitedness founded on the idea of advancing public interests	8.9	16
Willingness for doing, making, undertaking something by one's own accord in the name of collective goals	8.8	16
Acting on behalf of the community without force or coercion to promote public interests	7.9	16
Supporting others by free choice	7.8	16
Willingness to make changes in one's own life and lifestyle	9.1	16
Openness for new challenges	8.8	16
Searching for new opportunities	8.1	16
Ability to cope with individual failures	7.6	16
Being critical about one's own customs and habits	8.7	16
Confidence in the possibility that things could be better	8.0	16

Faith in the achievability of progressive reforms	8.8	16
Optimistic beliefs that wrongs are repairable	8.6	16
To believe that generally people are honest in dealing with others	7.1	16
To believe that generally people are helpful	6.7	16
To believe that generally people are taking into consideration common norms before they doing actions or making decisions	7.4	16
Willingness to participate in activities promoting public interests	8.5	16
Joining civil organisations and/or social movements	6.9	15
Protesting against things (decisions, actions, outcomes) that are contradicting or preventing the facilitation of public interests	7.3	16
To respect the individual opinion and approach of others	7.3	16
Being open for discussion with everybody	7.8	16

Table 6. 'Socio-cultural block' of the Pécs stakeholder survey
Source: Authors' own elaboration based on primer survey data

As regards the social and cultural features, Hungarian stakeholders generally perceive these factors as fundamental conditions. Especially values about social togetherness, cohesion, sharing collective responsibilities, and voluntary devotion are considered as important bases to a sustainable waste and resource management. Similarly, openness for change, belief in progressive capacities, deliberative communicative actions, optimism about the future, participation as well as reflexive agency and critical actorness are understood by the respondents as motivational and inspirational sources to the improvement of waste and resource management. To some extent social trust, helpfulness, and solidarity have more moderate relevancy for the stakeholders.

Pairwise comparison block of the Pécs stakeholder survey

The last block of the questionnaire used the method of pairwise comparison in order to find out from two theoretically interlinked options which one is preferred by the stakeholders from the perspective of relevancy to waste and resource management. The question posed to the respondents was the following: "*Finally, we are interested in how you perceive the relevance of the following factors compared to each other for a sustainable waste/resource management. 1 means you completely agree with the statement on the left; and 10 means you completely agree with the statement on the right. If your answer fell between 1 and 10, pick up the number that rightly reflects on your perception.*"

Pairwise Comparison	**Scale v.**	**Mean v.**	**N=**
1a) Waste/resource management should be funded by private financial resources	*1–5*	6.5	16
1b) Waste/resource management should be funded by public financial resources	*6–10*		
2a) Waste/resource management should be regulated by local level regulations	*1–5*	5.9	16
2b) Waste/resource management should be regulated by national level regulations	*6–10*		
3a) Waste/resource management should be regulated by local level regulations	*1–5*	5.0	16
3b) Waste/resource management should be regulated by EU level regulations	*6–10*		
4a) Waste/resource management should be regulated by national level regulations	*1–5*	4.7	16
4b) Waste/resource management should be regulated by EU level regulations	*6–10*		
5a) Multi-level strategies on waste/resource management should be formulated in bottom-up sense	*1–5*	4.3	16
5b) Multi-level strategies on waste/resource management should be formulated in top-down sense	*6–10*		
6a) In waste/resource management related decision makings, political actors should take the lead	*1–5*	7.8	16

6b) In waste/resource management related decision makings, non-political actors should take the lead	*6–10*		
7a) Waste/resource management related strategies and policies should be discussed by a narrow coalition of actors	*1–5*	8.6	17
7b) Waste/resource management related strategies and policies should be discussed by a wide coalition of actors	*6–10*		
8a) Waste/resource management related strategies and policies should be developed by a narrow coalition of decision makers	*1–5*	8.3	16
8b) Waste/resource management related strategies and policies should be developed by a wide coalition of decision makers	*6–10*		
9a) Waste/resource management policies should offer solutions to imminent challenges	*1–5*	8.5	15
9b) Waste/resource management policies should aim for long-term solutions	*6–10*		

Table 7. 'Pairwise comparison block' of the Pécs stakeholder survey
Source: Authors' own elaboration based on primer survey data

Hungarian stakeholders favour national and subnational regulations compared to the EU level legal frameworks. They believe that waste and resource management should be funded by public financial sources. They prefer bottom-up way designed multi-level strategies in the field, while respondents agree that decision-making processes should be controlled primarily by non-political actors. In line with this latter perception, stakeholders agree that waste/resource management related strategies and policies should be developed and discussed by a wide coalition of different partners.

3.3 Material flow analysis – Pécs case

3.3.1 MFA of organic waste

According to the referred development strategies of Pécs (and Hungary) (see Chapter 3.2.7), one of the most important waste flows is linked to organic waste. Based on the interviews with key stakeholders and the discussion with BIOKOM's experts, we have defined the organic waste (OW) that is, would be or should be collected and/or treated by the public service provider of the city. The selectively collected organic waste in our case contains biodegradable garden and park waste (BGPW), unbaked kitchen waste/food waste from households and other MSW producers (institutions, service providers etc.). There are some large or special local actors who potentially collect and/or treat their biowaste independently from the public service provider (for example big companies, institutions, offices). Sometimes big waste collectors transfer biowaste to the public service provider's site from these large or special waste producers. Another part of organic material flows (not only waste flows) comes from the agricultural producers, but most of the wastes coming from this sector are so-called industrial wastes and treated, circulated mostly in different channels.

In the research area there is no solution for separate collection of kitchen waste at the actors, except for a voluntary initiative of a private company (Biofilter Co.) (with broad territorial coverage) for oil/fat and other food waste collection (all of the residents can take the kitchen oil to the petrol stations or the company's sites, and only the actors from food and catering industries and retail/commerce points can transfer their food waste by this company).

The wastes or by-products of agricultural and forestry sector and food industry are collected separately from the households' and institutional (similar to household) organic waste, that is why they were excluded from our organic waste definition. In the research area there are two big biomass based complex power plants and district heating companies (Komló, Pécs) which use the so-called "waste" coming from the forestry and agricultural sectors.

One of Pécs's traditional factories is a big Tobacco Factory (BAT Pécsi Dohánygyár Kft.), that is why we inserted tobacco sector into Orbis based data analysis.

One key challenge of the investigated case study area defined by the experts and key stakeholders is the high biodegradable part of MSW.

In the wider research area there are two big cement factories which use large amount of RDF (by product of waste treatment), but not necessarily the locally generated part.

3.3.1.1 Step 1. Determination of material scope

Based on the interviews with key stakeholders and the discussion with BIOKOM's experts, we have selected three key waste flows: the organic waste, the municipal solid waste and the plastic packaging waste. This analysis is focused on the organic waste

flows. The organic waste (OW) is the biodegradable part of waste that is collected by the Dél-Kom Nonprofit Ltd. as the public service provider, and which contains the unbaked kitchen/food waste and the park and garden waste produced by households, the municipal park maintenance company, big public institutions (university, railway company, schools, offices, etc.) and private companies who can contract with the public service provider (due to the type and/or the amount of waste).

3.3.1.2 Step 2. Defining the material supply chain

Our organic waste definition applied in this project (see Chapter 3.3.1) concentrates on the functional public waste collection system of Pécs. However, the supply chains may include much more extensive activities, so the following Activity Groups were identified and NACE codes were selected to represent the supply chains which probably produce organic waste.

P1 – Primary production (20 NACE codes within the "A" categories from which there were 4 without any local actors)

P2 – Processing and manufacturing (22 NACE codes within the "C" categories from which there were 6 without any local actors)

W – Wholesale and logistic (12 NACE codes within the "G" categories from G46.1.1 to G46.3.9)

R – Retail and markets (6 NACE codes within the "G" categories from G47.1.1 to G47.8.1)

F – Food service/preparation and consumption (8 NACE codes within the "F" categories)

H – Food preparation and consumption at households (not any NACE codes, but the number of households had been estimated in 2011 within the Census (HCSO 2011))

I – Food preparation and consumption at institutions and service providers (34 NACE codes within the "N", "O", "P", "R" and "S" categories from which there were 3 without any local actors).

WM – Waste management (4 NACE codes E38.1.1; E38.1.2; E38.2.1, E38.2.2)

The household category did not have real connection with the NACE code list due to the lack of visible economic activities of households. The number of these actors was estimated in the database of HCSO (2011).

On the basis of these categories of activity groups and the existing connections among them the following comprehensive system diagram can be drawn (Figure 29).

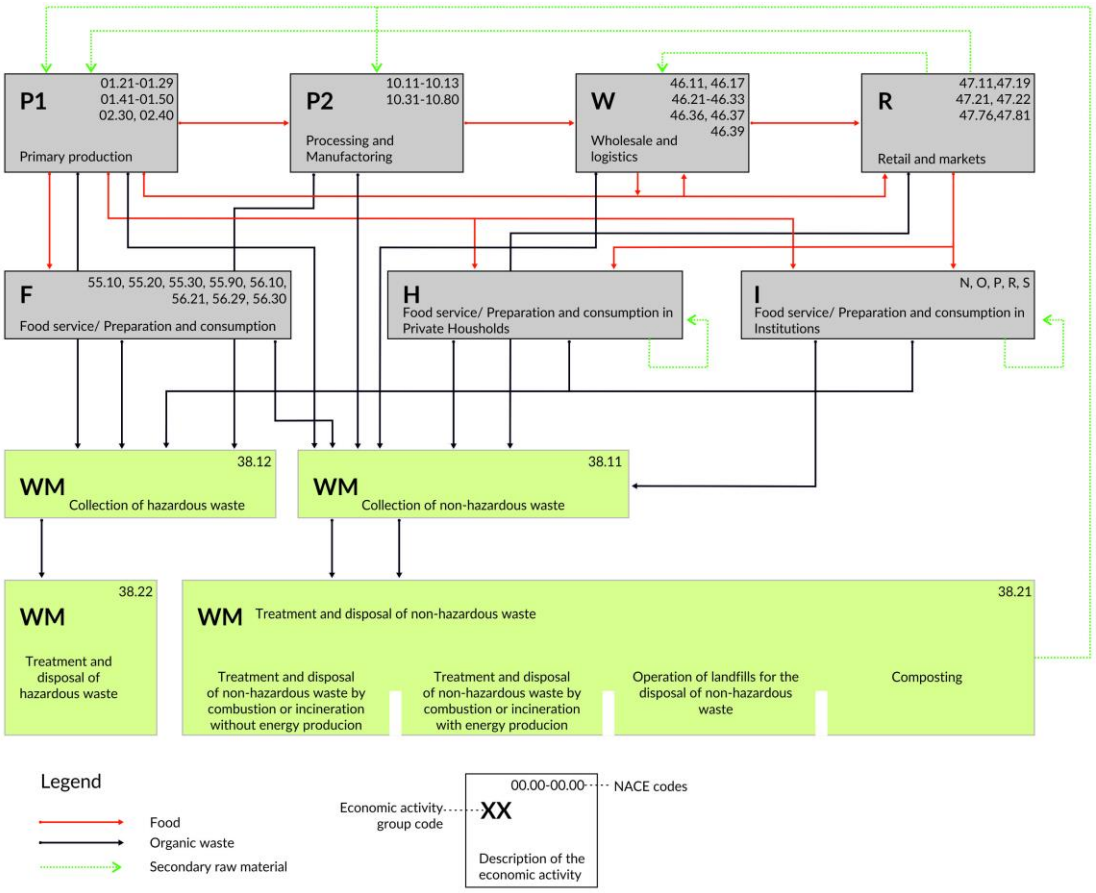


Figure 29: The system diagram of activities and flows of organic value chain in the Pécs Agglomeration
Source: Own elaboration

3.3.1.3 Step 3. Selection of geographical area and spatial scales

For the MFA the public administration unit of Pécs was chosen. In certain cases Baranya county (NUTS3) is the research area and there will be some calculations for the agglomeration of the city, which included the following settlements (Figure 30, Table 8): Pécs, Abaliget, Aranyosgadány, Bakonya, Baksa, Berkesd, Bicsérd, Birján, Bisse, Boda, Bogád, Cserkút, Egerág, Ellend, Görcsöny, Gyód, Hásságy, Hosszúhetény, Keszü, Kisherend, Kozármisleny, Kökény, Kővágószőlős, Kővágótöttös, Lothárd, Magyarsarlós, Martonfa, Nagykozár, Olasz, Orfű, Pécsudvard, Pellérd, Pereked, Pogány, Romonya, Szabadszentkirály, Szalánta, Szemely, Szilágy, Túrony and Zók. Although the public administrational territorial areas of the counties do not have real intervention position in the waste management in Hungary, counties have development and spatial (physical) planning roles and a so-called integrator position coming from the Hungarian planning hierarchy. Moreover, the flows of materials do not stop at the city borders, many actors are located around Pécs, and this is especially true from the analysed material flows for the plastic waste. Pécs as a local governmental unit has the right and the responsibility to manage at local level the task of waste collection and waste treatment. That is why Pécs is our delimited research area (sample area).

Figure 30: The settlements of Pécs Agglomeration
Source: Own elaboration based on KSH delineation (2011)

Municipality	District	County
Abaliget	Pécs	Baranya
Aranyosgadány	Pécs	Baranya
Bakonya	Pécs	Baranya
Baksa	Sellyei	Baranya
Berkesd	Pécs	Baranya
Bicsérd	Szentlőrinc	Baranya
Birján	Pécs	Baranya
Bisse	Siklósi	Baranya
Boda	Szentlőrinc	Baranya
Bogád	Pécs	Baranya
Cserkút	Pécs	Baranya
Egerág	Pécs	Baranya
Ellend	Pécs	Baranya
Görcsöny	Pécs	Baranya
Gyód	Pécs	Baranya
Hásságy	Bólyi	Baranya
Hosszúhetény	Pécs	Baranya
Keszü	Pécs	Baranya
Kisherend	Pécs	Baranya
Kozármisleny	Pécs	Baranya
Kökény	Pécs	Baranya
Kővágószőlős	Pécs	Baranya
Kővágótöttös	Pécs	Baranya
Lothárd	Pécs	Baranya
Magyarsarlós	Pécs	Baranya
Martonfa	Pécsvárad	Baranya
Nagykozár	Pécs	Baranya
Olasz	Bólyi	Baranya
Orfű	Pécs	Baranya
Pécs	Pécs	Baranya
Pécsudvard	Pécs	Baranya
Pellérd	Pécs	Baranya
Pereked	Pécs	Baranya
Pogány	Pécs	Baranya
Romonya	Pécs	Baranya
Szabadszentkirály	Szentlőrinc	Baranya
Szalánta	Pécs	Baranya
Szemely	Pécs	Baranya
Szilágy	Pécs	Baranya
Túrony	Siklós	Baranya
Zók	Szentlőrinc	Baranya

Table 8: The 41 settlements of Pécs Agglomeration and their public administrational classifications
Source: Own elaboration based on KSH delineation (2011)

Since 2017 the new waste public service provider of Pécs is Dél-Kom Nonprofit Ltd., which is owned by BIOKOM Nonprofit Ltd. (that was the previous service provider founded by the City of Pécs). Since the selective collection system started in Pécs in 1996, BIOKOM became a very well-known organisation in the region with a 'hallmark' of selective waste collection. After 2017 BIOKOM has become the property manager of

the Mecsek-Dráva Association's (which implemented the waste management infrastructure of the region) assets, sites and infrastructure (Figure 31).

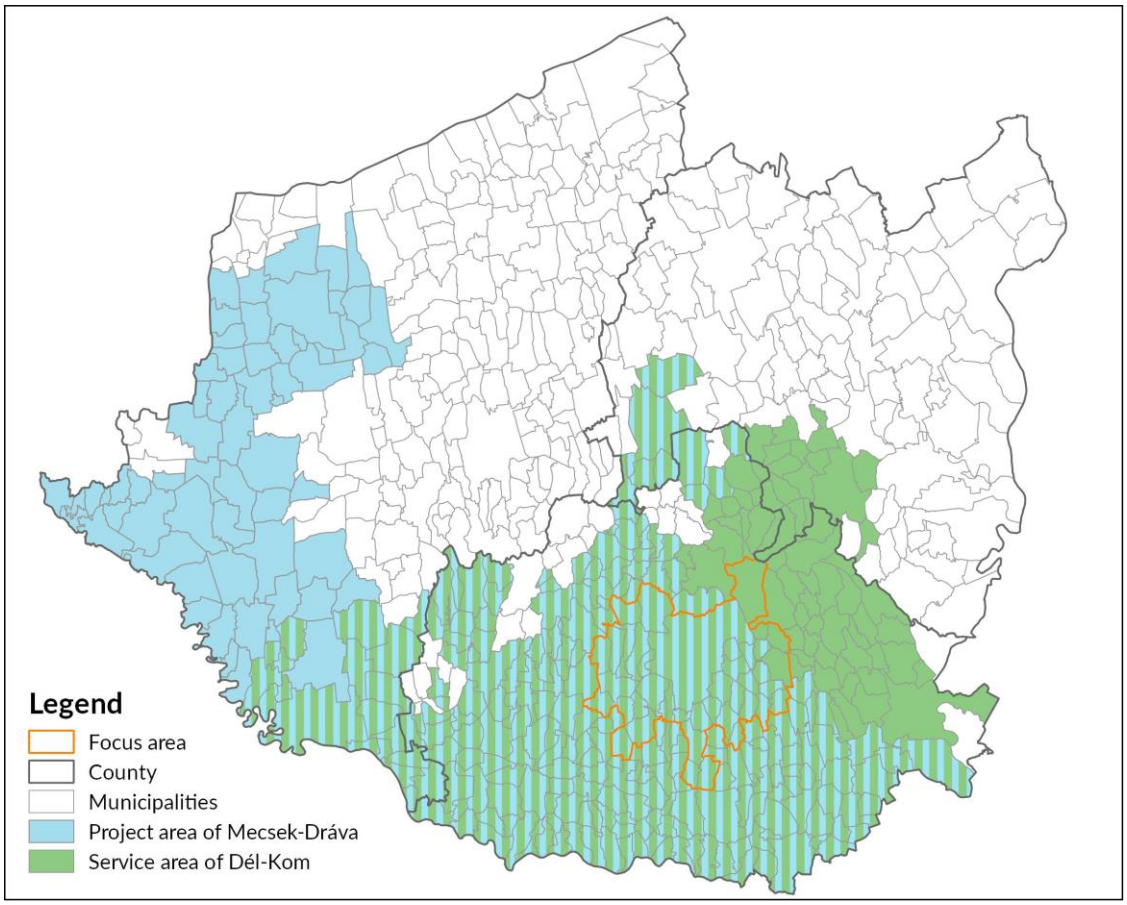


Figure 31: Mecsek-Dráva project area and the regional public service provider's area near Pécs (2017)
Source: Dél-Kom, Biokom

Dél-Kom Ltd. as public service provider collects the MSW and similar commercial, industrial and institutional wastes from Pécs and other 318 settlements around Pécs (Figure 31), including the focus area of the Pécs case (Figure 32).

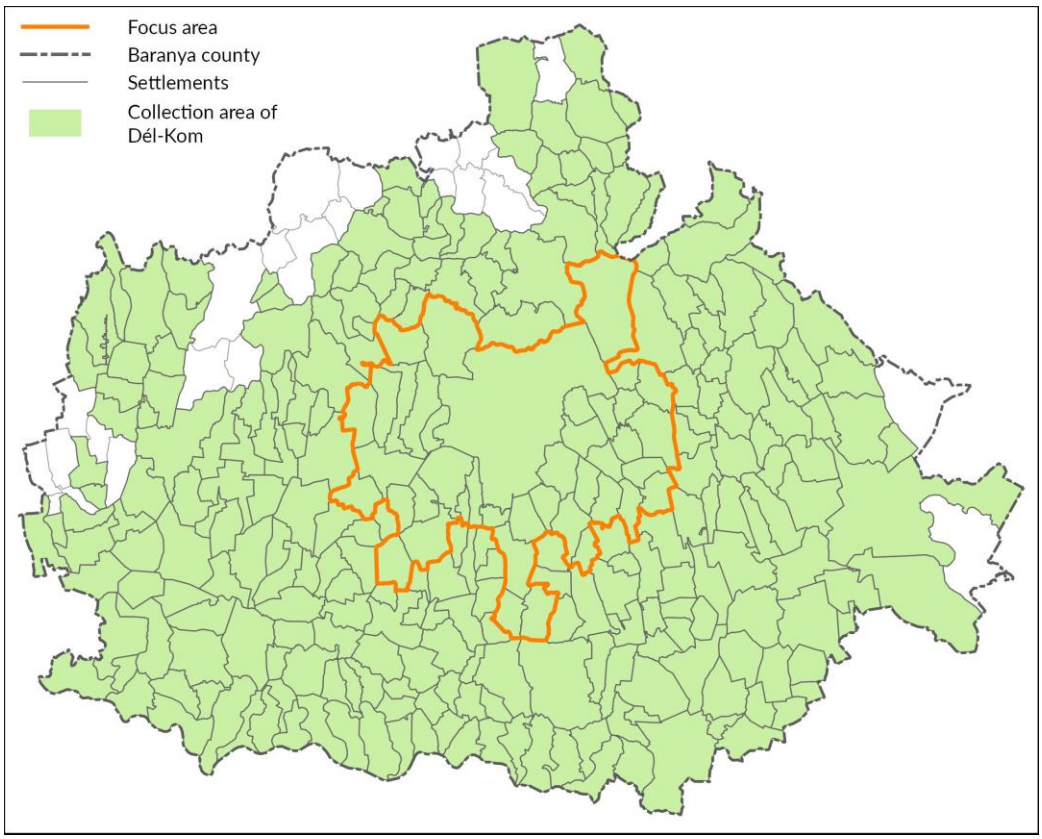


Figure 32: The collection area of Dél-Kom in Baranya county (2017)
Source: Dél-Kom

3.3.1.4 Step 4. Defining case specific supply chain

To identify the actors that generate OW within the research area is possible with filtering them out of the Orbis database for the relevant territorial scope. For the OW supply chain analysis there were 106 NACE codes selected, from which 3568 codes give results in the database only for Pécs, and 4511 for the agglomeration of Pécs.

Based on the national statistics and the population census (in 2011) the number of households was identified. In 2011 in Pécs 69,058 households, while in the agglomeration (with Pécs) 82,227 households were registered in the census.

We filtered public institutions from the Orbis database as economic actors, however, most of them are also contracted partners (similar to households) of the public service provider (and mostly produce similar waste categories as households), therefore in the process and representation model we took them into consideration with the analysis of the household sector.

Economic actors in the OW chain

The Orbis database was used for the collection of potential Organic Waste generators from the local economic actors. Table 9 and Figure 33, 34, show the results for Pécs as a sample area and for the total Agglomeration of Pécs.

NACE Category	Description	Number of companies	
P1	**Primary production**	**Pécs Agglomeration**	**Pécs**
A1.2.1	Growing of grapes	10	7
A1.2.2	~~Growing of tropical and subtropical fruits~~	~~0~~	~~0~~
A1.2.3	~~Growing of citrus fruits~~	~~0~~	~~0~~
A1.2.4	Growing of pome fruits and stone fruits	3	3
A1.2.5	Growing of other tree and bush fruits and nuts	6	6
A1.2.6	Growing of oleaginous fruits	1	0
A1.2.7	~~Growing of beverage crops~~	~~0~~	~~0~~
A1.2.8	Growing of spices, aromatic, drug and pharmaceutical crops	2	2
A1.2.9	Growing of other perennial crops	1	1
A1.4.1	Raising of dairy cattle	3	1
A1.4.2	Raising of other cattle and buffaloes	1	1
A1.4.3	Raising of horses and other equines	4	1
A1.4.4	Raising of camels and camelids	1	0
A1.4.5	~~Raising of sheep and goats~~	~~0~~	~~0~~
A1.4.6	Raising of swine/pigs	9	4
A1.4.7	Raising of poultry	12	9
A1.4.9	Raising of other animals	16	11
A1.5.0	Mixed farming	9	5
A2.3.0	Gathering of wild growing non wood products	1	1
A2.4.0	Support services to forestry	36	19
P2	**Processing and Manufacturing**	**Pécs Agglomeration**	**Pécs**
C10.1.1	Processing and preserving of meat	8	7
C10.1.2	Processing and preserving of poultry meat	1	1
C10.1.3	Production of meat and poultry meat products	4	4
C10.3.1	~~Processing and preserving of potatoes~~	~~0~~	~~0~~
C10.3.2	Manufacture of fruit and vegetable juice	1	1

C10.3.9	Other processing and preserving of fruit and vegetables	4	2
C10.4.1	Manufacture of oils and fats	2	1
C10.4.2	~~Manufacture of margarine and similar edible fats~~	~~0~~	~~0~~
C10.5.1	~~Operation of dairies and cheese making~~	~~0~~	~~0~~
C10.5.2	~~Manufacture of ice cream~~	~~0~~	~~0~~
C10.6.1	Manufacture of grain mill products	1	1
C10.6.2	Manufacture of starches and starch products	2	2
C10.7.1	Manufacture of bread; manufacture of fresh pastry goods and cakes	17	14
C10.7.2	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	2	2
C10.7.3	Manufacture of macaroni, noodles, couscous and similar farinaceous products	3	3
C10.8.1	~~Manufacture of sugar~~	~~0~~	~~0~~
C10.8.2	Manufacture of cocoa, chocolate and sugar confectionery	6	5
C10.8.3	~~Processing of tea and coffee~~	~~0~~	~~0~~
C10.8.4	Manufacture of condiments and seasonings	3	2
C10.8.5	Manufacture of prepared meals and dishes	2	2
C10.8.6	Manufacture of homogenised food preparations and dietetic food	1	0
C10.8.9	Manufacture of other food products n.e.c.	8	7
WM	**Waste Management**	**Pécs Agglomeration**	**Pécs**
E38.1.1	Collection of non-hazardous waste	18	13
E38.1.2	Collection of hazardous waste	2	2
E38.2.1	Treatment and disposal of non-hazardous waste	3	2
E38.2.2	Treatment and disposal of hazardous waste	2	0
W	**Wholesale and Logistics**	**Pécs Agglomeration**	**Pécs**
G46.1.1	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods	22	18
G46.1.7	Agents involved in the sale of food, beverages and tobacco	15	12
G46.2.1	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds	31	16

G46.2.2	Wholesale of flowers and plants	7	5
G46.2.3	Wholesale of live animals	17	13
G46.2.4	Wholesale of hides, skins and leather	2	2
G46.3.1	Wholesale of fruit and vegetables	18	9
G46.3.2	Wholesale of meat and meat products	10	7
G46.3.3	Wholesale of dairy products, eggs and edible oils and fats	6	3
G46.3.6	Wholesale of sugar and chocolate and sugar confectionery	5	4
G46.3.7	Wholesale of coffee, tea, cocoa and spices	2	2
G46.3.9	Non specialised wholesale of food, beverages and tobacco	10	7
R	**Retail and Markets**	**Pécs Agglomeration**	**Pécs**
G47.1.1	Retail sale in non-specialised stores with food, beverages or tobacco predominating	285	194
G47.1.9	Other retail sale in non-specialised stores	54	49
G47.2.1	Retail sale of fruit and vegetables in specialised stores	52	38
G47.2.2	Retail sale of meat and meat products in specialised stores	31	26
G47.7.6	Retail sale of flowers, plants, seeds, fertilisers, pet animals and pet food in specialised stores	64	50
G47.8.1	Retail sale via stalls and markets of food, beverages and tobacco products	47	31

Table 9: The number of actors registered in Pécs and in the Pécs Agglomeration per activity groups.
Source: ORBIS database
Note: Categories without actors are lined through

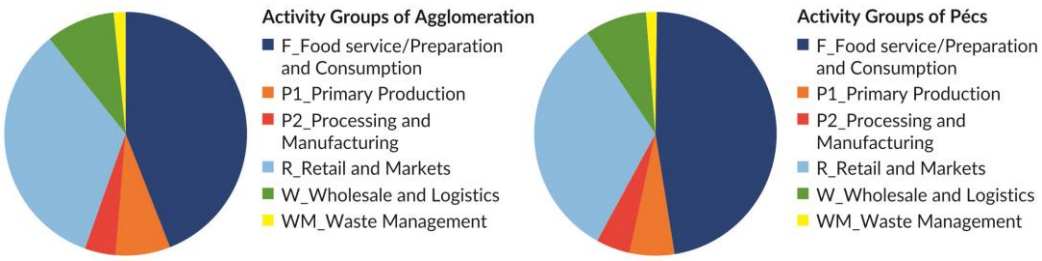


Figure 33: Pie chart for the number of companies registered in Pécs and the Pécs agglomeration per activity group
Source: ORBIS database

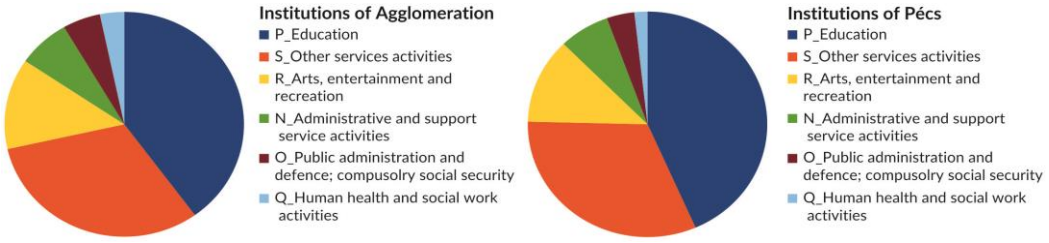


Figure 34: Pie chart for the number of institutions registered in Pécs and Pécs agglomeration per activity type of actors
Source: ORBIS database

3.3.1.5 Step 5. Activity-based mass flow modelling

Data gathering

Following the structure of the Amsterdam pilot, the data availability is to be presented by exploring and gathering data for the three main stages of BW; 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

1) Data on organic waste generation at household and institution level

Concerning a press release[46] from the Ministry of Agriculture (based on the examination of NÉBIH below), in Hungary 1.8 million tonnes of food waste is generated in every year, which means 68 kg/person. According to the NÉBIH, the National Food Chain Safety Office's report (2017), it is a 10-11% part from the total purchased food per households. From this average 68 kg/person food waste 48.70% is the avoidable (unused), 4.16% is the potentially avoidable (apple peel, bread crust, etc.) and 47.13% is the unavoidable (egg shell, bones, etc.) part.

From this amount of food waste, 62.83% goes to the waste and waste water systems, 18.45% functions as animal food and 18.72% is composted (NÉBIH 2017). It means that circa 42.7 kg per capita food waste is loaded into the MSW systems (although a huge part goes into the wastewater system).

Having regarded the Pécs case, first of all, we have to note that waste generation data can only be estimated, since not all waste is collected. In case of garden waste for example, grass clipping is composted (using home composting bins) in more than

[46] http://www.boon.hu/fm-evente-18-millio-tonna-elelmiszerhulladek-keletkezik-magyarorszagon/3669644

thousand households in Pécs, while an important part of tree leaves is burnt, even if it is banned by environmental laws.

Collected waste streams are weighed at the entry of the treatment facilities, providing reliable aggregated data. Precise data at a household level would only be available if client identification (RFID tag on the waste bin/bag) and on-board weighing were operated, but this is not the case in the investigated area.

Among the collected waste streams, organic waste can be found both in the residual waste and in the separately collected green waste. Table 10 below shows the composition of the residual waste stream collected last year in Pécs (and transported to Kökény), following quarterly performed analyses:

Name	Distribution (%)					
	1st quarter	2nd quarter	3rd quarter	4th quarter	Average	Corrected average
Biodegradable	**27.34**	**20.89**	**29.63**	**27.08**	**26.24**	**26.20**
Textile	2.67	3.66	2.67	4.10	3.28	3.30
Glass	2.59	4.17	2.03	1.87	2.67	2.60
Sanitary waste	3.15	4.10	3.55	3.91	3.68	3.70
Metal	2.88	4.71	6.45	3.48	4.38	4.40
Plastic	17.57	22.31	11.64	25.64	19.29	19.30
Composite	1.56	4.27	1.51	3.76	2.78	2.80
Cardboard	5.15	4.31	1.41	4.60	3.87	3.90
Non-classified non-combustible waste	2.30	1.94	0.28	1.04	1.39	1.40
Non-classified combustible waste	2.19	2.38	3.47	3.82	2.97	2.90
Paper	10.36	9.01	7.71	7.22	8.58	8.60
Hazardous waste	0.40	0.72	0.27	0.26	0.41	0.40
Fine fraction (<20mm)	21.85	17.53	29.36	13.22	20.49	20.50
Total:	100.01	100.00	99.98	100.00		100.00

Table 10: Composition of mixed municipal waste collected in Pécs in 2017
Source: Controlling database of BIOKOM group

We should mention here that in the above described part a contradiction seems to appear, namely that based on the Biokom calculation the OW waste is 26.2% of residual (mixed) waste (which results in average amounts from 37.7kg/capita to 268.8 kg/capita within the researched area), while in Hungary the average food waste is 68 kg/person (NÉBIH 2017). Calculating the amounts we should take into consideration (in the Pécs case) that over the 42.7 kg/person food waste (within the MSW and waste water system) there are the selectively collected green waste and the home composted parts, too. In the process model (chapter on household sector process and representation below) we are calculating with this and other data from HCSO data and representing the per capita OW waste in the agglomeration.

2) Collection of the household waste

Waste management is defined for several decades by the infrastructure created under the Mecsek-Dráva Programme, including 319 settlements. Collection and treatment are basically organised around two main material streams: municipal wastes subject to mixed collection and separately collected wastes. From the environmental point of view, the basic principle would be to maximise the yield of recycled materials for both material streams, but always keeping financial sustainability. The facilities are therefore designed in such a way that the treated material can be removed from the system at several levels of processing/refining.

Mixed waste collection

In order to process mixed waste, a mechanical-biological treatment centre was established in Pécs-Kökény. In the area of the project, collection districts have been established, the transport vehicles either transport the waste directly to the treatment centre or to the transfer stations established at the central settlements of the micro-regions. In the latter case, the waste of the collection district is loaded into walking floor trailers or press containers, and then transported to the mechanical preparation plants.

(The reason for inserting transfer station is that in some cases, direct transport (especially on those hilly areas where narrow roads are accessible with smaller trucks) is more expensive than to use transfer station where small trucks collect MSW then bigger tracks transport it to the landfill. The cost-benefit correspondence is drafted in Figure 35.)

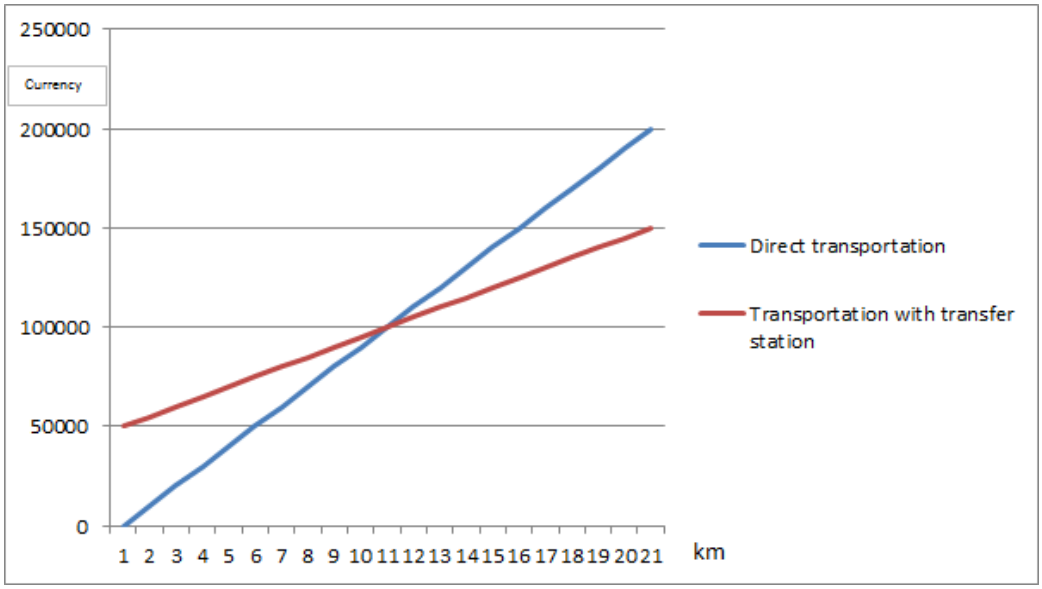


Figure 35. Drafted correspondence when to use direct transportation and transportation with transfer station in MSW transportation towards landfill/treatment.
Source: Own elaboration

Within the framework of the Mecsek-Dráva Programme, 4 transfer stations (Figure 36) were established with the following annual capacities:

Barcs: 12 thousand tons
Kaposszekcső: 14 thousand tons
Pécs: 12 thousand tons
Szentlőrinc: 15 thousand tons

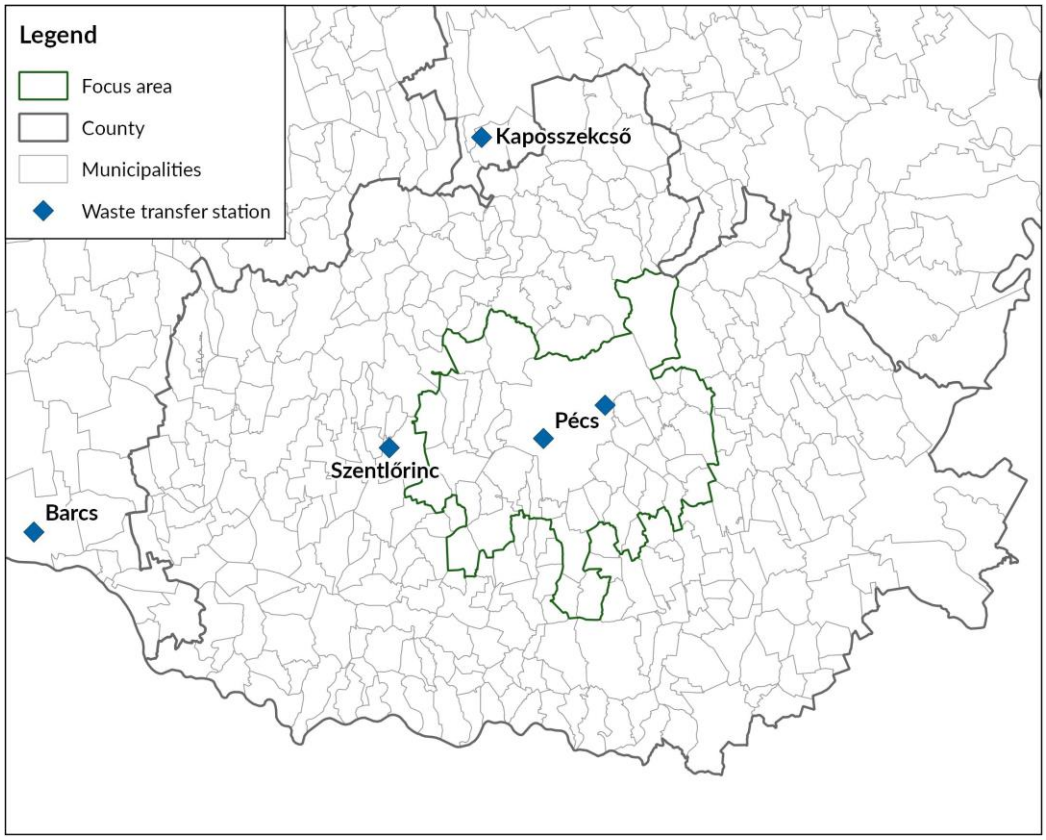


Figure 36: Waste transfer stations in Baranya county and its surrounding (2017)
Source: Biokom Nonprofit Ltd

The mechanical-biological treatment centre performs the mechanical pre-treatment of non-separately collected waste, followed by the biological treatment of its biodegradable fraction.

Separate waste collection and treatment

1. Collection islands

In the Mecsek-Dráva project area, at least one collection point was established in each settlement. In addition, in settlements with a population of 500 to 1,000 people, an additional island was placed, and above that one additional collection island per thousand inhabitants each, i.e. a total of 820 collection islands were built. Packaging wastes (paper, cardboard, plastics and glasses) are collected with this method, organic waste is excluded at the moment.

2. Door-to-door collection

Door-to-door separate collection has been introduced in the districts of towns with family houses and within a 20 km range of settlements with more than 15,000 inhabitants. For collecting, 240-litre individual collection bins were placed. Paper, plastic, metal and combined packaging can be collected in this bin. Separate collection of glass

waste is carried out in glass collection containers placed in public areas. Door-to-door, recoverable waste collection is done every second week.

In the high-rise buildings of Pécs – in addition to the collection islands – separate collection in stairways is also successful. In order to expand this system, 1,100-litre bins were placed, in which paper, plastic, metal and combined packaging can be collected similar to the collection at family houses.

3. Green waste collection

Door-to-door green waste collection has been successful since 2003 in the garden districts of Pécs. For collecting, 80-litre individual bio waste collection bins were placed. The capacity of the new green waste composting plant in Kökény is 9,750 tons/year.

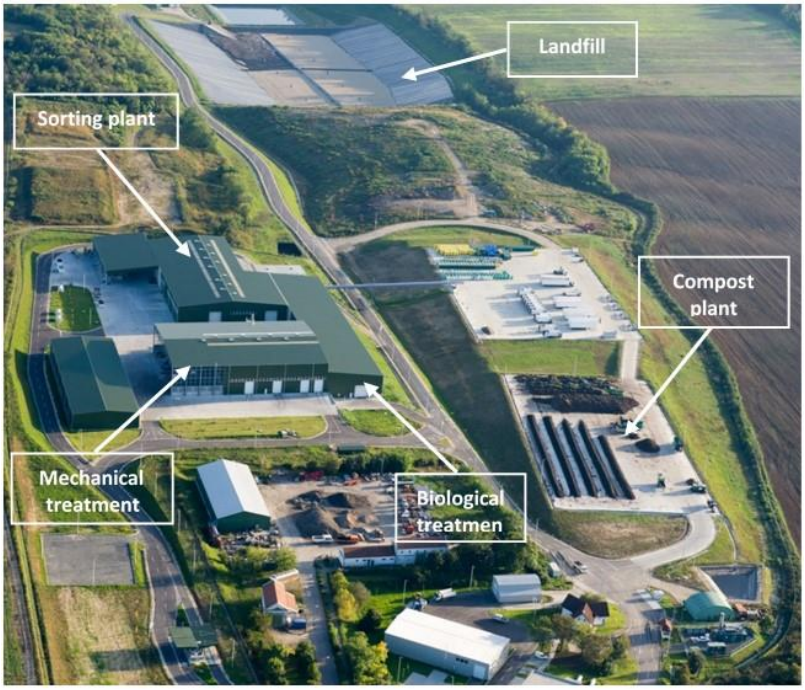
4. Civic Amenity sites (wasteyards)

In the wasteyards, separately collected waste generated by the public (paper, metal, plastic, green waste, etc.) large size wastes (furniture, bulky waste) and household appliances can be disposed of. Here, there is also the possibility of collecting "problematic" waste generated by households (paint containers, dry batteries, expired medicaments, electronic waste, etc.).

5. Food waste collection by business actors

There are some business actors (Biofilter, ATEV Zrt.) who also collect the different categories of food waste, mostly from the HORECA actors and food manufacturers, but the private households also can transfer their oil and fat waste into the collection points of Biofilter (at about 20 petrol stations), or their animal-protein waste to ATEV Zrt. (as a contractual partners of local governments for treating dead animals at households).

3) Treatment of the household waste



Picture 6: The most important waste treatment infrastructure in the region is the regional waste treatment centre located in Pécs-Kökény (2017)
Source: Biokom Nonprofit Ltd.

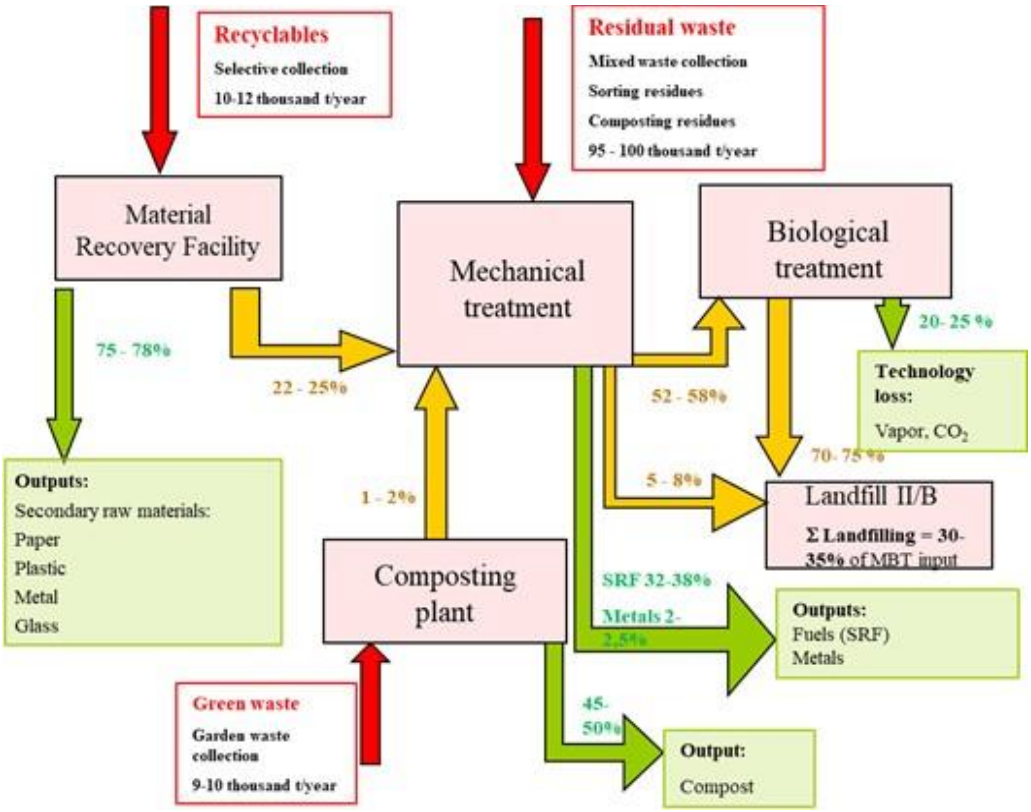


Figure 37: Internal waste streams of the Pécs-Kökény site (2017)
Source: Biokom Nonprofit Ltd

Waste is moved and treated both outside and within the site, in order to maximise the yield of recycled materials and to make the most valuable "end product" from a given waste stream. Of the wastes collected at the site of the generation, green waste is transferred into the composting plant (Figure 37), and the dry packaging materials are taken to the manual sorting plant (top left-hand section of figure).

- 45-50% of the mass of 9-10 thousand tons of incoming green waste as ready-made compost is received back, which we sell for purposes of soil improvement. The remaining 50-55% will be released in the form of gases and vapours, except for 1-2% foreign matter which will be transferred to the mechanical treatment unit after separation.
- The 10 to 12,000 tons of dry packaging material collected separately is sorted at a manual sorting plant, if possible, into pure-line secondary raw materials by the conveyor belt workers. Paper, plastic and metal raw materials of various qualities are sold in bales, glass is sold in bulk. This accounts for 75-78% of the incoming mass. It is important to note that glass waste is not transferred onto the sorting belt in order to avoid personal injuries. Sorting residue (approx. 22-25%) is taken to the mechanical treatment plant.
- The 95 to 100,000 tons of residual waste from mixed collection is delivered to the mechanical treatment unit. The waste transferred from the composting plant and the manual sorting plant, which can no longer be recovered materially, is added to this quantity. In the manner described above in the section on "mixed waste collection and treatment", organic decomposing, heavy and light (plastic, paper, wood, textile) fractions as well as metals are separated from each other. Secondary fuel (SRF) is produced from light fraction, accounting for 32-38% of the incoming waste mass. Separate magnetisable and non-magnetisable metals represent another 2 to 2.5. The 5-8 percent of heavy fraction (gravel, glass tiles, etc.) is deposited directly.
- Organic fraction from the mechanical treatment plant is first stabilised in a closed hall and then in an open space. This is the same technology as composting, however, due to the collection method of the treated material, legislation does not refer to this as composting but rather as stabilisation, and the final product is not called compost but "stabilate". The purpose of stabilisation is for the decomposition of organic materials to take place under controlled conditions, preferably under aerobic conditions, thus to ensure that CO_2 is produced and not methane, which is a typical by-product of traditional landfills (most of the global emissions of methane with strong greenhouse effect are attributable to landfills and cattle farming). 52 to 58% of the quantity delivered to the mechanical treatment unit arrives at the stabilising space. As a result of biological treatment, one-fourth/one-fifth of the treated volume is removed in the form of gases and vapour and 75-80% is deposited.

There is another flow that is not treated via the above described manner by Biokom and its waste management centre in Kökény. It is the seasonal waste of Christmas trees after the Christmas season. In January, 2017 46,93 tonnes, in January, 2018 47,14 tonnes of Christmas trees were collected by the City Maintenance Branch and were transferred to the local Biomass Power Plant (Veolia) for burning purposes (making electricity).

COMPANY WASTE FLOW DATA

Secondary data

As a first attempt to collect data we tried to look for data from secondary sources. Eurostat data are mainly relevant for country or NUTS 2 levels, therefore these data are not proper for the purpose MFA at local level. Waste related data in the Hungarian Statistical Office can be available for settlement (LAU 1) level, however, these data are relating to household and institutional collection (of MSW and some selectively collected material).

The former Ministry of the Environment – based on the yearly report of major companies – operate a 'waste database' where data of waste generated (including household sector as well) is available only for NUTS 2 level. (The amount was 642,673,032 kg in 2016[47].) The situation is the same with treatment of the waste. What is available here for company level is the 100 biggest waste producers in Hungary. It includes the biggest retailing companies (with aggregated data of waste production at country level), and other major companies with non-hazardous primary waste production. From the Pécs agglomeration, 3 out of the 100 biggest company are represented.

In this OKIR database, some waste production data are also available for primary production of waste relating to different (NACE) sectors or grouped by EWC codes.

The settlement territorial information database of the HCSO is rich in data, however, for our purposes we can only use very few datasets, just to show the origins of some agricultural entity that can be relevant for the OW production.

Some of the companies (such as Tesco) published some data with CSR purposes that can be used limitedly for MFA purposes, rather in downscaling process.

There was not scientific literature found on calculating food or park and gardening waste relating to the analysed case study area of Pécs, Pécs agglomeration or Baranya county.

[47] OKIR database

Parallel with the below described up-scaling and primary data collection processes, we decided to collect data from the local waste management company as the Biokom Group also collects waste (food waste and park and gardening waste) from companies.

Biokom database is based on the weight measurement of trucks collecting waste in the Mecsek-Dráva waste management project area. The database includes all the weight data of all the tracks in 2017 and can be filtered by the final destination of the waste (e.g. composting plant, sorting plant, biological treatment, mechanical treatment, landfill etc. (cf. Picture 6). Filtering the "target place" of composting plant suppliers can be identified.

Collecting primary data

In our case, collecting primary data was twofold. Firstly, we followed the procedure in the pilot cases and sent out questions to the companies where e-mail was available in the ORBIS database. In this survey we included all the companies we identified in step 4, including the institutions that usually use regular waste bins and can be evaluated with the household domain (using the MSW data from Biokom Group). Out of 4,486 companies (including production, retail, wholesale and 'institutional' sectors, excluding actors with waste management activity) 1,231 had e-mail addresses in the Orbis database, hence 1,231 e-mails were sent out (on the 12th of November, 2018) surveying the production and treatment of OW. Additionally, e-mails to Atev Zrt, Pannon/Veolia Power Plant and to Biofilter were sent out in order to gather data for the MFA for the Pécs agglomeration. (Atev is responsible for collecting and treating animal-protein waste, Biofilter is responsible for the collection of used oil and food-waste from big producer companies in Hungary, by the law. Pannon/Veolia Power Plant is the electricity and district heating provider for Pécs burning biomass in its blocks.)

We received more than 100 'answers' as the mail is undeliverable as the mail address was not working anymore. We received 22 real answers. 16 out of them was a kind reminder that they are not dealing with OW respectively. 2 of them refused to answer due to their business reason. 4 of the respondents provided data. Since, similar to AMA (D3.3), the result and the amount and representation of collected data were very limited. However, one of the respondents was the park and gardening maintenance branch of the city and they allowed us to use their data, since in this case we inserted these data into our MFA analysis.

Downscaling OW data

Relating to Hungary there we did not find similar unpublished report such was available for AMA analysis. Therefore, besides the above mentioned secondary data sources other related special datasets and reports were collected in order to have more data and to use them for downscaling. These data are structured in the following subchapters where we describe how and where company OW is 1) generated, 2) collected and 3) treated.

1) Generation of company waste

As it was stated in D3.3 at the European level, companies are responsible for 47% of food waste generated in the entire chain; 12% in primary production, 18% in processing, 5% in retail and 12% in food service (Stenmarck et al., 2016).

For company waste – in the Pécs case – OW can be collected under the following categories: MSW, animal-proteins, Oil, fats and swill, park and gardening waste.

MSW

According to the 309/2014 Governing Order, those companies which do not have contract with the local waste management provider have to make a yearly report on their waste generation and treatment. It also means that mainly small companies, institutions, educational institutions have contract (based on the interview and data with local waste management company) with the local waste management company (namely Dél-Kom, member of the Biokom group). These companies put their wastes into the regular waste bin that means their OW appears in the MSW. We calculated – as in the case of household – that 26% of their waste is the biodegradable organic part (see the Table 10: Composition of mixed municipal waste collected in Pécs in 2017).

Animal-protein waste

According to Eurostat data (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en) in 2016, in Hungary 15,908,288 tonnes of waste was generated in all NACE activities and households. Out of this amount, 734,568 tonnes were Animal and Vegetal wastes.

Oil, fats and swill

Used oil, fats and swill are generated in food service (F) sector and they must be collected separately. Oil and fats from smaller companies (and household sector) can appear both in MSW and in household waste collecting depos and in the ending up in the sewer by being disposed of through the sink or toilet.

Park and gardening waste

In the Hungarian case besides food waste, we are calculating with park and gardening waste as a part OW (as it is described above). In the Pécs case in the company sector park and gardening waste is mainly generated at vineyards (P1 growing of grapes), fruit gardens (P1, A1.2.x). One of the responding[48] vineyards reported 190 m^3 of gardening waste from 31 ha (in Pécs) that was given to Biokom group for further treatment (composting).

[48] The respondent asked to use the data confidential, without mentioning the name of the responding entity.

An important actor producing park and gardening waste is the Hungarian State Railway (MÁV) with its railway maintenance activity.

A major generator of park and gardening waste is the City of Pécs (namely its City Maintenance Branch that recently belongs to Biokom Nonprofit Ltd.). The maintenance of the parks and gardens of the city of Pécs generated 823,900 kg of organic waste. These are the most important sectors for park and gardening waste production.

Other secondary data for the MFA

An Interreg research project (Gruber and Obersteiner, 2016) investigated and estimated the generated amounts of food waste in some Central European countries by sectors. The amounts can be found in Table 11.

Country		Generated Amounts of Food Waste				
Hungary		Amounts (t/year)		Reference	Information on data source	Data gaps
Sectors of Food Supply Chain		Total Food Waste	Avoidable Food Waste			
1.Production	Total	41,580.79	n.d.	EHIR - National environmental information system	Environmental data browser	Only data from EW C subgroup (02 01): animal- and plant-tissue waste and wastes not otherwise specified were found
2. Processing	Total	292,476.4	n.d.	EHIR - National environmental information system	Environmental data browser	
3.Wholesale/ Retail/ Market	Total	4,750.09	n.d.	EHIR - National environmental information system	Environmental data browser	The data do not cover the total amount of waste from this category. Cannot enable other amounts because it has been treated together with the

						household waste. The EWC 20 03 02 contains more waste than the food waste but cannot be separable
4. Food Service	Total	4,690,454	n.d.	EHIR - National environment-tal information system	Environ-mental data browser	Only data about biodegradable kitchen and canteen waste
5. Households	FW-RW	184,246.7	n.d.	EHIR - National environment-tal information system	Environ-mental data browser	Only biodegradable waste data (EWC 20 02 01); data for waste contained in different fractions not available

Table 11: Generated food waste amounts in Hungary (2015)
Source: http://www.reducefoodwaste.eu/uploads/5/8/6/4/58648241/d.t1.1.1_sq-report_final.pdf p.75.

Another dataset of produced waste can be found in the OKIR database. Although it is grouped by NACE rev02 categorisation, the rate of OW within the amount of generated waste cannot be differentiated and the dataset only uses the first two digits of NACE codes (Table 12).

Sector	***Hazardous waste amount (kg)***	***Non-hazardous waste (kg)***	***Total***
A1 – Crop and animal production, hunting and related service activities	7,882,694	394,240,084	402,122,778
A2 – Forestry and logging	63,619	1,832,208	1,895,827
A3 – Fishing and aquaculture	3,329	191,166	194,495
C10 – Manufacture of food products	2,034,758	455,320,252	457,355,010

C11 – Manufacture of beverages	837,941	35,650,896	36,488,837
C12 – Manufacture of tobacco products	10,486	23,70,640	2,381,126
G46 – Wholesale trade, except of motor vehicles and motorcycles	3,902,986	64,156,160	68,059,146
G47 – Retail trade, except of motor vehicles and motorcycles	5,172,123	134,226,649	139,398,772
I55 – Accommodation	205,301	4,487,553	4,692,854
I56 – Food and beverage service activities	89,413	9,445,350	9,534,763

Table 12: Generated waste by sectors in Hungary in (2016)
Source: OKIR database

What is richer in data for an analysis is another dataset (from OKIR database) that includes EWC codes besides the sectors.

Tesco is the only retailer in Central Europe that measures and publishes own food waste data. In 2018, Tesco's total food waste was reduced to 38,054 tonnes compared to 54,102 tonnes in 2016/17. In Hungary Tesco was able to reduce food waste by 35%, from 14,991 tonnes to 9,764 tonnes. According to Tesco data the food waste percentage was 2% in the financial year 2016/17 and 1,1% in 2017/18 in Hungary. (http://www.tescomagyarorszag.hu/en/tesco-and-society/food-waste/food-waste) In the following figure (Figure 38) the composition of the food waste generated by Tesco can be found.

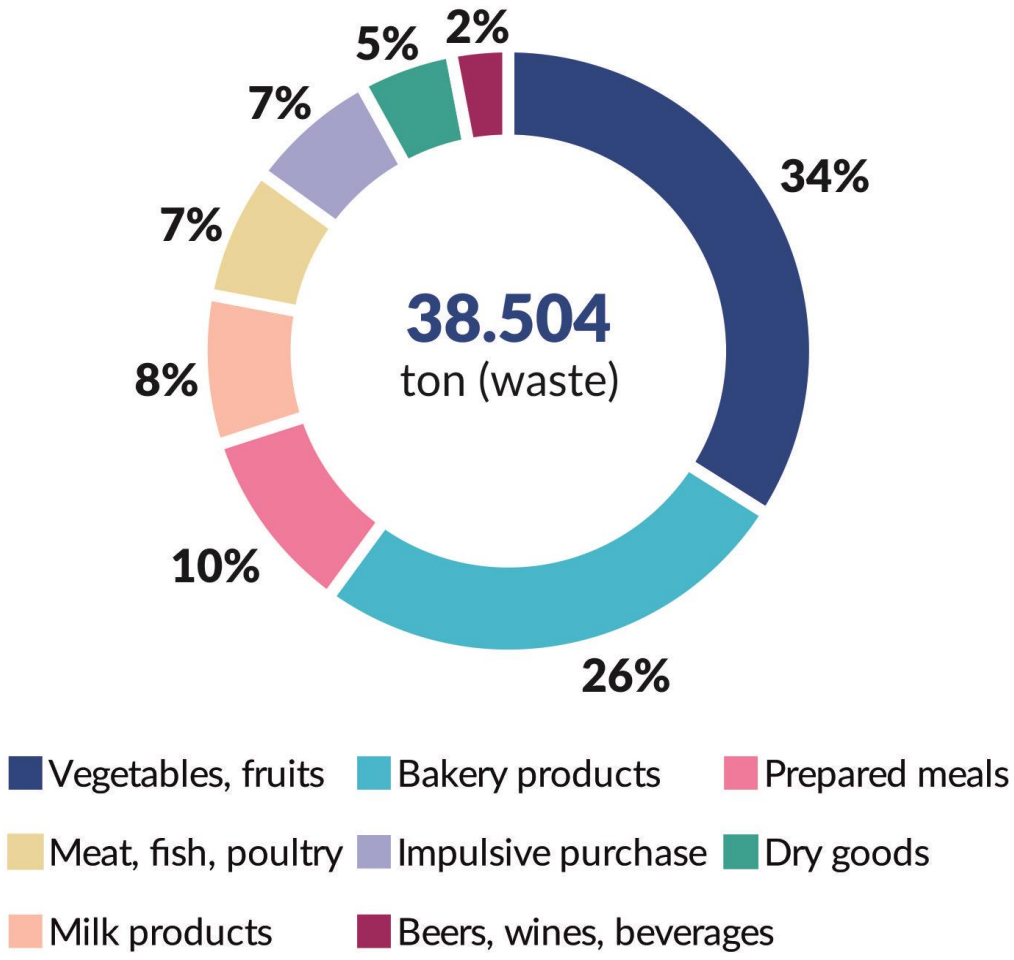


Figure 38: The composition of food waste generated by Tesco in the financial year of 2017/18 in Central Europe
Source:
http://www.tescomagyarorszag.hu/hu/k%C3%B6z%C3%B6ss%C3%A9gek/%C3%A9lelmiszer-pazarl%C3%A1s-elleni-k%C3%BCzdelem/elelmiszer-hulladek-jelentes

2) Collection of company waste

Collection of company waste in Hungary is related to the size of the company on the one hand, and to the type of the waste on the other.

Small companies (such as bakeries) usually use the regular waste bins for disposing their food waste, since their (organic) waste appears as a part of MSW. Major producer, wholesale, retail and food service companies are obliged to make contract for dedicated companies to treat their major food waste flows: oil and fat is collected by Biofilter, animal-protein waste is collected and treated by (the state owned) ATEV Zrt. Animal-protein waste (collected by ATEV Zrt.) is disposed and handled outside of Pécs agglomeration focus area and region (Baranya county). Altogether, in 2016, Biofilter

collected 13,000 tonnes of used oil, fat and swill in Hungary for further processing (for biogas or biodiesel production)[49].

All the organic waste (823,900 kg) generated by the maintenance of the parks and gardens of the City of Pécs was collected by Biokom (city maintenance branch) and was transported for composting purposes to the Kökény Regional Waste Management Centre.

3) Treatment of company waste

As it was described above, the used oil and fat and the animal-tissue waste is collected and treated by state-owned non-profit companies (Biofilter and ATEV Zrt.).

Based on an interview made with one of the biggest meat retailer companies in Pécs another flow appeared. Concerning the interview, in those cases where the 'use before date' has expired and the meat is not vitiated, the meat can be transported to the local Zoo (in Pécs) for animal feeding.

Company related park and gardening wastes (unless they are treated onsite) are treated at the Kökény Regional Waste Management Centre and are composted. Another smaller part of OWs (such as Christmas trees after the Christmas season) are burned at the biomass blocks of the local power plant.

An increasing treatment of company 'food waste' is donation. Although there is a strict regulation for the treatment of food waste, more and more food waste are donated for feeding purposes to poor people. The Hungarian Food Bank Association is organising (not only in Christmas/'donation' seasons) the collection and distribution of food 'waste' (usually food with out of best before date).

Having regarded donation – as a treatment of food waste – more and more private initiatives appear. According to the above cited Tesco report, in Hungary, in the financial year of 2016/17 3,737 tonnes, in 2017/18 7,299 tonnes of 'food waste' were donated.

Joining databases, downscaled and upscaled data for company flows

For the purpose of AS-MFA at company level, finally three databases were used in the Pécs agglomeration case. One from the Orbis, the other one is the Biokom database from Biokom (that contains the weight of the wastes collected by the company during the year of 2017), and thirdly a database from the Ministry of Agriculture. This latter contains all the companies that have to report their waste generation in a year. The companies have to report about that part of own waste generation which is not collected by the public service provider as municipal solid waste[50].

[49] Zip Magazin, December, 2017, p.30.

[50] 309/2014. (XII. 11.) Korm. rendelet a hulladékkal kapcsolatos nyilvántartási és adatszolgáltatási kötelezettségekről

Ministry of Agriculture database

The database from the Ministry of Agriculture contains all the companies and their sites who are obliged to report their waste generation. This database contains only the type of the company, the company environmental ID (KÜJ), the environmental ID of their sites (KTJ), the geocode location, and in same case the NACE code of these companies. There are no data for waste generation, number of employees, revenue and the name/statistical/tax ID of the company. Therefore, another dataset was asked from the Ministry of Innovation and Technology where company statistical/Tax ID and company environmental (KÜJ) ID is available and can be joined to the ORBIS database. The Ministry of Innovation and Technology – after a long mailing procedure – promised this database by the 15th of January, 2019.

Anyhow, in this database 3,458 sites could be identified in the Pécs agglomeration. After a filtering to relevant potential OW chain 412 sites could be identified.

Biokom database

For analysing the case study of Pécs, we asked the local waste management company (BIOKOM group) to provide us waste collection data for a whole year of the waste treatment site of Kökény (that is the central waste treatment site in the wide region). (The database is based on the weight of waste delivered to Kökény Waste Management Centre during the year of 2017.) It contains 27,788 records about the waste delivery of 251 businesses/other institutions. The first step was to filter the data for the organic wastes, thus, we only kept the records associated to the following EWC codes: 20103, 20304, 190503, 200201 and 200302.
In the next step we applied a filter for Pécs and its agglomeration as focus area and the districts of Budapest. The reason for the integration of companies with capital city's location was that some of the big waste producer companies (especially retailers) have registered address in Budapest. After the filtering we ended up with 40 actors for OW. These 40 companies are the biggest who are transporting OW to Kökény for composting purposes. Besides the 40 company actors there were two main 'suppliers' in this database, namely Biokom and Dél-Kom. Under the amount of these two companies the waste amount of households and the waste amount of (smaller) companies can be found – those companies who have contract with the waste local service providers (Biokom and Dél-Kom). It was not possible to identify the companies behind.

Orbis database

To use the database of ORBIS for processing and representing the main OW flows in the Pécs agglomeration we mainly followed the process of AMS case in D3.3. Firstly, concerning the steps No1, No2, and No3 company data from ORBIS database were

downloaded with the indicated NACE codes (that might relate to OW flows in Pécs case). For the company related analysis Institutions (and households) were excluded from the list, as well as not relevant (false) records. This filtering process resulted in 1,370 potentially relevant companies in the Pécs agglomeration.

Having a look at the employees of the Orbis, it can be realised that more than 63% of the companies did not have data for 'number of employees'. Those companies where the name is the name of the owner (sole proprietorship) the number of employees were filled with '1'. In other cases – based on format of the company (Ltd. or Limited Partnership) – we made estimation based on the Hungarian average (calculating based on the Hungarian Tax Office database, 2015). Afterwards, the total number of employees per sector for Hungary was taken into consideration. (The database of the employees for Hungary is mixed. What is available and is used for the process model is shown in Table 13 below).

NACE category (available in HCSO)	A - Agriculture, forestry and fishing	C - Manufacturing	C.10. Manufacture of food products	G. 471-479 (Retail trade, except of motor vehicles and motorcycles)	I - Accommodation and food service activities
Number of employees	217,300	997,800	133,500	366,700	172,500

Table 13: Employees in different sectors in Hungary (Jan-March, 2018)
Source: http://www.ksh.hu/docs/hun/xstadat/xstadat_evkozi/e_qlf005a.html?down=468

(We should mention here that because of the above mentioned gaps of Orbis database, the results of the processes and representations we drew up based on ORBIS are not entirely reliable.)

For downscaling we use the above mentioned Table 13 that shows the wastes generated by different sectors. Using the data of employment in different sectors we can define the food waste per employment in different sectors, hence inserting these data to the Orbis dataset we can calculate the production of food waste of companies in the Pécs agglomeration in some sectors that can be matched in the two databases (Table 12, 13).

Joining databases

In order to get a more precise dataset we tried to join the Orbis and Biokom databases (although the latter only consists of 40 relevant actors). To do so we had to find a key feature, but in this format this was impossible. In the Orbis the only resemblance for an ID was the BvD ID number which is the same as the KSH (Hungarian Statistical) ID number. In the BIOKOM database there were only KÜJ (for the organisations) and KTJ

(for the sites) IDs, that are special ID numbers of waste generators in Hungary. To make a connection with KSH ID, we need another dataset from the Ministry of Innovation and Technology; however, as it was described above, we have not received these dataset so far. Therefore, we tried to join the two databases manually, based on the names of companies.

As Agricultural dataset has fewer possibilities to join the database to Orbis (as there is no common ID for joining these two databases), hence we treat this database separately. However, in a later stage – for GDSE data upgrade – it is necessary to use these data as well. The reason is that a major amount of retailers are missing from the Orbis database, namely those who have their headquarters outside the region (NUTS2 and NUTS3) downloaded from Orbis. However, the branches of these retailers (e.g. Tesco, Aldi, Lidl, SPAR) are in the Agricultural database with geolocation.

Material flow analysis of the organic waste chain

Similar to the AMA pilot, as the system diagram of food waste shows, two subsystems can be identified:

1) organic waste from households and institutions consumption

2) organic waste along the value chain outside households but nevertheless located in Pécs agglomeration.

Since the household and institutional flows were integrated into one subsystem, due to the similar waste collection practice of the public service provider, we analyse them together. At the same time the companies' subsystem will be presented separately as different method for data collection and modelling was applied for this subsystem.

Representation & Process Models of the Household and Institution Related Organic Waste Chain

According to waste collection process Pécs is divided into at least five and the total neighbouring area another three main districts (see Figures 39-42 and table 14):

1. City centre, where MSW is collected (door-to-door) more than twice a week, packaging and green wastes are collected door-to-door;
2. Peripheral districts of Pécs and one settlement (Abaliget) from the agglomeration where MSW is collected once a week, and collection of separated packaging and green (compostable organic) waste is not available (in these areas the selective collection islands and civic amenity sites are available for the residents);
3. Hilly districts of the city, where only MSW is collected door-to-door (in small bins) twice a week, green waste is treated by home composting (in these areas collection islands and civic amenity sites (waste yards) are available for the residents to collect separately their packaging wastes);

4. Districts with high-rise buildings, where MSW is collected door-to-door (with 1,100 litre bins) twice a week and the separated packaging waste is also collected door-to-door (with 1,100 litre bins), but the green waste collection options are not available;
5. Other districts of the city where are door-to-door collection of MSW (twice a week) and separated packaging waste and green waste are available;
6. Settlements from the agglomeration where MSW is collected once a week, and door-to-door collection of packaging and green waste is available;
7. Settlements of the Pécs agglomeration where MSW is collected once a week, and door-to-door collection is available for the packaging waste (and not for the green waste);
8. One settlement (Orfű) from the agglomeration where MSW is collected once a week, and door-to-door collection is available for the green waste (and not for the packaging waste).

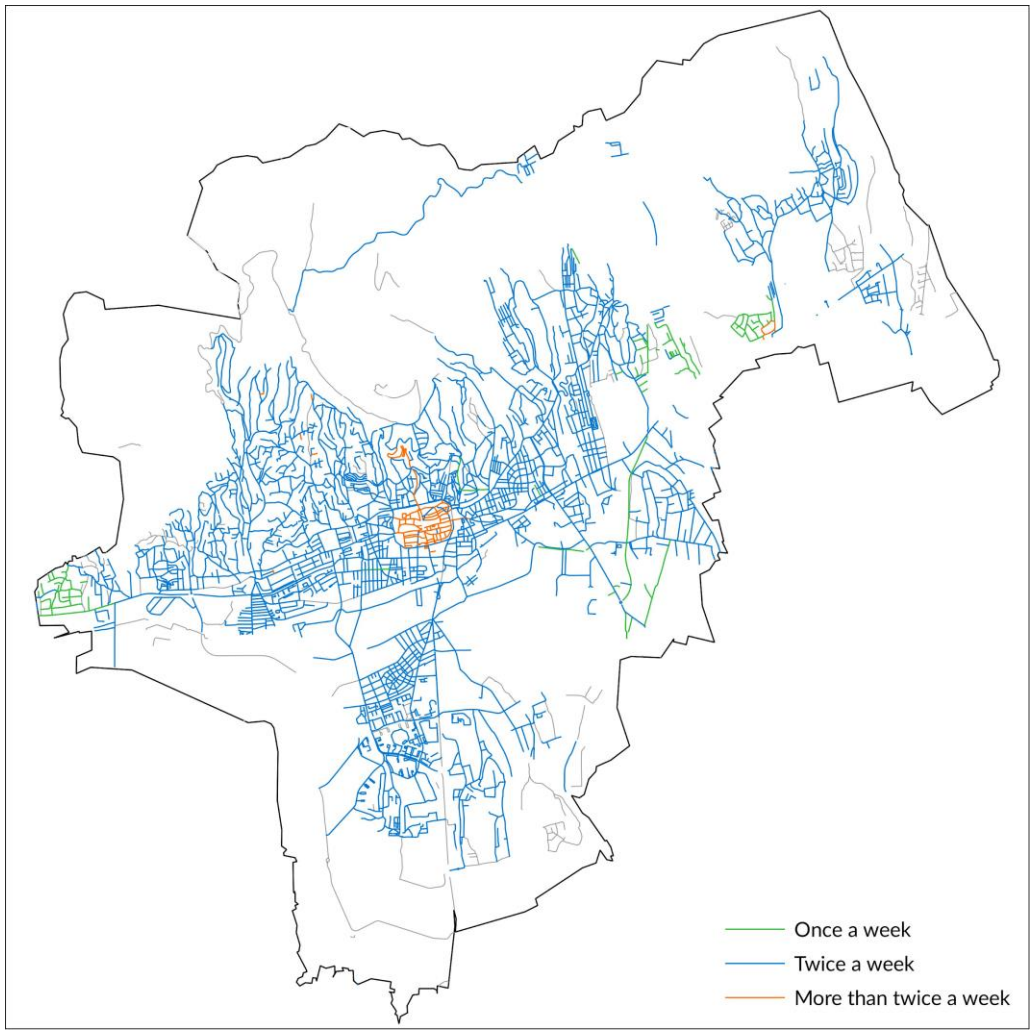


Figure 39: The frequency of the MSW collection in Pécs (2017)
Source: Biokom data

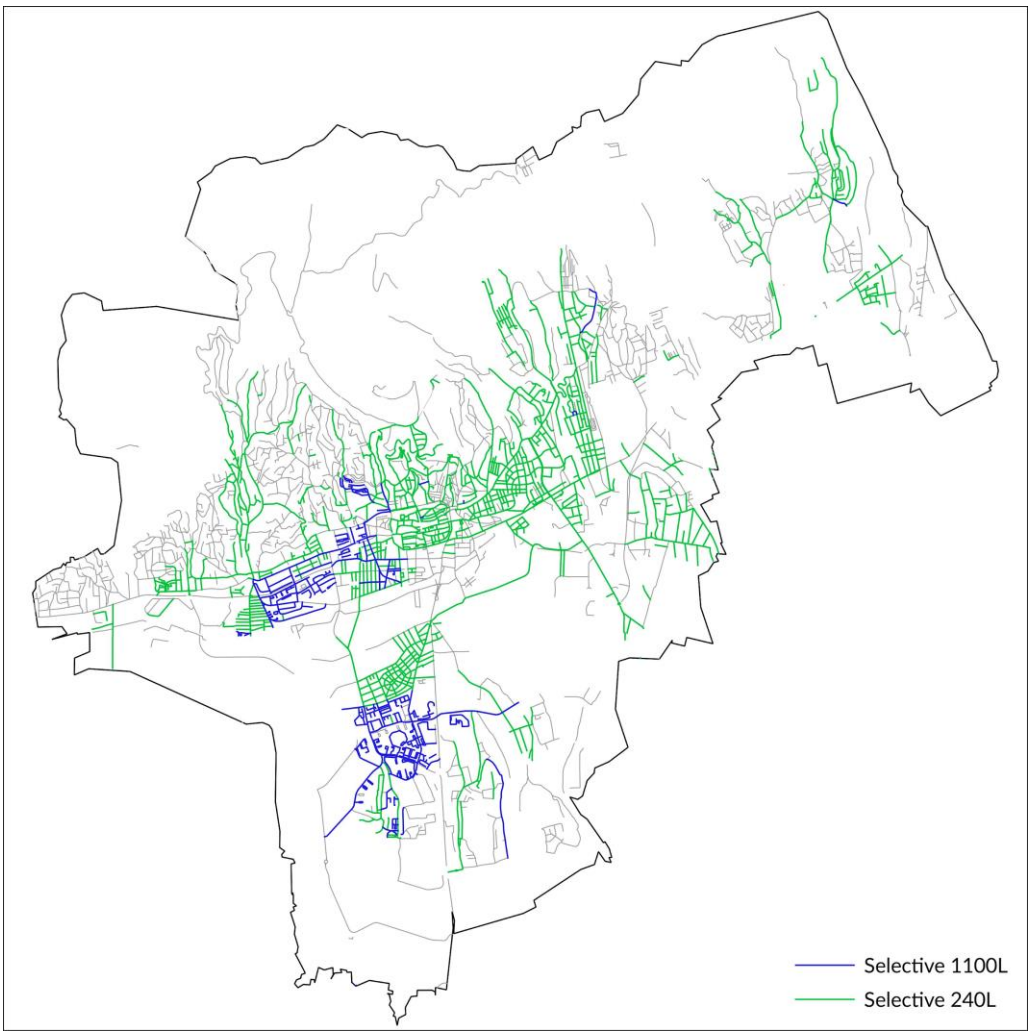


Figure 40: The distribution of the two types of selective bins (2017)
Source: Biokom data

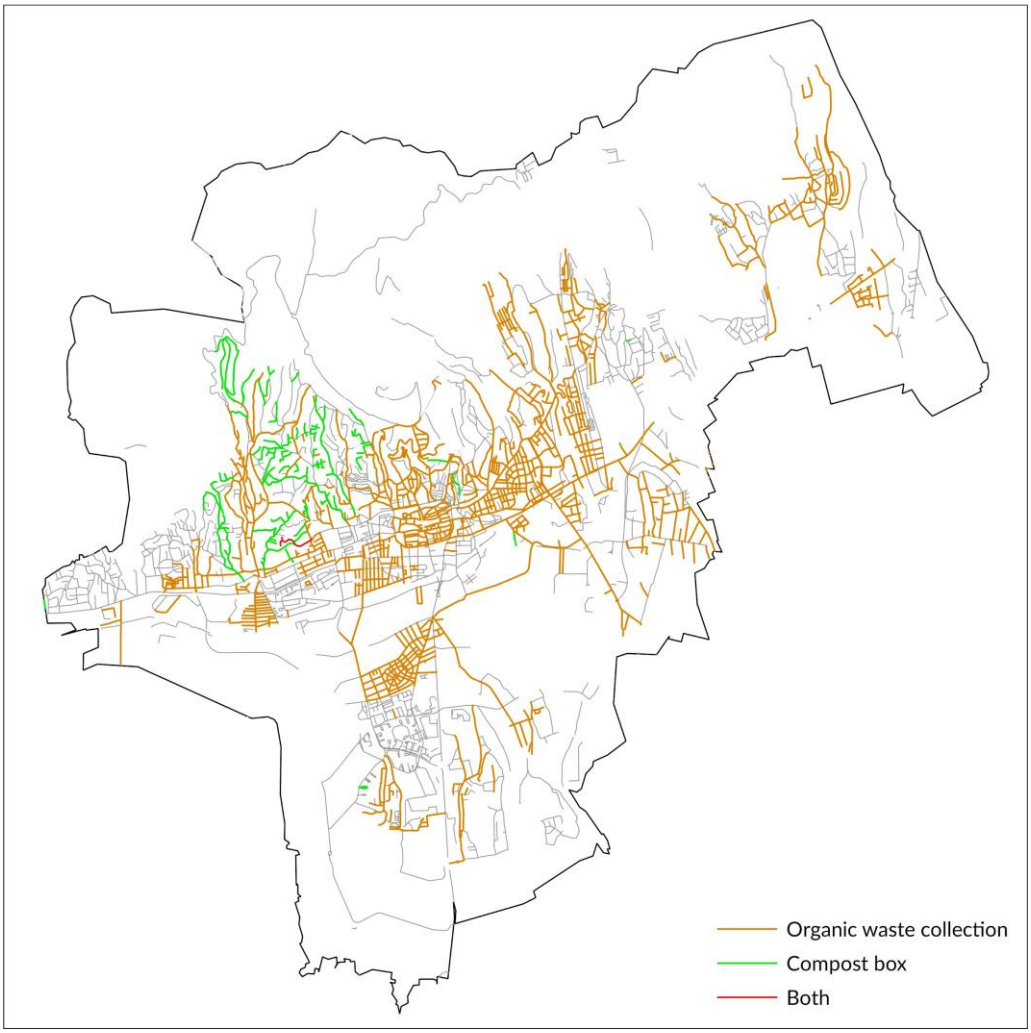


Figure 41: Organic waste collection and home composting area in Pécs (2017)
Source: Biokom data

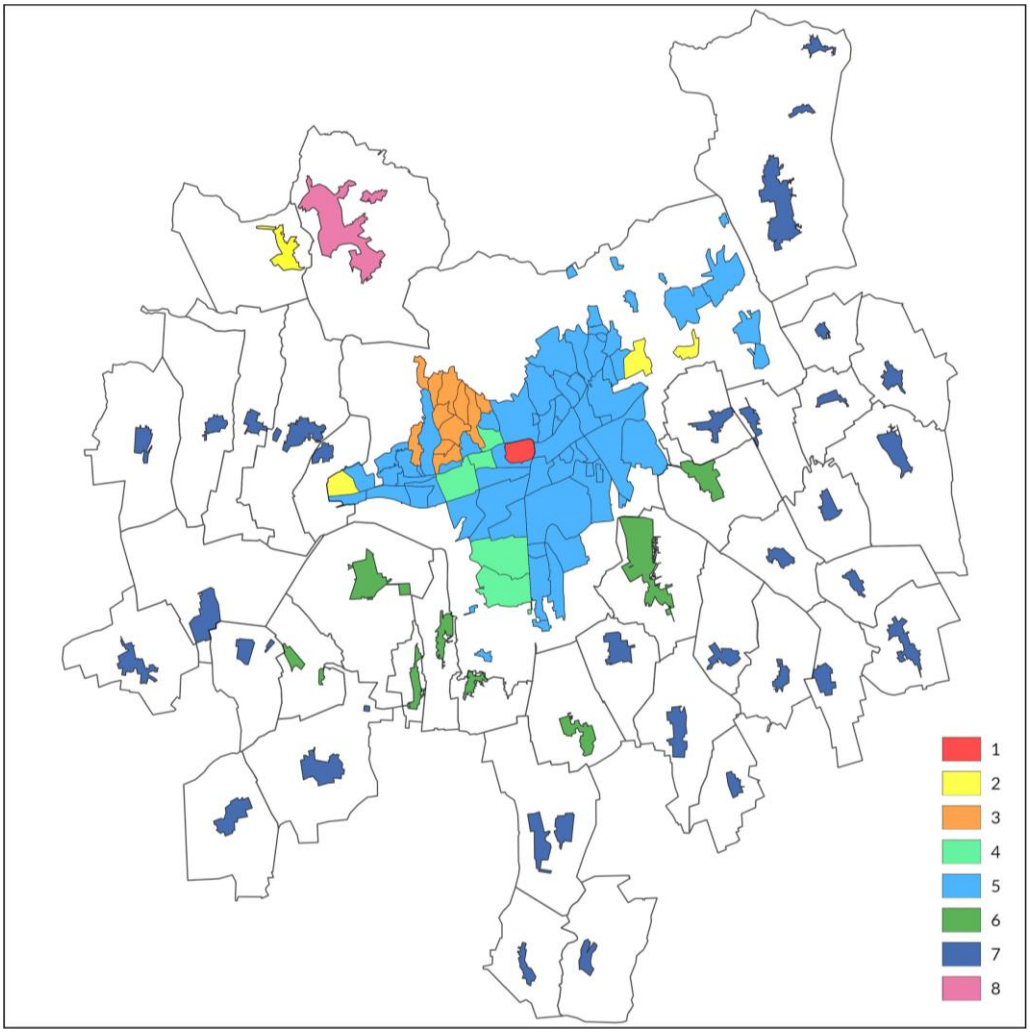


Figure 42: The typology of waste collection areas of the Pécs Agglomeration (2017)
Keys: 1) City centre of Pécs; 2) Peripheral districts of Pécs and Abaliget, 3) Hilly areas of Pécs, 4) High-rise building areas of Pécs, 5) Other districts of Pécs, 6) Neighbouring area with full service, 7) Neighbouring area without door-to-door organic waste collection, 8) Orfű
Source: Own elaboration

District categories	MSW door-to-door	Packaging waste	Green waste	Collection islands	Civic amenity sites (waste yards)
1	>2/week	door-to-door	door-to-door	available	available
2	1/week	no	no	available	available
3	2/week	no	home composting	available	available
4	2/week	door-to-door	no	available	available
5	2/week	door-to-door	door-to-door	available	available
6	1/week	door-to-door	door-to-door	available	available
7	1/week	door-to-door	no	available	available
8	1/week	no	door-to-door	available	available

Table 14: The waste collection categories of the Focus Area
Source: Own elaboration based on Biokom data

Organic waste from waste collected as residual mixed municipal household waste

The 365.7 thousand (2016) inhabitants in the researched area (Baranya county) produce 107.5 thousand tonnes (293.9 kg/capita) MSW from which 86%, i.e. 92,352 tonnes (252.5 kg/capita) are collected as residual waste. (The residual waste was calculated from the HCSO waste database (2018) from which the total MSW was reduced by the separately collected volumes). It looks better than the national statistics where the average MSW generation was 301.7 kg/capita and the residual part was 260 kg/capita. Within the Focus Area the MSW indicator reaches 261.2 kg/capita and the residual waste generation was 228.7 kg/capita (Figure 43 and 44).

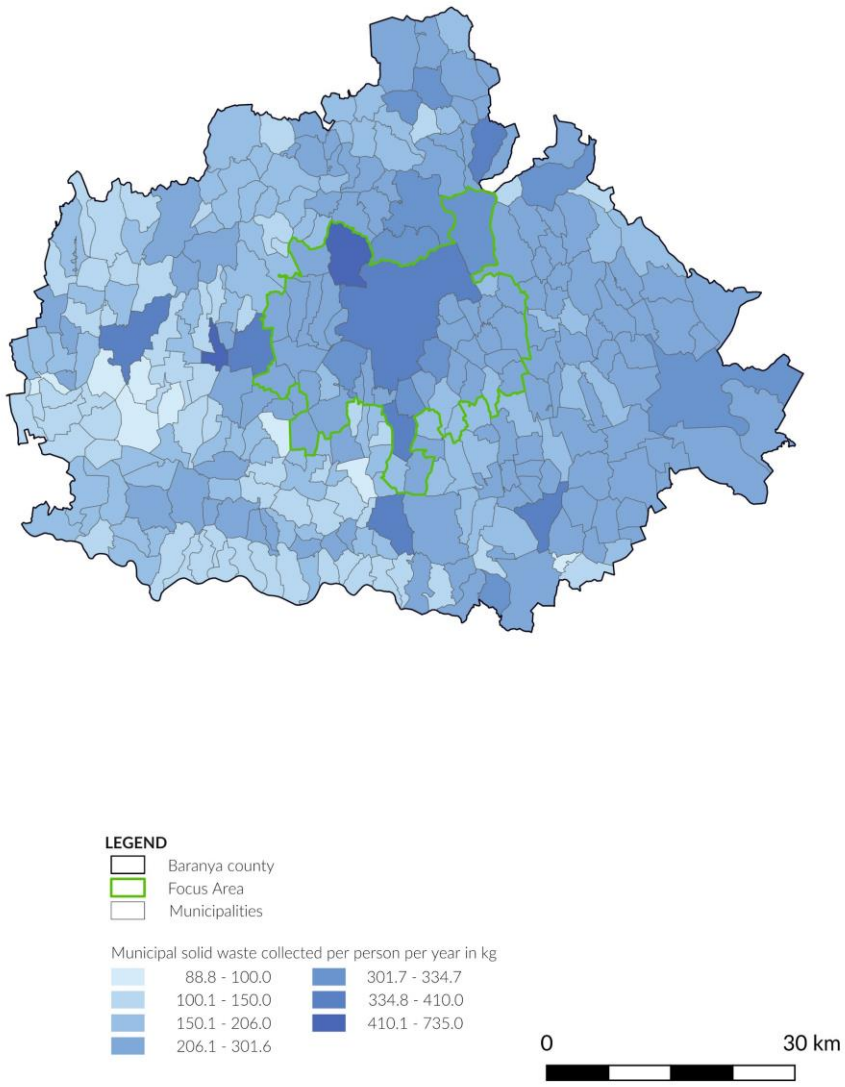


Figure 43: Generated Municipal Solid Waste per capita per year in Baranya county (2016)
Source: Own calculation based on HCSO statistics (HCSO 2018)

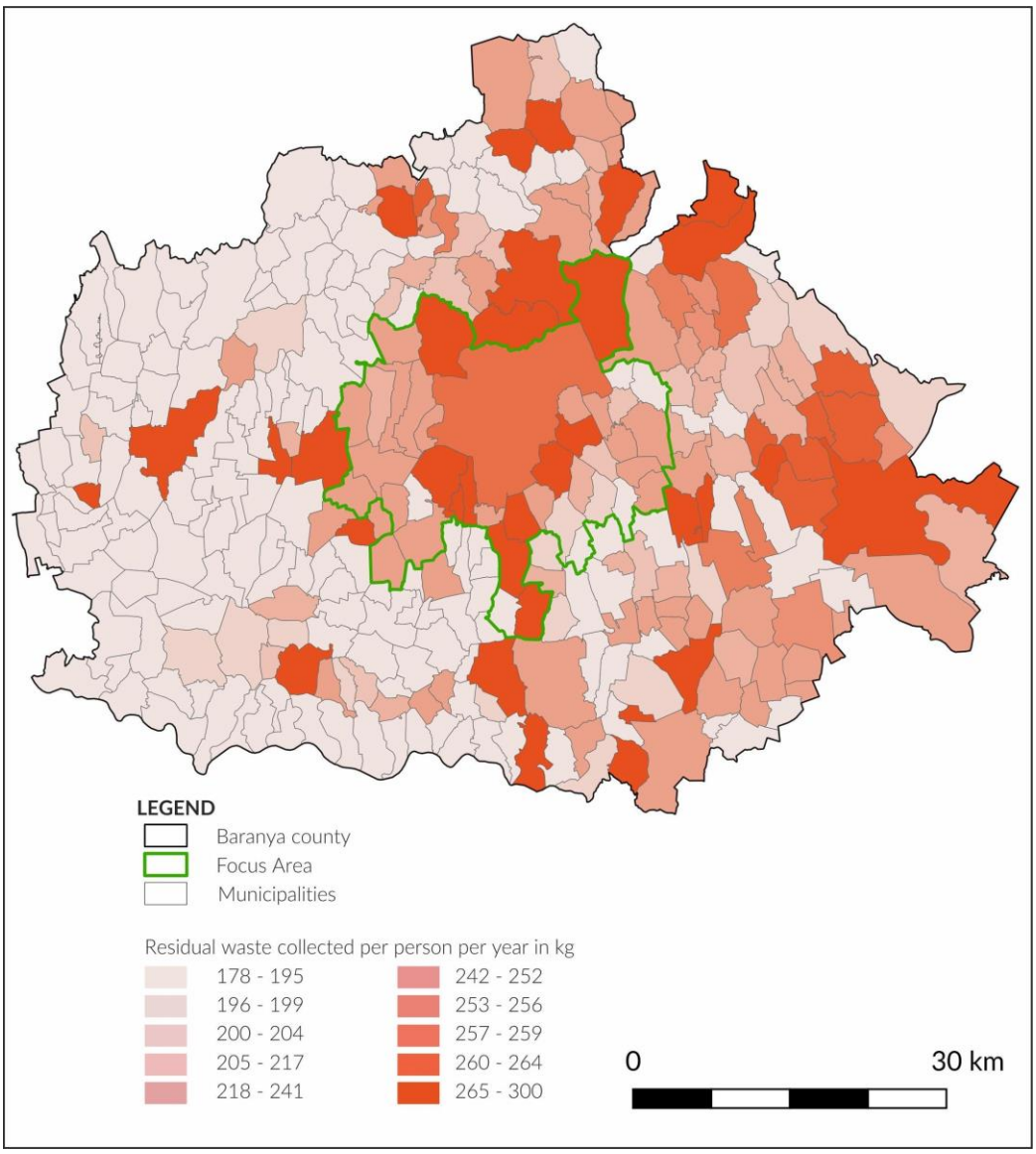


Figure 44: The residual waste generation in Baranya county per year per capita (2016)
Source: Own calculation based on HCSO statistics (HCSO 2018)

In Figure 44 it can be seen that the amount of residual waste is relatively low in Pécs that suggested us that selective collection is in good condition. The similar phenomenon can be seen in small settlements in Baranya as well. The reason for this latter can be that in smaller settlements in rural (poorer) areas people can treat their waste on site: they might compost the organic ingredients, while they can burn paper (and very often plastic bottle, especially in winter time).

From the national statistics (HCSO 2018) we calculated the generated organic waste per capita for the municipalities of the research area. The calculation method was based on the municipal residual waste generation (the total volume of MSW from households, institutions and public places reduced by the separately collected waste fractions). According to controlling database of BIOKOM group, we have estimation for the average biodegradable part of residual waste, which is 26.2% (Table 13). In our

calculation 26.2 per cent was taken from the residual waste in each municipality (it is the biodegradable part of residual waste) and it was increased by the composted part of total treated and incinerated municipal solid waste (Figure 45).

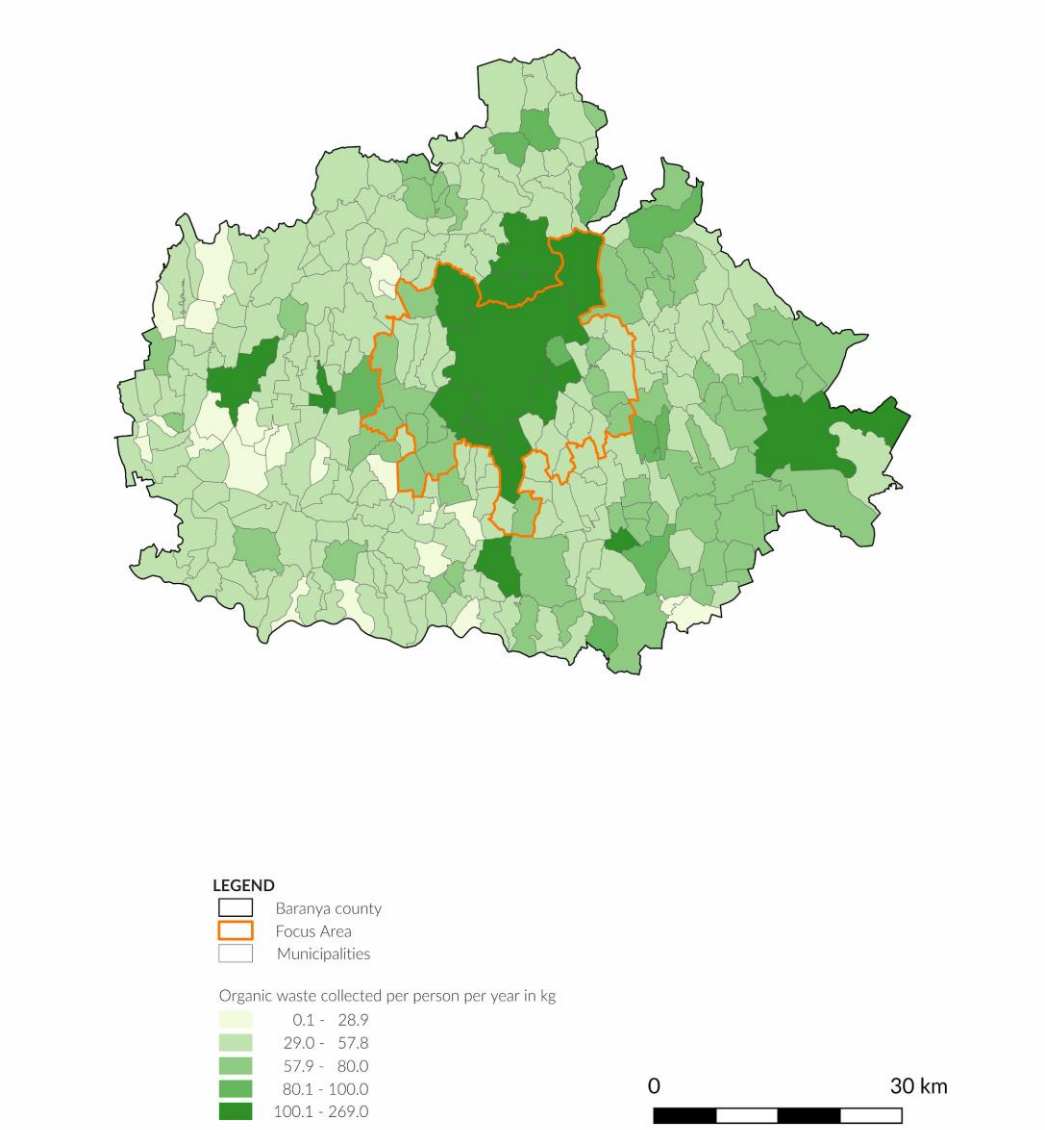


Figure 45: The organic waste generation per capita per year in Baranya in (2016)
Source: Own calculation based on HCSO statistics (HCSO 2018)

The organic waste generation ranges from 37.7 kg per capita (Martonfa) to 268.8 kg per capita (Orfű). According to the waste collection typology of the researched area, Martonfa is similar to the peripheral districts of Pécs (rare waste collection) without door-to-door organic waste collection, and Orfű is a typical tourist destination with a lot of green areas at the houses and recreational buildings. In Pécs the average (estimated) OW generation reaches 103.2 kg/person.

Organic waste related waste treatment in the Pécs agglomeration

As the main flow of OW at household level is "integrated" into the MSW flow (Figure 46) – and we have the rate of the biodegradable composition (based on the above mentioned sampling of Biokom –, we can draw up the flows of household OW (Figure 47) within the focus area (Pécs agglomeration) and beyond, using the data of the transfer station of the Mecsek-Dráva Waste Management organisation.

In Pécs, flows are going to the two transfer stations (Eperfás, Szigeti Tanya) and then to Kökény. From the agglomeration, some flows are going to the Szentlőrinc transfer station then to Kökény or directly to Kökény Waste Management Centre for further treatment.

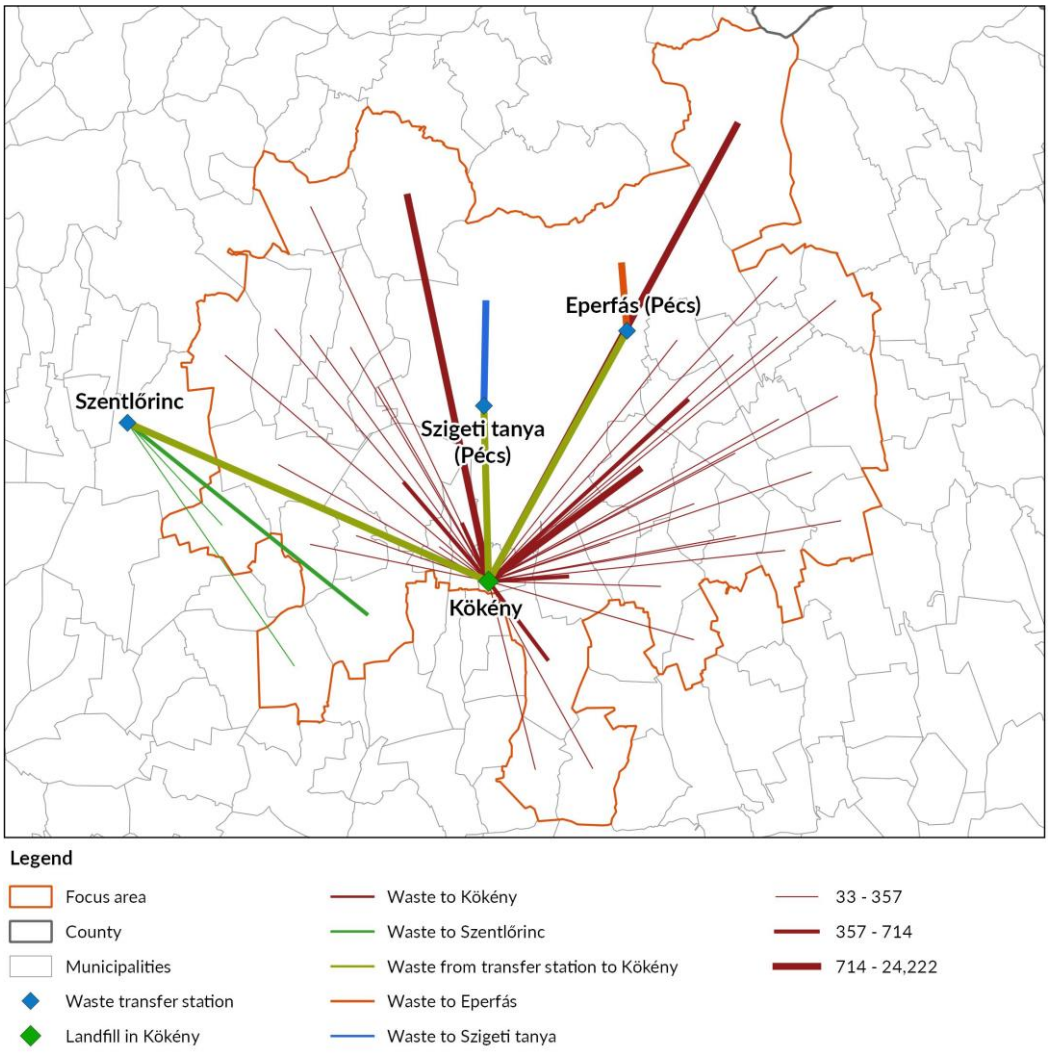


Figure 46: The flows of MSW from the households (centroids of the settlements) towards the transfer and/or waste treatment station(s) in Pécs agglomeration (tonnes) (2017) Source: Biokom database

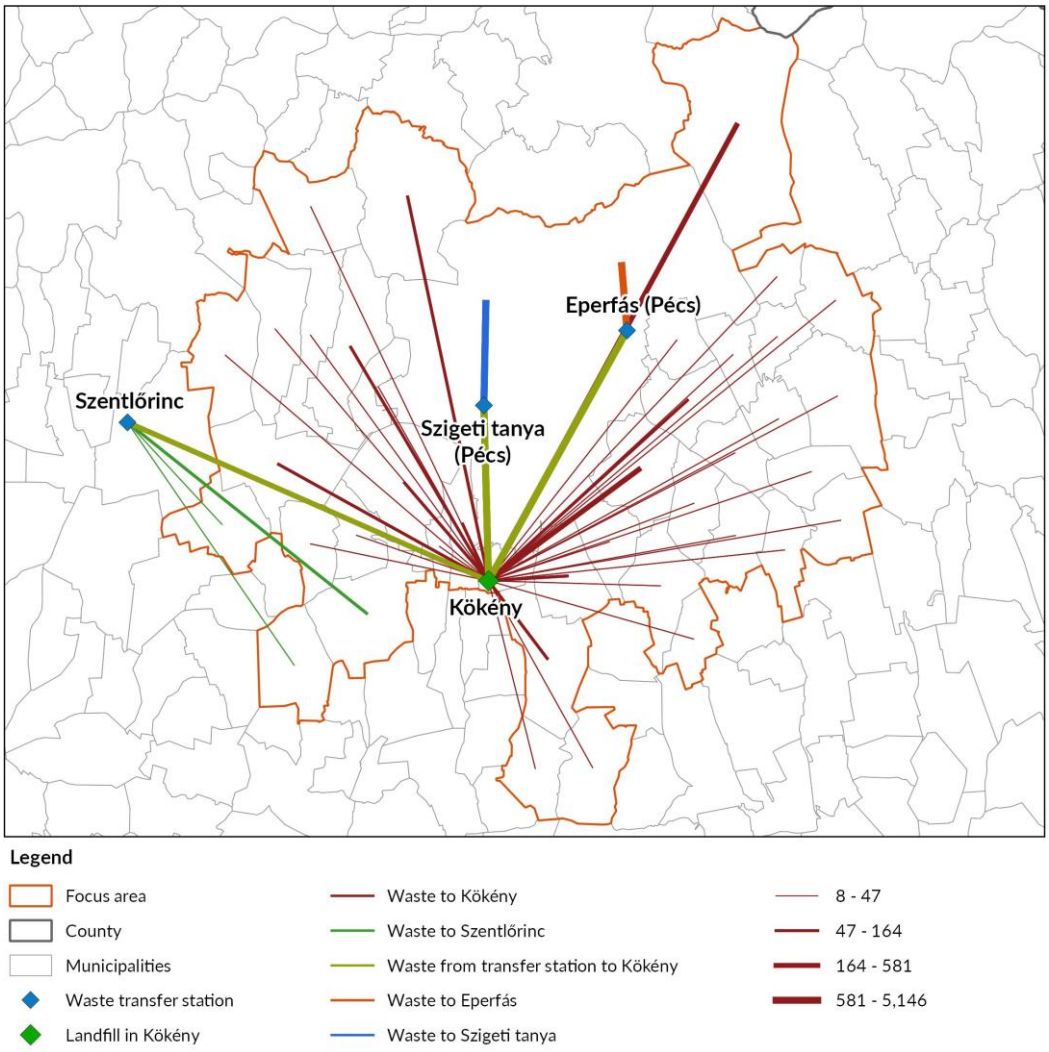


Figure 47: The flows of OW from the households (centroids of the settlements) towards the transfer and/or waste treatment station(s) in Pécs agglomeration (tonnes) (2017)
Source: Biokom database

Representation and process model of the company related OW chain

As it was described above, at the recent phase (due to the big gaps in databases described above) the processes and representation of the food and other biodegradable wastes are limited and alternative ways are needed to approach the main processes.

Processes in company related park and gardening waste

Based on the Biokom weight measurement data in Kökény (Regional Waste Treatment Centre), in 2017 9,302,560 kg biodegradable waste was deposited in Kökény for composting, coming from the wider region (South Transdanubia), from the service area of Mecsek-Dráva Waste Management Nonprofit Ltd. The amount of compostable green waste coming from the Pécs and its agglomeration was 8,909,240 kg. The composition

of this compostable OW is shown in Table 15, where the highest amount belongs to the EWC code of 20 02 (garden and park wastes, including cemetery waste).

EWC Code	***Amount (kg)***
02 01 03 - plant-tissue waste	30,560
03 01 05 - sawdust, shavings, cuttings, wood, particle board and veneer other than those mentioned in 03 01 04	5,300
20 02 01 - biodegradable waste	8,605,100
20 03 02 - waste from markets	268,280
SUM	*8,909,240*

Table 15: The composition of the deposited OW for composting in Kökény from Pécs agglomeration in 2017 by EWC categories
Source: Biokom database

In the Biokom database, most of the data is labelled as "Biokom" or "Dél-Kom" (as supplier) that means these amounts of park and gardening waste were collected either via the regular way of household OW collection or from the transfer stations/household waste deposit stations of the waste treatment companies. These OW wastes are mainly park and gardening wastes (less than 5% can be the food waste, according the interview of a representative of Biokom) and most of them are coming from the household sector. Out of 8,909,240 kg of OW transported for composting, 1,547,600 kg green waste was produced and transported for composting in 2017 in Pécs agglomeration. These wastes are usually generated by the maintenance of green infrastructure of the city (835,540 kg) or the maintenance of the parks and gardens of companies or institutions. The flows of these company related P&G waste can be seen on the Figure 48.

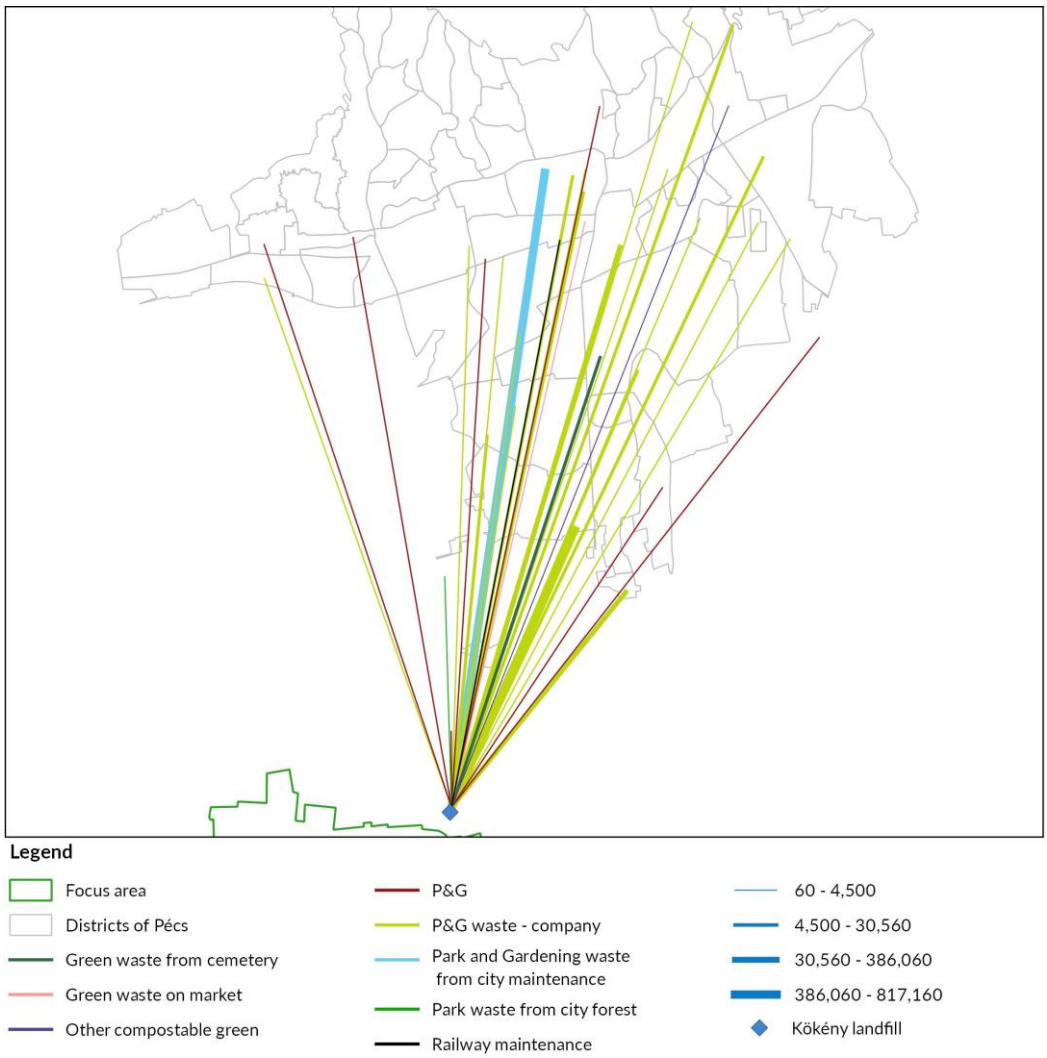


Figure 48: The material flow collected as P&G waste in Pécs agglomeration transporting to the Kökény composting facility (2017). It represents 1,547,600 kg P&G waste out of the 8,909,240 kg. (Note: Sometimes the location does not cover the real place of origin of the P&G waste as the location indicates the seat of the company and it was not possible to identify the real origin of the waste.)

Processes in company related food/biodegradable waste

When using the agricultural census in 2010 we represent the number of 'animal-unit', in order to indicate those areas where high attention is needed for animal faeces, urine and manure (EWC 02 01 06) (Figure 49).

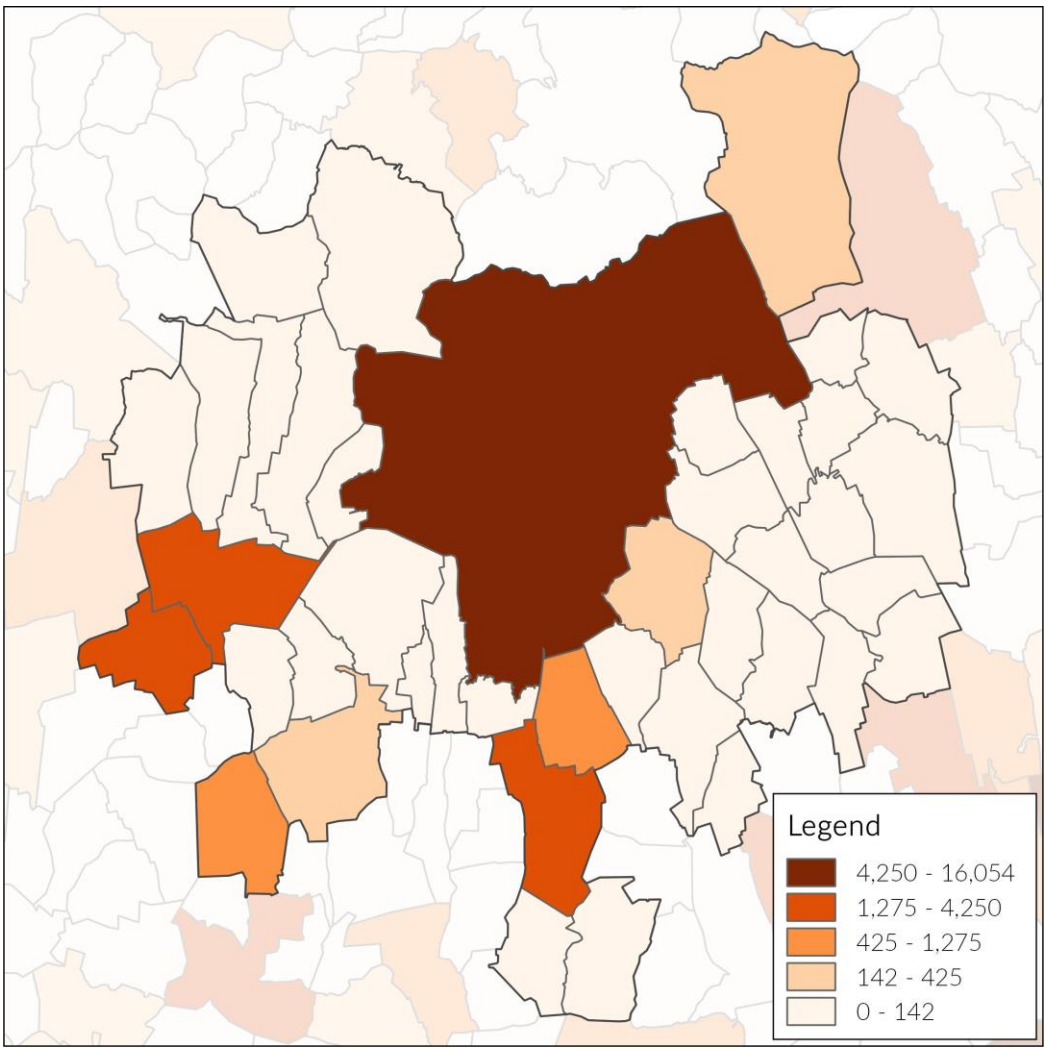


Figure 49: Number of 'animal units[51]' in the Pécs agglomeration (2010)
Source: Agricultural census – Hungary – TeIR

Based on the Orbis data and the calculation (described above) we indicated the amount of wastes (in kg) that can be provided by the companies in Food and Beverage Service (Figure 50), in Accommodation (Figure 51) (that clearly relates to the attraction sites of the focus area) and in Manufacture of Food (Figure 52) sectors.

[51] Animal unit is an administrative term for counting animals for different analysis. One animal unit (in Hungary) is equal to 1 cow older than 2 years or 1 horse older than 6 months. The amount of animal units of different types of animal are defined in the first Annex of the 57/2014 order of the Ministry of Agriculture.

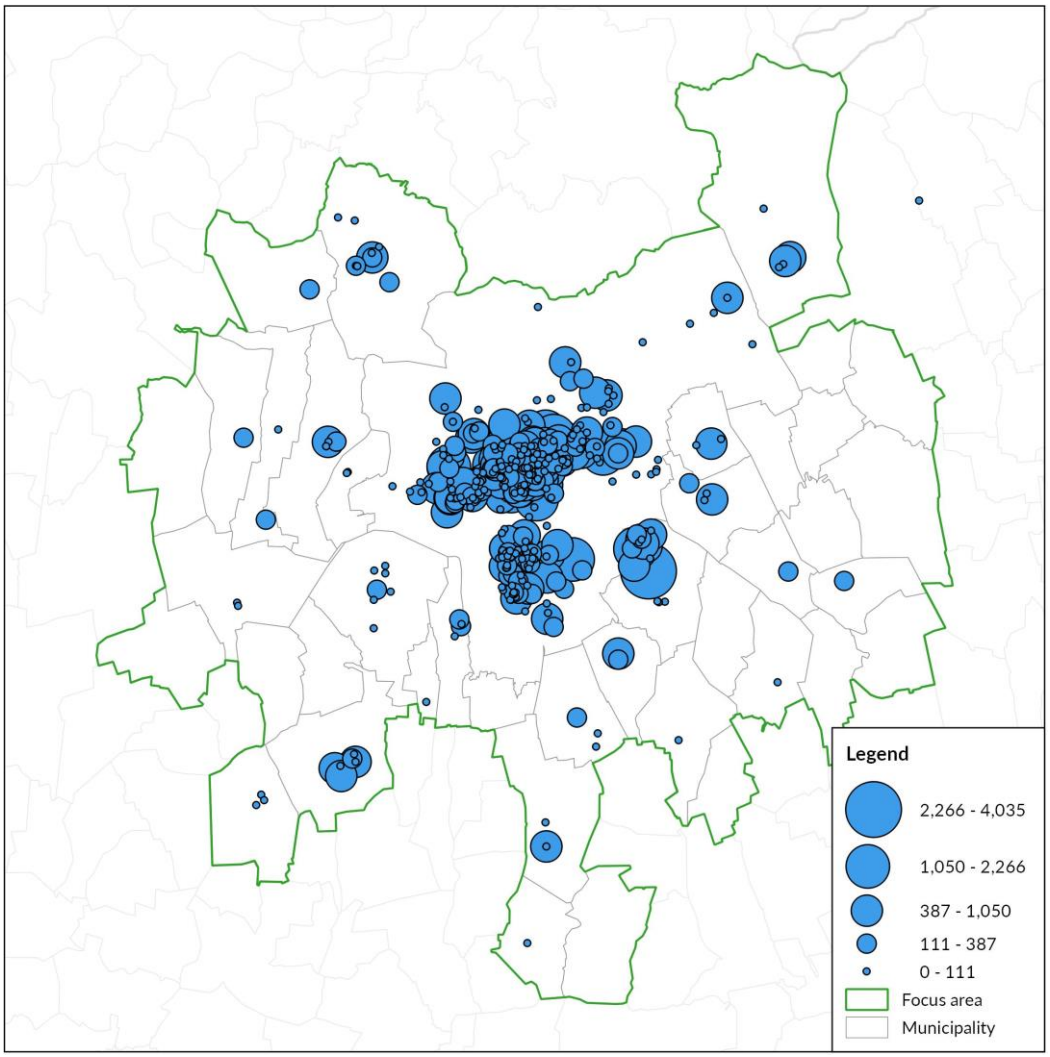


Figure 50: Amount of wastes that can be generated at companies in the Pécs agglomeration in Food and Beverage Service sector (2016)
Source: Own calculation based on OKIR, HCSO and Orbis data

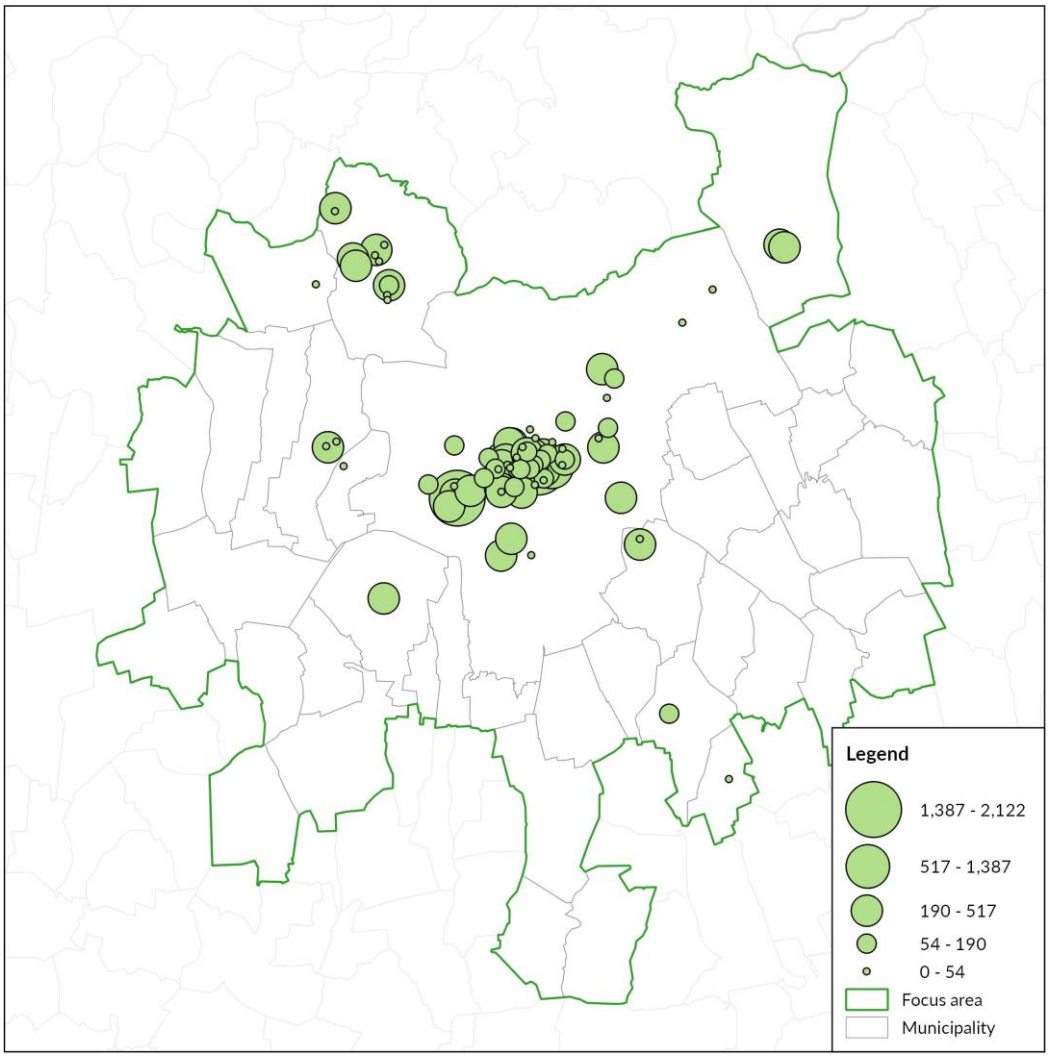


Figure 51: Amount of wastes that can be generated at companies in the Pécs agglomeration in Accommodation sector (2016)
Source: Own calculation based on OKIR, HCSO and Orbis data

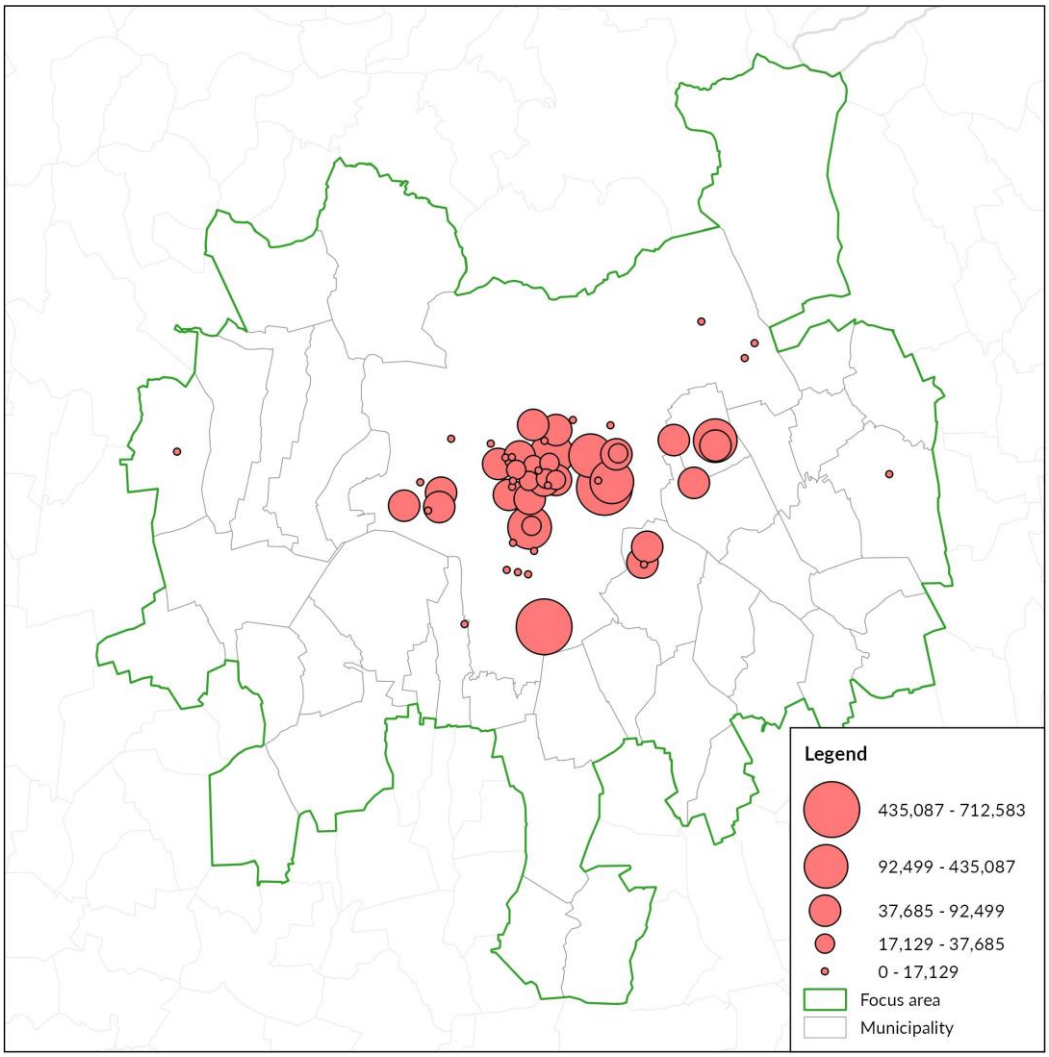


Figure 52: Amount of wastes that can be generated at companies in the Pécs agglomeration in Manufacture of Food sector (2016)
Source: Own calculation based on OKIR, HCSO and Orbis data

The regional circularity of agricultural and forestry by-products

As it was mentioned in an early sustainable development strategy – 'Pécs Eco-City, Mecsek-Dráva Eco-Region' (see in Chapter 3.2.7.1) –, the future vision of the city of Pécs and its wider region was to set up and enforce a cooperation, symbiosis (with short supply chains) where Pécs can provide industry products and services for the surrounding rural areas, while the rural area (around Pécs) can provide agricultural products. The main goal of this cooperation was to reduce the ecological footprint of the Mecsek-Dráva region. Besides the several individual-like small-scale attempts, the following 'allocation' can be an example for this kind of cooperation.

In 2004, the 45-year-old power plant changed its fuel from coal to wood-based biomass. The 49.9 MWp capacity biomass block substituted the former coal based electricity production and the district heating for the city of Pécs. Besides the wood based block, a natural gas based block also provided energy. In 2013 a new 35 MWp block was built for burning straw, collecting it from the surrounding agricultural areas. Since then the

power plant has been totally based on renewable energy using the resources from the nearby areas. (Due the fuel change, the power plant has had a huge positive impact on emission and the air quality of Pécs.)

As the Power Plant of Veolia in Pécs has an unavoidable role in the life of the city and has a significant relation to organic waste/flow and circularity in a wider spatial scale, here we are representing the processes of it. In Figure 53 a simple input-output scheme can be seen. The power plant basically uses the two types of biomass as input material (Table 16 and 17). (Natural gas is only used in emergency case.)

Wood based biomass block (49.4 MWp)	
'Fuel'	***Average consumption in a year (tonnes) (based on the previous years average)***
Forest chips/waste	216,328
Sawdust	1,906
Sawmill residues	21,728
Sunflower husks	29,069
Christmas tree	50
Cylindrical wood	approx.: 130,000
SUM	*399,081*

Table 16. The 'fuels' of the biomass blocks of Veolia Pécs Power Plant
Source: Zöld Zóna Látogatóközpont, 2018 (Green Zone Visitor Centre, 2018)

Straw based biomass block (35 MWp)	
'Fuel'	***Average consumption in a year (tonnes) (based on the previous years average)***
Straw of cereal	144,723
Tailings, agricultural cleaning residue	9,421
Corn stalk	292
Rape steam	10,729
Energy cane (miscanthus)	2,751
SUM	*167,916*

Table 17. The 'fuels' of the biomass blocks of Veolia Pécs Power Plant
Source: Zöld Zóna Látogatóközpont, 2018 (Green Zone Visitor Centre, 2018)

As an output, electricity is loaded into the national grid, while district heating (as a co-product) is heating and providing hot water for 31,000 households and 450 public institutions. Figure 54 is representing the circularity of the biomass in the process, including the reuse of ash on agricultural lands.

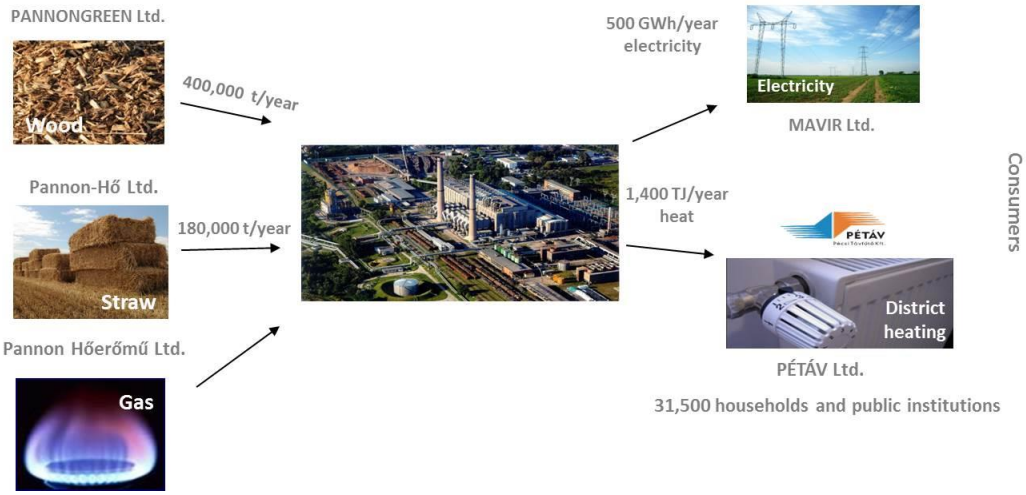


Figure 53: Flows of agricultural and forestry by-products on regional scale (2018)
Source: Rudolf P. 2018, p.4.

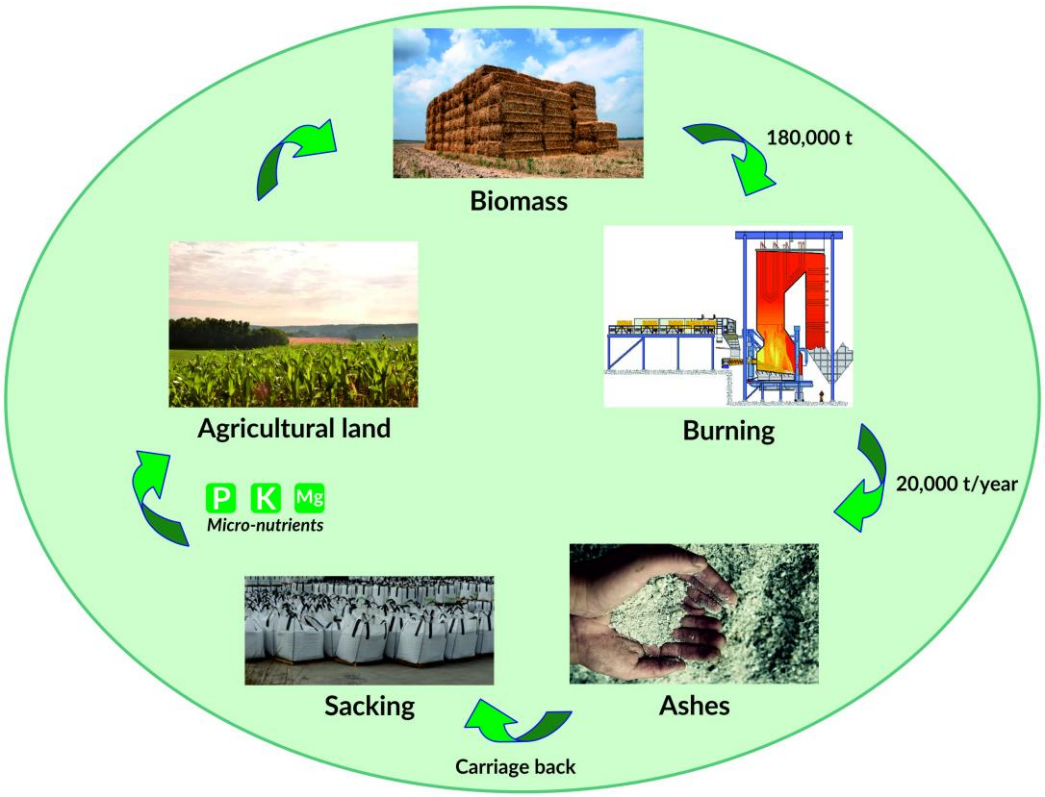


Figure 54: The circular flow of biomass use (2018)
Source: Rudolf P. 2018, p.12.

Although the role of the Pécs power plant (and its fuel change to renewable) is usually cited as a good example towards circularity, having regarded the flow of biomasses (Figure 55 and Figure 56) the distance of the straw and the wood is sometimes debatable. 100 km of the collection distance of boreal and arboreal by-products can be little and big too, depending on the viewpoint of the arguer – it is at least debatable.

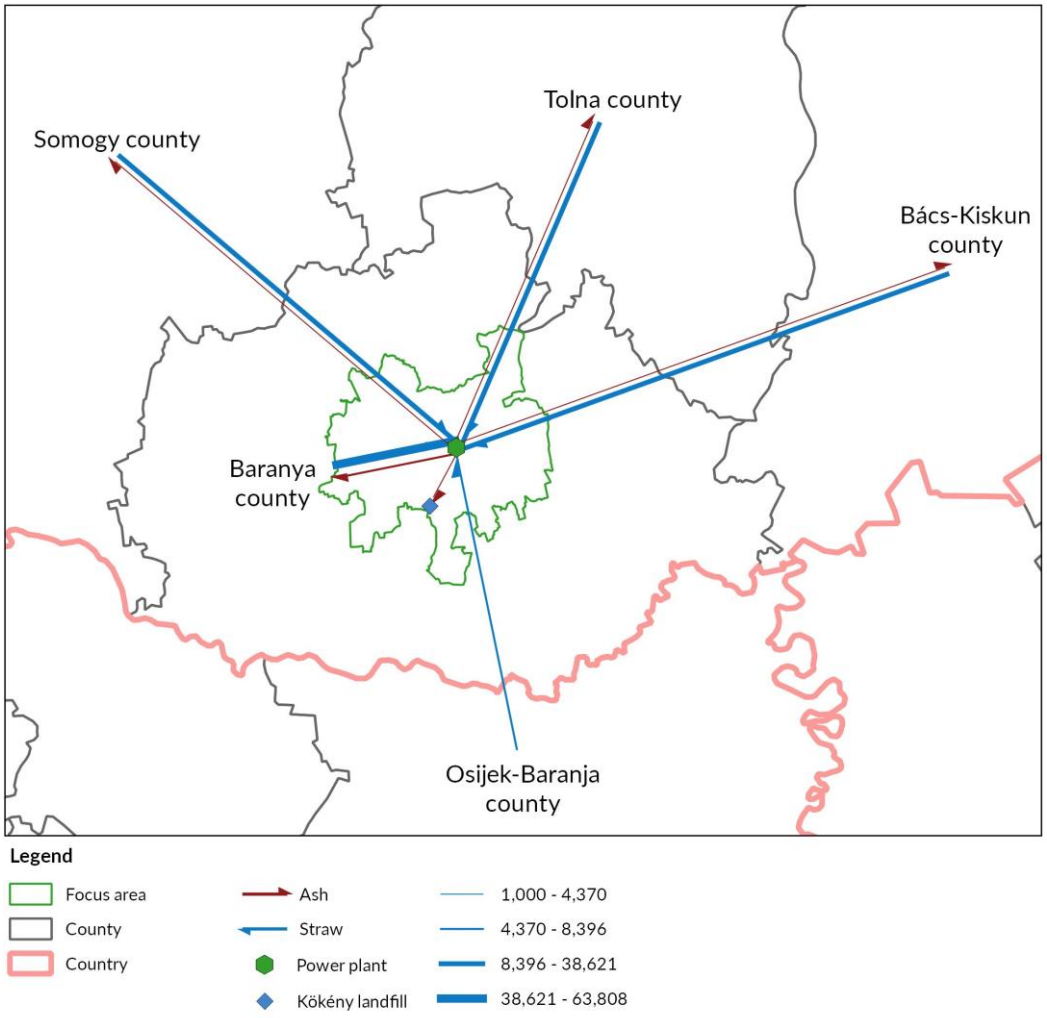


Figure 55: The flow of straw based biomass and ash in the wider region of the case study area (tonnes); (2018)

Source: Rudolf P. 2018, Zöld Zóna Látogatóközpont, 2018 (Green Zone Visitor Centre, 2018)

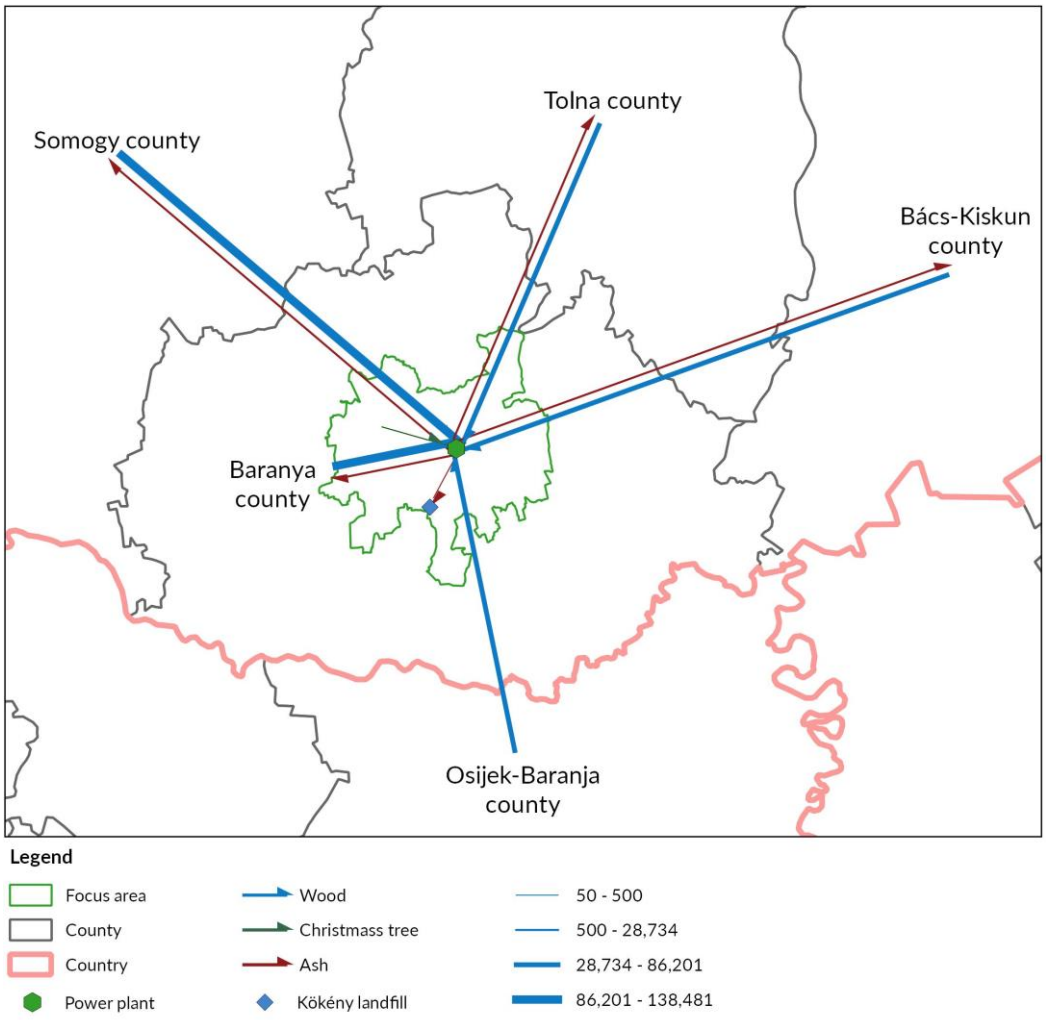


Figure 56: The flow of wood based biomass and ash in the wider region of the case study area (tonnes); (2018)

Source: Rudolf P. 2018, Zöld Zóna Látogatóközpont, 2018 (Green Zone Visitor Centre, 2018)

4. Reflection and Conclusion – the relevance of enabling context

In this reflective session the viewpoints of D3.3 have also been taken into consideration, however, the structure has not been followed strictly. The reason was that the revealed correspondence slightly differed from the one in D3.3, due to the socio-cultural and economic differences and different historico-economic trajectories. On the other hand, the recent restructuring of waste management governance is an issue that has to be taken into consideration as an important enabling context.

4.1 Waste sensitivity and other factors

In order to understand the situation of the Pécs case, it is essential to take into consideration the historical/geopolitical background deriving from the geographical position of the case area. The area is historically peripheral, characterised by poor economic performance, the whole area had a very unfavourable position in terms of investment due to the geopolitical risks in the 20th century. On the other hand, due to avoidance of industry, pollution was also at a lower level. In addition, the very much closed border area allowed the sustenance of nature in a good condition that resulted in a higher proportion of natural conservation area in the region, compared to other parts of the country. It might have an effect on the more positive waste sensitivity at household level, however, it cannot be proved by a former representative survey (c.f. Baranyai and Varjú, 2017).

In general, it can be said that waste sensitivity is not high in Hungary, neither at household nor at corporate level. The OECD report pinpointed to the lagging at governmental level as well, suggesting a whole-of-government approach to accelerate processes towards circular economy.

Having regarded the different levels of governance, there is a contradictory approach between the central government and the local stakeholders. Local level prefers bottom-up designed multi-level strategies in the field, while respondents agree that decision-making processes should be controlled primarily by non-political actors. In line with this latter perception, stakeholders agree that waste/resource management related strategies and policies should be developed and discussed by a wide coalition of different partners. As regards the national government, the recent situation is going to the other way round. From 2010 there has been a very strong centralisation process within the total governmental area (only few functions/tasks have remained at local governments), which reaches the waste management sector as well. As a result of the new legislation, the local governments have the responsibility of waste management at local level, but they cannot manage the local waste alone. These conditions don't help the spreading of circular concept at local level. On the other hand, the main local actors, the city and the public service provider lost their economic interest in the area of better selective collection or secondary raw materials. Without this interest, and without local

companies which have own interest within the reuse, recycling or minimisation of the waste there is no possibility to introduce the circular economy concept at local level.

Furthermore, Pécs seems to be a pioneer and good example in Hungary towards the circular economy. Although the city of Pécs does not have 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. Besides this, the development strategy Pécs has chosen is definitely based on endogenous resources, something that is considered more adaptive (as it provides resilience) than the involvement of external capital. One of the manifestations of it is the Pécs Eco-city, Mecsek-Dráva Ecological Region concept. The results of stakeholder survey also supported this approach. Values about social togetherness, cohesion, sharing collective responsibilities, and voluntary devotion – concerning the results – are considered as important bases to a sustainable waste and resource management in the Pécs stakeholder survey. Similarly, openness for change, belief in progressive capacities, deliberative communicative actions, optimism about the future, participation as well as reflexive agency and critical activity are understood by the respondents as motivational and inspirational sources to the improvement of waste and resource management.

4.2 Waste(scape) dynamics in space and time

On the other hand, the economic history and the trajectory of mining – as a significant industry in the case of Pécs – has had a huge impact in the creation of wastescapes giving challenges to be solved for the city and its agglomeration. The abandoned slop and ash depositing sites have given not only problems but possibilities for the decision-makers to find good eco-innovative solutions for regenerating and reusing these sites. Besides the classical rehabilitation, positive eco-innovative solutions can also be found (the story of Tüskésrét).

Furthermore, the closing of the coal mines had another multiplier effect. Due the closing of extraction of coal, the local power plant had to change its fuel that also made the air of the city cleaner. On the other hand, in the pursuit of new fuel, the power plant started to use the nearby areas' by-products, giving some job opportunity in the nearby poor area. (It also has to be mentioned that the new fuel operation caused several debates between the power plant and some local stakeholders concerning some opinions, the use of agricultural by-product has a negative effect on the fertilisation of the agricultural areas, namely carbon is extracted from the soil while burning the straw, instead of leaving it on the land.)

4.3 Modelling of material flows

In Figure 44 it can be seen that the amount of residual waste is relatively low in Pécs that suggested us that selective collection is in good condition. The similar phenomenon can be seen in small settlements in Baranya as well. The reason for this latter can be that in smaller settlements in rural (poorer) areas people can treat their

waste on site: they might compost the organic ingredients, while they can burn paper (and very often plastic bottle, especially in winter time).

However, behind this phenomenon (low level waste in Pécs), another behaviour might be seen that is the 'waste transportation' to the agglomeration. Households are consuming in Pécs and bringing the productions to the agglomeration. Then, at the end of the cycle of the production, waste is landed in the agglomeration. Having regarded the mentioned figure it can also be seen that 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 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.

Another 'waste transportation' can be seen in the case of Orfű, a popular tourist destination in the agglomeration. Both the high amount of household waste and the high risk of waste from the sector of Accommodation and Food and Beverage sector are indicated in the MFA.

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