Future Cities and Environment

Efforts and Barriers Shifting a City Region Towards Circular Transition – Lessons from a Living Lab from Pécs, Hungary

CASE STUDIES

]u[ubiquity press

VIKTOR VARJÚ
ÁGNES ÓVÁRI
CECÍLIA MEZEI
ANDREA SUVÁK
CSABA VÉR

*Author affiliations can be found in the back matter of this article

ABSTRACT

A Circular Economy is usually seen as achieving 'zero waste' and closing the material flow loops. However, multiple governance, economic, legal, socio-spatial, cultural, and behavioural barriers may easily hamper the transition. This study summarises the lessons learned from the waste flow analysis and living lab (LL) of a case study from the H2020 REPAiR project. It shows how the results of a waste flow analysis created for an urban area can help decision-makers to co-create new place-based eco-innovative solutions and hence shift the city towards circularity. At the same time, during the living lab process, it became clear that the decision support method alone is not enough to co-create or co-design new innovations, in addition the regulatory environment and the peculiarities of governance may also present multiple obstacles. The centralised governance in Hungary and the centralisation tendency in waste management and secondary resource use hamper efficient local resource management. The work in the LL showed that a centralised governance structure hinders not only the co-creation of new solutions but also the transfer of good practices from other peri-urban areas. This is important because a society that is generally less innovative and less developed at the beginning of sustainability transition is innovating for the first time via the transfer of eco-innovative solutions. Our paper shows that the governance structure of a given spatial unit (i.e. a city region) may be a significant factor in the successful or unsuccessful adoption of good practices and for the circular transition, as may system adaptability, the level of local technological development, the level of integration of actors, strategies, interests, and policy interventions.

CORRESPONDING AUTHOR:

Viktor Varjú

Institute for Regional Studies, KRTK, 22 Papnövelde Str., 7621 Pécs, Hungary; Institute for Rural Development and Sustainable Economy, Hungarian University of Agriculture and Life Sciences (MATE), Kaposvár Campus, 40 Guba S. str., 7400 Kaposvár, Hungary

varju@rkk.hu

KEYWORDS:

circular economy; circular transition; waste flows; waste management; governance

TO CITE THIS ARTICLE:

Varjú, V, Óvári, Á, Mezei, C, Suvák, A and Vér, Cs. 2022. Efforts and Barriers Shifting a City Region Towards Circular Transition – Lessons from a Living Lab from Pécs, Hungary. *Future Cities and Environment,* 8(1): 10, 1–12. DOI: https://doi.org/10.5334/fce.157

INTRODUCTION

In the past fifteen years, the circular economy (CE) has become an everyday concept, especially in environmental research and environmental policy (Reike et al., 2018). CE has a wide range of definitions, and most frequently it is illustrated with a combination of reduce, reuse and recycle activities (Kirchherr et al., 2017). There are many initiatives for the implementation of CE by governmental bodies, NGOs, consultancy firms (Kalmykova et al., 2018), and cities on global, national and local/regional levels (Milligan and O'Keeffe, 2019), each having specific responsibilities and territorial limitations/scopes (Varjú, 2020).

The concept of the circular economy, besides living in balance with the natural environment (Azizli, 2021), is aiming for 'zero waste'; the transition towards CE is about closing the material flow loops and alleviating environmental challenges. However, multiple governance, economic, legal, socio-spatial and cultural, and behavioural barriers easily hamper this transition (Gesawahong et al., 2021; Heurkens and Dąbrowski, 2020; Varjú, 2020). Consequently, the question arises whether these barriers are generic and whether there are any place-specific barriers to CE transition.

This case study offers a territorial and social understanding of the state of the circular transition in Hungary presenting a case study from Pécs. This paper presents how stakeholders and researchers attempted to co-explore and co-create a potential circular economy in the living lab (LL), exploring recent waste flows and modifying them by co-creating new solutions.

This case study is based on the H2020 project entitled REPAiR, which aims to explore the state of circular transition in six peri-urban areas, which have significant potential to play a positive role in enhancing urban sustainability (Wandl & Magoni, 2017), and to provide local and regional authorities (in the case study areas of Amsterdam, Naples, Ghent, Hamburg, Łódź and Pécs) with an innovative transdisciplinary, open source geo-design decision support environment (GDSE) developed and implemented in living labs.

After the presentation of methods and materials and the short description of the case study area the paper shows the most important achievement of Pécs in environmental development activities, then, it presents the current situation of several selected material/waste flows in the Pécs urban area. From the description of the decision-making framework, the reader obtains an overview of how the eco-innovative solutions were co-created with stakeholders in an LL. Based on these results, the discussion and conclusion section discuss both the efforts made towards CE and the main barriers that hamper the circular economy transition.

MATERIALS AND METHODS

First, we performed an analysis of the policy and legislative documents to identify the relevant stakeholders of the municipal waste flows on multiple levels. Then, after 10 interviews with stakeholders (e.g. representatives and experts from local government, a representative of the green authority, a director from a local power plant, representatives of a regional waste management company) in the period August – November 2017, a workshop was held in Pécs with local/regional waste experts, practitioners and stakeholders as described in Obersteg et al., (2017). Based on the results of these preliminary investigations, we conducted a waste material flow analysis, the results of which draw attention to several key problems. To find solutions for these problems we used the method of the living lab and a decision support tool (GDSE) for visualising the main challenging areas in the regional waste management sector and presenting them to the stakeholders, hence, to co-create eco-innovative solutions for them.

THE STUDY AREA

Pécs and its peri-urban area are situated in the south-western part of Hungary in Baranya County, one of the most peripheral regions in the country (Pénzes & Demeter, 2021). With a population of around 150,000, the city is the fifth largest in Hungary. The population of the city region has been decreasing constantly since the 1990s, mostly due to outbound migration.[1] The number of households in Pécs was 69,058 (according to the 2011 census) while this number including the agglomeration is 82,227.

The city and its region/agglomeration show a classical city picture in Hungarian terms, and it is not as urbanised as the great metropolitan cities in the western part of Europe. However, it fits the classification that most European territory belongs to: the 'middle landscape', a territory with 'hybrid geography' (Garreau, 1991; Ulied et al., 2010). Following the classification and the detailed (GIS-based) territorial split by Wandl et al. (2014), in Figure 1 it can be seen that only the very centre of the city belongs to the urbanised category while the rest, except the high-rise residential part built in the 1970s and 1980s, is peri-urban. Settlements in the agglomeration are rural areas, only the very centres of these settlements fall into the peri-urban category. Additionally, as the city lies at the confluence of mountainous and lowland areas the geography and the orography of the city influence the processes of waste collection.

Dél-Kom, the authorised regional waste management company, collects and treats the investigated waste flows in the study area, except for the food waste fraction generated in canteens, restaurants, and by catering services, which is collected by independent companies.

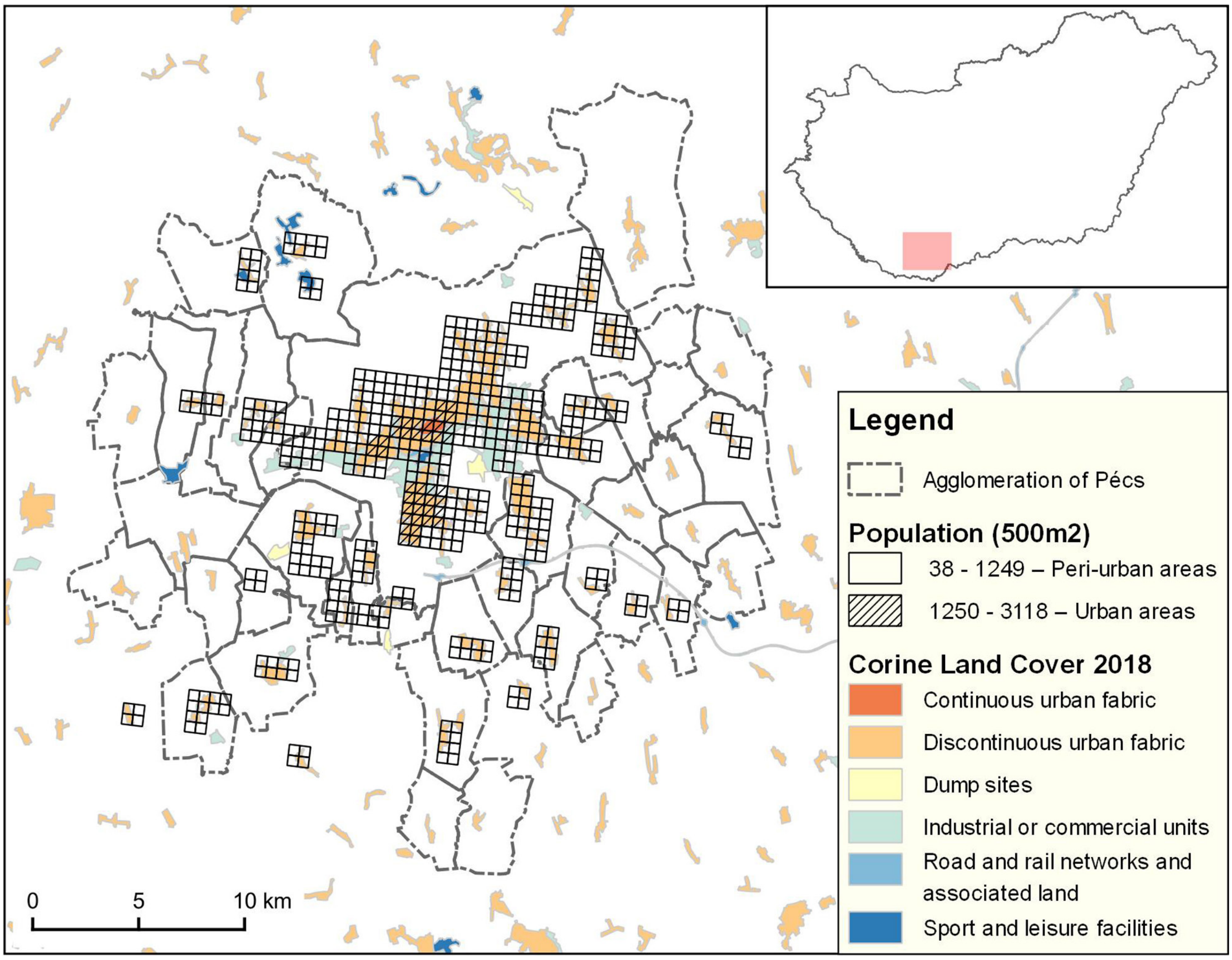

Figure 1 Rural, peri-urban and urban areas in the Pécs urban region. Source: Authors' version based on (Wandl et al., 2014) drawn by Tamás Szabó.

Apart from the geographical characteristics mentioned above, population density also determines the method of the collection (i.e., separate door-to-door collection of green waste, non-separate organic waste collection, home composting, separate plastic and paper waste collection, etc.) of the various types of waste, resulting in eight different collection districts.

In 2017 approximately 22,080 t of organic fraction of municipal solid waste (OFMSW) were collected in the study area, which is around 20% of the total amount of annual municipal solid waste (MSW) (112,385 t). A total of 12,240 t non-separately collected (NSC) OFMSW was subjected to aerobic mechanical-biological treatment (MBT) generating so-called compost-like organic (CLO) material. CLO made up about 30% of the total collected MSW in 2017 and was landfilled after treatment. The remaining 9,840 t of separately-collected OFMSW (SC-OFMSW) from restaurants, catering and food service waste flows were recycled in the Tettye anaerobic digestion plant in the study area, while green waste from household and park maintenance was converted into compost for sale at a composting plant (Sanjuan-Delmás et al., 2021).

MATERIAL FLOW ANALYSIS

For the material (waste) flow calculation we used REPAiR's Activity-based Spatial Material Flow Analysis (Geldermans et al., 2017) as a starting point and tailored it to the case of the Pécs agglomeration.

Based on interviews with the key stakeholders, for the material flow analysis we pre-investigated the organic waste, the municipal solid waste and the plastic packaging waste fractions. Finally, within the scope of a very detailed analysis, we focused only on the organic waste fraction.

The analysed flows of the organic waste fraction included the biodegradable part of residual waste collected by the regional waste management company, uncooked kitchen/food waste and park and gardening waste produced by households, the organic waste resulting from the maintenance of public green areas, and the organic waste generated by major institutions and private companies (Figure 2).

We used the Orbis database to identify these other actors generating OW, (this database contains the NACE codes of the business actors). For this analysis, we selected 106 NACE codes, which resulted in 4511 actors for the Pécs city region including not only private

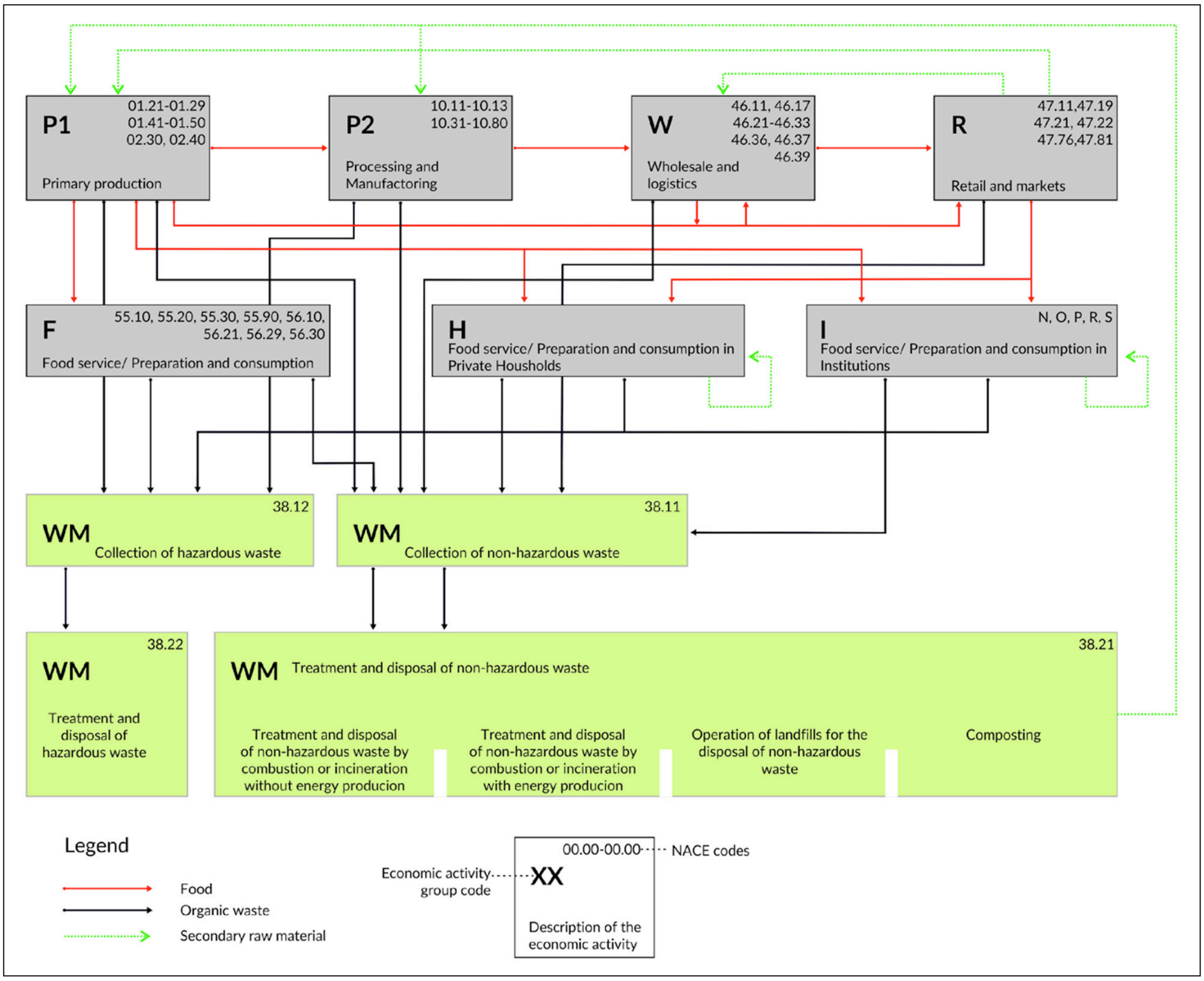

Figure 2 The system diagram of activities and flows of the organic value chain in the Pécs Agglomeration. Source: Own work.

companies but public institutions (e.g., schools) as well. Following the structure of the Amsterdam pilot study from the REPAiR project, we gathered data for the three main stages of the waste management domain: 1) waste generation (data from companies/households), 2) waste collection (data from waste collectors) and 3) waste treatment (data from waste treatment plants) (Geldermans et al., 2019).

PERI-URBAN LIVING LAB (PULL) AND GDSE

The use of living laboratories in planning processes in Europe started in the 2000s. Since then, the concept has been applied widely to foster urban experimentation and collaborative planning and to provide a methodology for facilitating open innovation and knowledge co-creation. The living laboratories bring together citizens, consumers, and users into an innovation system, resulting in a multi-stakeholder and multidimensional structure, thereby leveraging a larger mass of knowledge, ideas and experiences (Eriksson et al., 2006; Lepik et al., 2010; Steen and van Bueren, 2017; van Geenhuizen, 2018; Bozdağ and İNam, 2021). In the Horizon 2020 REPAiR project, Peri-Urban Living Labs (PULLs) were set up in six European regions, including Pécs, to engage stakeholders in the co-creation of eco-innovative solutions for each region. The stakeholders were selected by the project partners from the waste management sectors in each region. These included stakeholders from universities as well, along with stakeholders from the non-profit and for-profit sectors. They were identified in each PULL and were invited to the workshops by the researchers. Participation in a PULL involved various activities that followed a predefined framework and the methodology described in Wandl et al. (2019) for the living labs and for the knowledge transfer events that followed. Some of the stakeholders were involved in all workshops, for others, the participation was less regular (Dąbrowski et al., 2019).

The identification of challenges and objectives during expert interviews with stakeholders was the first step of the process, followed by two workshops as part of a PULL. After that, the challenges and the problem areas listed by the participants in the LL were integrated and categorised into four main groups considering their connections with the main waste flows. Further discussions followed in the LL, which led to the identification of eight problem areas in organic waste management, five in plastic, seven in residual waste flows, and 11 in overall waste generation specific for the Pécs urban region (Mezei et al., 2020). These problems were categorised and prioritised to find the most important challenges facing the city, using a scoring process involving all the (participating) stakeholders.

Other workshops were dedicated to each of the identified main material flows. A "knowledge transfer workshop" was held at the end of the process (Dąbrowski et al., 2019) where eco-innovative solutions from other city regions were presented and discussed in terms of their adaptability to the situation in Pécs (Varjú et al., 2018).

The PULL was supported by a visualising tool, a geo-design decision support environment/GDSE (Franke et al., 2020). The background data for this tool were collected and entered by the researchers and the software was developed within the REPAiR project. The results of the waste flow analysis were also entered into the software as a way of representing the status quo (the current situation) of the regional waste management system. The support tool also included the objectives and challenges identified (mentioned above) offering the possibility to the researchers to re-evaluate their importance. Based on this background knowledge and on the elaborated eco-innovative solutions (which were integrated into the GDSE system as well) the stakeholders had the opportunity to modify the waste flows and to see the output of these changes. These tests show the probability of a particular eco-innovative solution (EIS) being able to properly decrease a given waste flow.

RESULTS

ORGANIC WASTE FLOW IN THE PÉCS AREA

For the time being, for the whole Pécs region, there is no solution implemented for the separate collection of kitchen waste generated by households, nor for the waste generated by companies, although there is a scheme in the planning stage. However, there are large or special local actors who collect and/or treat their own biowaste independently of the regional waste management company. Such an example is the oil/fat waste generated in the catering sector. In connection with this, we mention the voluntary initiative of a private company (Biofilter Co.) with broad territorial coverage for oil/fat and other food waste collection. Moreover, residents can take oil/fat waste to the petrol stations of the largest Hungarian oil company (MOL). In the case of the catering sector, a kind of "grey" solution is available for treating the generated food waste, which involves contracting with individuals who keep dogs and feed them with food waste. (Feeding other animals raised for meat production with "food waste" is not permitted by EU regulations.)

Other by-products, such as the organic "waste" generated by the forestry and agriculture sectors, are not collected by the regional waste management company. The treatment of such wastes needs other specific and sustainable solutions. In the study, these materials are "treated"/used in two major biomass-based co-generating power plants providing electricity and district heating (in Komló and Pécs) (Varjú et al., 2018).

Households

We used the results of an investigation carried out by the Ministry of Agriculture to calculate the amount of household food waste generated. According to this study, 68 kg/capita, 1.8 million tonnes of food waste (which is around 10% of the total purchased food per household) is generated in Hungary every year. Of this amount 47.7% is avoidable, 4.16% is potentially avoidable and 47.13% is unavoidable. From this amount of food waste, 62.83% goes into the waste and wastewater systems, 18.45% is used as animal food and 18.72% is composted ("Maradék nélkül program. Kutatási eredmények összefoglalása," 2017).

In Pécs, waste generation data can only be estimated as not all organic waste is collected. For instance, garden waste is composted (using home composting bins) in more than a thousand households in Pécs (3,000 composting bins were donated to households in the scope of a local government project). Still, a significant proportion of tree leaves is burnt, even though this practice is banned by the local environmental legislation.

The remaining, not composted, and not separately collected organic waste is collected with the residual waste from households and other institutional actors that contracted this service with the local waste collecting company. The composition of this residual waste is presented in Table 1. (Varjú et al., 2018).

The separate door-to-door collection of municipal waste is carried out in the districts of detached houses in Pecs. In high-rise buildings, in addition to the collection islands, a separate collection system implemented in stairways is also functioning. Door-to-door green waste collection has been carried out in the suburban districts of Pécs since 2003. This type of waste is treated in the new green waste composting plant in Kökény, the capacity of which of 9,750 tons/year is sufficient for the agglomeration. In smaller settlements in the city region with a population of 500 to 1,000 people, at least one collection point/island was established for separately collecting packaging waste (paper, cardboard, plastics, and glass); organic waste is not included in this separate collection system (Varjú et al., 2018).

Once the residual waste is collected, it is transported to a mechanical-biological treatment centre in Pécs-Kökény. There the mechanical pre-treatment of non-separately collected waste is performed, followed by the biological treatment of its biodegradable fraction (Varjú et al., 2018)

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 (<20 mm)	21.85	17.53	29.36	13.22	20.49	20.50
Total:	100.01	100.00	99.98	100.00		100.00

Table 1 Composition of mixed municipal waste collected in Pécs in 2017.
Source: Controlling database of BIOKOM group.

At the waste treatment centre of Pécs (located in Kökény), the organic waste collected is treated in the composting plant. 45–50% of the 9–10 thousand tonnes of incoming green waste can be transformed into compost, which is sold for soil improvement. The remaining 50–55% is released in the form of gases during the composting process. Around 1–2% of residual foreign matter is transferred to the mechanical treatment unit after separation. Approximately 100,000 tons of residual waste from mixed collection is delivered to the mechanical treatment unit per year. There, the organic decomposing, heavy and light (plastic, paper, wood, textile) fractions and metals are separated from each other. The organic fraction is first stabilised in an indoor facility and then in an open area. This process uses the same technology as composting, however, due to the collection method of the treated material, legislation describes this process as stabilisation, while the final product is a "stabilate", instead of compost. The purpose of this process is to decompose organic materials under controlled, aerobic conditions to ensure that CO_2 is produced, instead of methane, which is the classic by-product of conventional landfills. As a result, around 20% of the treated mass is released in the form of gases and vapour and the rest of it is deposited (Varjú et al., 2018).

Company waste

We used several databases to estimate the OW generated by companies in the Pécs city region. The ministerial office responsible for environmental policy operates an OKIR 'waste database' using data from the annual reports of major companies. This OKIR database includes waste generation data for different (NACE) sectors and activities grouped by EWC code. Only very few datasets can be used from the settlement territorial information database of the Hungarian Central Statistical Office (HCSO). These are useful for identifying the locations of agricultural companies that are relevant in terms of OW production in the region.

Data from the big food retailers (e.g. TESCO) was also used for the calculation of OW.

In addition, the BIOKOM Group (the parent company of the regional waste management company) provides data on the waste collected (food waste and park and gardening waste) from companies. These data include the weights of all the trucks transporting collected waste in 2017 and the database can be filtered according to the final destination of the waste (e.g. composting plant, sorting plant, biological treatment, mechanical treatment, landfill, etc.) (Varjú et al., 2018).

The Orbis database was also used for primary data collection. Where company e-mail addresses were available, researchers sent out a short questionnaire. Out of 4,486 companies (selected by NACE code, as described in the methodology section), 1,231 had an e-mail address. However, the results were very limited (the number of completed questionnaires was very low), hence secondary data collection was carried out to identify company waste flows. The collection system used for the waste generated by the companies in Hungary depends on the size of the company and on the type of waste generated. Small companies (such as bakeries) usually use the regular municipal waste bins system for disposing of their food waste, hence OW appears as a part of MSW. Major producers, wholesale companies, major retailers, and food service companies have to contract a dedicated waste collecting company. Animal-protein waste (collected by a special company, ATEV Zrt.) is disposed of and handled outside of the Pécs agglomeration.

As shown, the collection of data on the OW flow in companies had several limitations. Hence, drawing up the material flow analysis (MFA) at company level was a challenge, requiring the use of three databases. The data used for the MFA resulted from combining the data available in the Orbis database (with basic operating data), the data from the regional waste management company (a database with 27,788 records from 251 companies) and the database from the Ministry of Agriculture, which contains all the companies with the obligation to report their yearly waste generation.

The database from the Ministry of Agriculture consists of all the companies and their sites. For each company, this database lists the type of the company, its environmental ID (KÜJ), the ID of its sites (KTJ), the geocoded location, and the NACE code. Because this database contains no information on the number of employees, revenue, and the name/statistical/tax ID of the company, another dataset from the Ministry of Innovation and Technology was used to retrieve such information (company statistical/tax ID and company environmental (KÜJ) ID) and this data was combined with the Orbis database. Filtering the identified 3,458 sites in the Pécs region, resulted in 412 sites with relevant OW production (Varjú et al., 2018). These were used to calculate the main organic waste flows of companies in the study area.

Besides the above-calculated waste flows, supplementary data from Biofilter and Biokom, the city's maintenance and waste management company, helped to add more organic waste flows to the MFA. Out of 8,909 tonnes of organic waste, in 2017 1,548 tonnes of green waste were generated by the maintenance of the green infrastructure of the city and by the maintenance of the parks and gardens of companies and institutions, and approx. 6,000 tonnes of residual green waste from the door-to-door collection was transported to the composting plant from the Pécs agglomeration (Varjú et al., 2018).

Following the calculations described above, the resulting amounts of OW were uploaded to the GDSE tool to visualise the current situation of the organic flows in the Pécs region (Figure 3). This was a preliminary step towards the co-creation of EISs with stakeholders.

PULL AND THE ECO-INNOVATIVE SOLUTIONS

In addition to the main organic waste flows described above, the GDSE decision support system integrated the challenges and problems identified by stakeholders in the previous workshop. (A more detailed description of this can be found in the Methods and Materials section.) It was also part of the PULL workshops for the invited experts and stakeholders to find and develop new eco-innovative solutions (EISs) based on visualised, critical

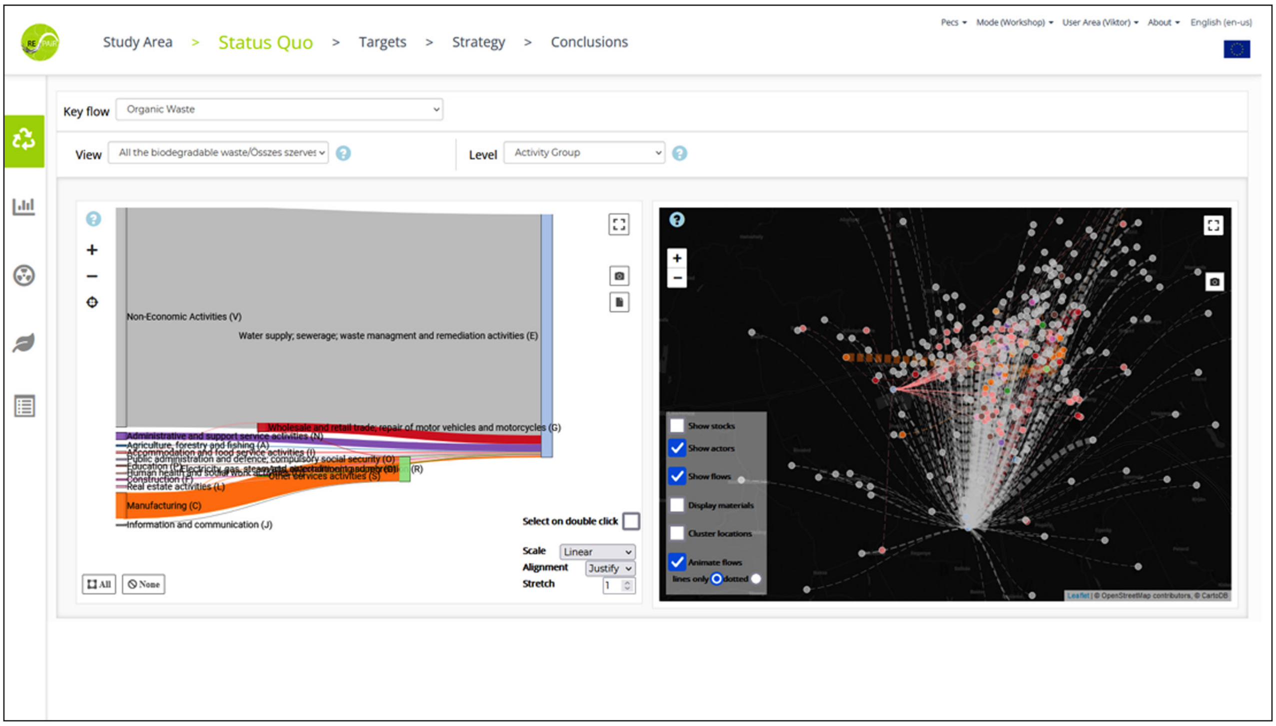

Figure 3 Organic waste flows in the Pécs region visualised in Sankey and geo-design diagrams in the GDSE. Source: Own work using GDSE visualisation.

material flows, to reduce the volume of the waste generated. The participants in the workshops came from the academic domain, the business sector, the civil sector, the waste management company domain, and local decision-makers. A total of 15 solutions were formulated in the LL and another three were derived and discussed in the 'knowledge transfer" event. (A detailed description/catalogue of the EISs may be found in Mezei et al., 2020 and on the H2020 REPAiR webpage.) All of these solutions aimed to solve a place-based waste generation challenge by suggesting alternative and innovative ways to reduce waste, either by reusing materials or by preventing the creation of waste. Per se, they were not (entirely) brand new innovations, but they brought fresh ideas and new knowledge into the local socio-cultural context. However, this process of EIS formation also demonstrated the limitations of the waste management in the Pécs Agglomeration originating from the national and regional circumstances (current technological, political and legal systems).

The organic waste flow-related EISs developed by the experts were also integrated into the GDSE system in such a way that the effects of the EIS on each organic flow were quantified based on scientific literature and expert estimates. In this way, the GDSE was ready to support stakeholders in the decision-making process, and the tool was tested during the LL.

During the decision support tests, the experts were able to choose from a variety of options after learning about the status quo/current situation of the system. They were able to choose a particular waste flow to focus on, a specific EIS they considered adequate for addressing an identified challenge, to specify which actors would be involved, and in which area of the city the solution would be implemented. After selecting these parameters, the decision support system calculated and produced a visualisation of the changed material flows. In addition, the GDSE is also suitable for comparing the work and results of different groups with various "compositions" of experts and. (More technical details can be found in Arciniegas et al., 2020; Franke et al., 2020; Wandl et al., 2019).

DISCUSSION

Although the city of Pécs does not have a circular economy plan, not even a standalone sectoral plan for waste management, "green thinking" has been present at policy level in the area since the 1990s. The introduction of the separate collection of (paper, plastic and glass) waste dates back to 1996, which was the first such initiative in Hungary. The concept of ecological footprint first manifested in the "Pécs Eco-City", Mecsek-Dráva Ecological Region Programme at the beginning of the 2000s. The shift in the city towards renewable energy started in the 2000s after the collapse of mining in the region, the fuel used in the local power plant changed from coal to arboreal biomass in 2004, then a new biomass burning block (for straw) was built in 2013. The latest development provides district heating for the city area (Kiss, 2004; Varjú et al., 2018) and plays a very important role in the life of the city. Also, by using/collecting the straw from the surrounding areas, the Veolia Power Plant has become a central actor in the organic waste/flow at a wider spatial (cross-regional) scale. These antecedents represented a good and early start for shifting the city region towards circularity. However, as it turned out in the Living Lab, numerous barriers hamper efficient and significant transition; one of them being the circumstance of governance.

Mining tends to affect many human settlements adversely and requires careful planning and development. Mining was a significant industry in the city and had a huge impact through the creation of waste escapes or brownfields in the area. However, the abandoned ash deposit sites have provided not only challenges but possibilities too, possibilities for the decision-makers to find good eco-innovative solutions for regenerating these areas. Besides classical rehabilitation, positive eco-innovative solutions can also be found (Varjú et al., 2018). An example of this is the rehabilitation of the 200 ha former landfill where fly ash was deposited in cells next to the power plant during the roughly 50-year coal-firing period. After the growth of the city this area was no longer peripheral, becoming a central part within the city body between the old and the new housing estates. During the revitalisation, the city in cooperation with the power plant created a city park for recreational purposes (e.g., running track, playground, football field, wakeboard facility), and further development plans are under preparation.

There were several attempts made in the interest of resource efficiency by the local governments in the city region and by key stakeholders, however, concerning the interview we made in the REPAiR project, there was very little information about the concept of the circular economy. Most of the interviewees had not heard about the notion. Some of them had heard about it but had made no attempt to implement it. We examined recent planning documentation (from 2021), city development strategies and sectoral environment-related plans (e.g., Pécs Environmental Programme, Pécs mobility plan), and although several climate or air quality priorities and investment plans exist, development elements and strategy relating to the circular economy cannot be found, neither in any strategy, nor in the planned investments.

Pécs and the city's waste management company have a creditable history in professional and sustainable waste management. Up to 2017, Biokom was the public waste collection service provider and afterwards this position was taken over by Dél-Kom Nonprofit Ltd, a subsidiary of Biokom, covering the region of South-Transdanubia and serving around 438,000 inhabitants in 313 municipalities (including the Pécs region), reflecting the National Coordination of Waste Management and Asset Management Plc's (NHKV Plc) regionalisation ambitions. Due to the regulative framework of waste management in Hungary, Biokom is the asset manager of the service area's infrastructure and assets, but the owner of the secondary raw materials is the central body of the NHKV. In this role, the NHKV has the right to sell the tradable 'products' (e.g. plastic, RDF), while the regional waste collection service providers lost their commercial role and their partnerships with the stakeholders and end-users. They also faced a massive limitation to their management decisions, development potential and independence (Obersteg et al., 2017). Besides the fact that this means that the regional actors do not have the opportunity to use locally generated waste/secondary raw materials discharged locally, it also hampers the reduction of the environmental impact of transport. Furthermore, as the regional waste management company is excluded from the market it is unable to make a profit, and hence cannot develop the services that would help in the transition towards circularity. These were some of the numerous problems that arose during the living lab. As the centralisation of waste management continues (which, in general, has been a very strong tendency in Hungary since 2010 (Varjú, 2021)), for-profit actors have anticipated the resulting issues and have expressed doubts about the new centralised system. The LL results showed that the waste management actors at the local level would prefer bottom-up designed multi-level strategies and emphasised that the decision-making processes should be controlled primarily by non-political actors, hence resource management policies should be developed and discussed by a wide coalition of different partners.

One of the results of the circumstances presented above is that the spread of circular processes has become very slow. By losing control of parts of the waste management system the main local actors, the city and the waste collector, lost their economic interest in promoting selective collection or paying for efforts to use secondary raw materials.

Another negative outcome of the centralisation processes has also emerged in the co-design process of eco-innovative solutions, as this poses several obstacles to feasibility. An example is that the regional waste management company cannot sell the separately collected materials as a secondary raw material within the region for local partners because the property right passed on to the newly created and centralised national waste management coordination and trustee company. As a result, most of the ideas that were developed were primarily aimed at reducing waste creation (which is a positive, indirect effect).

Another obstacle to efficient circular transition was the strong legal restriction on the use of food waste because of public health concerns. This means, for instance, that remaining prepared food could not be resold or donated for social purposes.

The calculation of waste flows showed that the amount of residual waste in 2016 was relatively low in Pécs (around 260 kg/capita) compared to the EU (489 kg/capita) and the national average (381 kg/capita) (HCSO and Eurostat data). This finding is also supported by data from HCSO that showed the leading position of the city region in selective collection. However, another reason for the low level of waste generation in the city area of Pécs may be waste transportation to the agglomeration. Households are consuming/buying goods in the city and transporting the products, and the waste (including the packaging waste) to the agglomeration. A similarly low level of generated waste can be seen in the smaller settlements of the agglomeration. The reason for this brought another social-economic phenomenon into the spotlight: in rural (poorer) areas many people treat their waste on-site, on one hand, they may compost organic components, and on the other, they burn paper (and very often plastic bottles, especially in wintertime) for heating their homes, while causing serious air quality problems (Varjú et al., 2018). This latter phenomenon can be also seen in the poorer, sometimes segregated parts of the city of Pécs as well. During the PULL, stakeholders identified a foreign eco-innovative solution to this problem; this was an example from Switzerland where a special tool can measure the composition of the ash remaining in fireplaces. However, the technological infrastructure (e.g., the ash sensor, the laboratory capacity) and the lack of authorisation for control (of the fireplaces, which is a legislative barrier) hampers the implementation of such solutions.

CONCLUSION

This paper offers a territorial and social interpretation of the state of the circular transition in Hungary by presenting a case study from the city of Pécs and its peri-urban area. The study summarised the lessons learned from a waste flow analysis and a living lab supported by an H2020 project. The study showed how the results of a waste flow analysis created for a specific urban area can help decision-making at the local level. At the same time, during the living lab process, it became clear that the decision support method alone is not enough to develop innovations; geographical and cultural contexts, among others, may act as determinant factors (Kerimoglu and Ekinci, 2021). Besides, the regulatory environment also poses multiple obstacles to co-creative innovation.

Administrative traditions and the quality of governance may influence development activities and the functioning of spatial governance systems (Cotella et al., 2021), hence, CE-related development at the city region level may also be impacted. As shown in this paper, both centralised waste governance and the limitations to development it causes can hamper the transition towards circularity.

Also, the local circumstances influence the type and level of innovation of the identified solutions; the eco-innovative solutions elaborated in the living lab process were context-specific, meaning that the solutions for Pécs cannot be seen as being very innovative in general, however, they are innovative in the Hungarian (Pécs) context (Mezei and Varjú, 2019; Obersteg et al., 2019, 2017; Varjú et al., 2018).

The work in the LL showed that a centralised governance structure hinders not only the co-creation of new solutions but also good practice transfer. This observation is important because a society that is generally less innovative and less developed at the beginning of a sustainability transition is innovating for the first time via the transfer of eco-innovative solutions and good practices from outside. Our paper shows that the governance structure of a given spatial unit (i.e. a city region) may be a significant factor in the successful or unsuccessful adoption of good practices and in the circular transition, alongside the adaptability of the system, the level of local technological development, the level of integration of actors, strategies, interests, and policy interventions.

Based on the PULL and research conducted in the REPAiR project, the main challenges for the Pécs region were the following:

- The concept of Circular Economy (CE) is only known by some stakeholders and experts in the region;
- The centralised governing order limits the possibility for implementation of proper resource use;
- The conflict of interests between the waste management companies and the new central waste management actor (NHKV) hinders the CE transition (Obersteg et al., 2017).

As a positive side-effect, the research contributed to better communication and increased interaction among the stakeholders from the waste management domain in the Pécs area. This helped to deepen the level of understanding of the system and to increase awareness about its challenges and issues, hence it could be the first step toward a successful transition towards a circular economy (Mezei et al., 2020).

Another lesson learned from the waste flow analysis is the difficulty of data collection. Public bodies collecting this kind of data have difficulties sharing them (due to the lack of administrative capacity), while companies are not interested in sharing data for research purposes.

A positive outcome of the EISs developing process in the living labs highlights the importance of identifying all/many of the potential stakeholders in particular areas and domains and involving them in the planning and decision-making processes. Once they are involved, co-creation is accelerated.

NOTE

1 http://www.ksh.hu/docs/hun/xftp/idoszaki/nepsz2011/nepsz_03_03_2011.pdf; http://www.terport.hu/webfm_send/4171.

ACKNOWLEDGEMENTS

The authors would like to thank Viktor Vadkerti Tóth and Tamás Szabó for their kind support during the PULL workshops.

FUNDING INFORMATION

This research has been carried out within the framework of the European Horizon 2020 funded research REPAiR: REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism and has received funding under grant agreement no. 688920.

COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR AFFILIATIONS

Viktor Varjú orcid.org/0000-0003-3954-4518
Institute for Regional Studies, KRTK, 22 Papnövelde Str., 7621 Pécs, Hungary; Institute for Rural Development and Sustainable Economy, University of Agriculture and Life Sciences (MATE), Kaposvár Campus, 40 Guba S. str., 7400 Kaposvár, Hungary

Ágnes Óvári orcid.org/0000-0003-0273-2291
Institute for Regional Studies, KRTK, 22 Papnövelde Str., 7621 Pécs, Hungary; Doctoral School of Earth Sciences of the University of Pécs, 6 Ifjúság Str., 7624 Pécs, Hungary

Cecília Mezei orcid.org/0000-0003-2109-2293
Institute for Regional Studies, KRTK, 22 Papnövelde Str., 7621 Pécs, Hungary; Institute for Rural Development and Sustainable Economy, University of Agriculture and Life Sciences (MATE), HU

Andrea Suvák orcid.org/0000-0002-3507-1541
Institute for Regional Studies, KRTK, 22 Papnövelde Str., 7621 Pécs, Hungary

Csaba Vér orcid.org/0000-0002-4750-9360
Department of Environment Engineering, Faculty of Engineering and Information Technology, University of Pécs, 7624 Pécs, 2 Boszorkány str, HU

REFERENCES

Arciniegas, G, Wandl, A, Sileryte, R, Bohnet, M, Gutsche, J-M, Franke, C, Dukai, B and **Commandeur, T.** 2020. D2.5 Adapted GDSE modules.

Azizli, B. 2021. Circular Economy: An Analysis for Turkey. *Regional and Business Studies*, 13(2): 31–44. DOI: https://doi.org/10.33568/rbs.2915

Bozdağ, A and **İNam, Ş.** 2021. Collaborative land use planning in urban renewal. *JURA*, 13. DOI: https://doi.org/10.37043/JURA.2021.13.2.7

Cotella, G, Janin Rivolin, U, Pede, E and **Pioletti, M.** 2021. Multi-level regional development governance: A European typology. *ESR&P*, 28: 201–221. DOI: https://doi.org/10.18778/1231-1952.28.1.11

Dąbrowski, M, Varjú, V and **Amenta, L.** 2019. Transferring Circular Economy Solutions across Differentiated Territories: Understanding and Overcoming the Barriers for Knowledge Transfer. *Urban Planning*, 4: 52–62. DOI: https://doi.org/10.17645/up.v4i3.2162

Eriksson, M, Niitamo, V-P, Kulkki, S and **Hribernik, KA.** 2006. Living labs as a multi-contextual R&D methodology, in 2006 IEEE International Technology Management Conference (ICE). *Presented at the 2006 IEEE International Technology Management Conference (ICE)*, 1–8. IEEE, Milan, Italy. DOI: https://doi.org/10.1109/ICE.2006.7477082

Franke, C, Arciniegas, G, Sileryte, R, Bohnet, M, Gutsche, J-M, Wandl, A and **Gutsche, S.** 2020. D2.6 Technical Documentation.

Garreau, J. 1991. *Edge City: Life on the new frontier*. Doubleday. https://scholar.google.com/scholar_lookup?title=Edge%20city%3A%20Life%20on%20the%20new%20frontier&publication_year=1991&author=J.%20Garreau

Geldermans, B, Bellstedt, C, Formato, E, Varjú, V, Grünhut, Z, Cerreta, M, Amenta, L, Inglese, P, van der Leer, J and **Wandl, A.** 2017. D3.1 Introduction to methodology for integrated spatial, material flow and social analyses.

Geldermans, B, Wandl, A, Steenmeijer, M, Furlan, C, Streefland, T, Formato, E, Cerreta, M, Amenta, L, Inglese, P, Iodice, S, Berruti, G, Varju, V, Grunhut, Z, Bodor, Á, Lovász, V, Moticska, Z, Tonini, D, Taelman, SE, Meister, K, Uncenta, PM, Attademo, A, Bellstedt, C, Arciniegas, G, Acke, A and **Kamps, M.** 2019. D3.3 Process model for the two pilot cases: Amsterdam, the Netherlands & Naples, Italy. REPAiR: REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism 222.

Gesawahong, S, Wongwatcharapaiboon, J and **Muangnapoh, K.** 2021. Identifying Key Implication Factors to Influence the Approach and Promotion of the Sustainable Furniture-Sharing Platform in the Circular Economy in Bangkok, Thailand. *Future Cities and Environment*, 7: 11. DOI: https://doi.org/10.5334/fce.122

Heurkens, E and **Dąbrowski, M.** 2020. Circling the square: Governance of the circular economy transition in the Amsterdam Metropolitan Area. *ESR&P*, 27: 11–31. DOI: https://doi.org/10.18778/1231-1952.27.2.02

Kalmykova, Y, Sadagopan, M and **Rosado, L.** 2018. Circular economy – From review of theories and practices to development of implementation tools. Resources, Conservation and Recycling. *Sustainable Resource Management and the Circular Economy*, 135: 190–201. DOI: https://doi.org/10.1016/j.resconrec.2017.10.034

Kerimoglu, E and **Ekinci, D.** 2021. How innovative are the cities? A mulit-variable approach to measuring innovation in Turkey. *JURA*, 13. DOI: https://doi.org/10.37043/JURA.2021.13.2.1

Kirchherr, J, Reike, D and **Hekkert, M.** 2017. Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127: 221–232. DOI: https://doi.org/10.1016/j.resconrec.2017.09.005

Kiss, T. 2004. Pécs Eco-City Mecsek-Dráva Ecological Region Programme.

Lepik, K-L, Krigul, M and **Terk, E.** 2010. Introducing Living Lab's Method as Knowledge Transfer from one Socio-Institutional Context to another: Evidence from Helsinki-Tallinn Cross-Border Region. *J.UCS*, 16: 1089–1101.

Maradék nélkül program. Kutatási eredmények összefoglalása, 2017.

Mezei, C, Vadkerti Tóth, V and **Varjú, V.** 2020. D5.8 Eco-innovative solutions for Pécs – Deliverable of REPAiR project.

Mezei, C and **Varjú, V.** 2019. A helyi erőforrásokon alapuló helyi fejlesztés lehetőségei az átalakuló hazai hulladékgazdálkodási közszolgáltatásban. *Tér és Társadalom*, 33: 41–61. DOI: https://doi.org/10.17649/TET.33.2.3089

Milligan, B and **O'Keeffe, M.** 2019. Global Governance of Resources and Implications for Resource Efficiency in Europe. *Ecological Economics, Resource Efficiency: Concepts, Challenges, Scenarios and Policy Options*, 155: 46–58. DOI: https://doi.org/10.1016/j.ecolecon.2018.01.007

Obersteg, A, Arlati, A, Acke, A, Berruti, G, Czapiewski, K, Dąbrowski, M, Heurkens, E, Mezei, C, Palestino, MF, Varjú, V, Wójcik, M and **Knieling, J.** 2019. Urban Regions Shifting to Circular Economy: Understanding Challenges for New Ways of Governance. *Urban Planning*, 4: 19–31. DOI: https://doi.org/10.17645/up.v4i3.2158

Obersteg, A, Fraser, T, Arlati, A, Acke, A, Bański, J, Czapiewski, K, Wójcik, M, Mezei, C and **Varjú, V.** 2017. D6.2 Governance and Decision-Making Processes in Follow-up Cases – Deliverable of the REPAiR project.

Pénzes, J and **Demeter, G.** 2021. Peripheral areas and their distinctive characteristics: The case of Hungary. *Moravian Geographical Reports*, 29(3): 217–230. DOI: https://doi.org/10.2478/mgr-2021-0016

Reike, D, Vermeulen, WJV and **Witjes, S.** 2018. The circular economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options. Resources, Conservation and Recycling.

Sustainable Resource Management and the Circular Economy, 135: 246–264. DOI: https://doi.org/10.1016/j.resconrec.2017.08.027

Sanjuan-Delmás, D, Taelman, SE, Arlati, A, Obersteg, A, Vér, C, Óvári, Á, Tonini, D and **Dewulf, J.** 2021. Sustainability assessment of organic waste management in three EU Cities: Analysing stakeholder-based solutions. *Waste Management*, 132: 44–55. DOI: https://doi.org/10.1016/j.wasman.2021.07.013

Steen, K and **van Bueren, E.** 2017. Urban Living Labs: A living lab way of working. Amsterdam: Amsterdam Institute for Advanced Metropolitan Solutions (AMS).

Ulied, A, Biosca, O and **Rodrigo, R.** 2010. Urban and rural narratives and spatial development. *Mcrit SL*. https://scholar.google.com/scholar_lookup?title=Urban%20and%20rural%20narratives%20and%20spatail%20development%2C%20Barcelona&publication_year=2010&author=Mcrit

van Geenhuizen, M. 2018. A framework for the evaluation of living labs as boundary spanners in innovation. *Environment and Planning C: Politics and Space*, 36: 1280–1298. DOI: https://doi.org/10.1177/2399654417753623

Varjú, V. 2020. Foreword. *European Spatial Research and Policy*, 27: 5–10. DOI: https://doi.org/10.18778/1231-1952.27.2.01

Varjú, V. 2021. The policy transfer of environmental policy integration: path dependency, route flexibility, or the Hungarian way? *Policy Studies*, 1–19. DOI: https://doi.org/10.1080/01442872.2021.1882670

Varjú, V, Mezei, C, Vér, C, Lovász, V, Grünhut, Z, Bodor, Á, Szabó, T, Jargalsaikhan, K and **Azizli, B.** 2018. D3.7 Process model Pécs – Deliverable of REPAiR project.

Wandl, A, Arciniegas, G, Heurkens, E, Sileryte, R, Song, Y and **Gutsche, J-M.** 2019. D2.4 Handbook for Geodesign Workshops. DOI: https://doi.org/10.17645/up.v4i3.2173

Wandl, A and **Magoni, M.** 2017. Sustainable Planning of Peri-Urban Areas: Introduction to the Special Issue. *Planning Practice & Research*, 32(1): 1–3. DOI: https://doi.org/10.1080/02697459.2017.1264191

Wandl, A, Nadin, V, Zonneveld, W and **Rooij, R.** 2014. Beyond urban–rural classifications: Characterising and mapping territories-in-between across Europe. *Landscape and Urban Planning*, 130: 50–63. DOI: https://doi.org/10.1016/j.landurbplan.2014.06.010

TO CITE THIS ARTICLE:
Varjú, V, Óvári, Á, Mezei, C, Suvák, A and Vér, Cs. 2022. Efforts and Barriers Shifting a City Region Towards Circular Transition – Lessons from a Living Lab from Pécs, Hungary. *Future Cities and Environment,* 8(1): 10, 1–12. DOI: https://doi.org/10.5334/fce.157

Submitted: 22 April 2022 **Accepted:** 25 July 2022 **Published:** 13 September 2022

Future Cities and Environment is a peer-reviewed open access journal published by Ubiquity Press.