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Urban landscape design exercises in urban metabolism: reconnecting with Central Limburg's regenerative resource landscape

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Abstract

The design research presented here uses urban landscape design to attempt to reframe sustainable resource management. Urban metabolism projects generally originate in industrial ecology, emphasizing performance-oriented technical and entrepreneurial approaches. However, industrial ecology approaches experience difficulties in making meaningful connections to social, economic and spatial contexts.

Building on landscape architecture analysis and design methods such as mapping and systemic design, this article will highlight urban landscape design's capacity to reframe questions stemming from the urban metabolism model through the production of future imaginaries.

Using the Belgian Central Limburg region's transition into a circular economy as a design exercise, this paper suggests that urban landscape design's constructivist approach has the potential to embed social and economic dimensions in applying urban metabolism. Operating 'from within' its intervention field, urban landscape design potentially facilitates transdisciplinary dialogues in urban metabolism design research.

Keywords

urban landscape design / urban metabolism / circular economy / systemic design / Belgium

Designing urban metabolisms

With the increasing complexity of urban growth in the twentieth century, the integration of urbanism, engineering and planning became more and more difficult. Nowadays, subsurface utilities are typically conceived by engineers, while planners and urbanists design the urban spaces above the ground. Simultaneously, the urban use of natural resources became more and more wasteful and unsustainable.

The idea of the city as an 'urban metabolism' resulted from a rising awareness of natural resource scarcity and the challenges associated with this. The term 'urban metabolism', however, suffers from disciplinary fields being disconnected, while pushing their boundaries to fit the term to their particular field. Instead of pushing the boundaries of separate disciplines, it would be better to find ways in which these disciplines can work in an integrated way. According to the 1956 Urban Design Conference, disciplines from which knowledge should be included in urban design should be planning, landscape architecture and engineering. ⁵The Harvard Graduate School of Design's *Grounding Metabolism* book, for example, acknowledges the influence of both environmental engineering and critical approaches to urban

metabolism, originating in political ecology and urban geography,⁸ in the urban design discourse. The book calls for a meaningful connection to more socially, politically and ecologically viable models of urbanism.⁹

Urban metabolism and sustainable urban development

Urban metabolism serves as a framework for describing and analysing material and energy exchanges between cities and their environment.¹⁰ It originates from the environmental sciences and was described in 1965 by engineer Abel Wolman in ‘The Metabolism of Cities’, his article on the deterioration of air and water qualities in American cities.¹¹ In spatial practice and architectural design, the urban metabolism metaphor inspired resource-conscious concepts such as ‘cradle to cradle’¹² and ‘eco-towns’ such as Hammarby Sjöstad.¹³

Despite early examples like biologist Patrick Geddes in 1885, who, in his critique on urbanization, described the exchange of material and energy flows,¹⁴ and ecologist Paul Duvingneaud in 1974, who studied Brussels as an organism that exchanges flows of water, energy and materials between urban space and the biosphere,¹⁵ urban metabolism studies are to this day primarily conducted in the field of industrial ecology. These studies quantify material in- and outputs through ‘material flow analysis’¹⁶ and present the physical spaces and infrastructures in which these flows exist as abstractions. According to Kennedy, Pincetl and Bunje, environmental scientists such as Peter Newman attempted to extend the urban metabolism framework with social and economic dimensions, following Girardet’s 1992 *Gaia Atlas of Cities*, which recognizes a link between urban metabolism and sustainable cities.¹⁷ Yet, the authors conclude, social, health and economic indicators still tend to be ‘added on’ rather than inherently embedded in urban metabolism.¹⁸

Based on his analysis of contemporary spatial urban metabolism conceptualizations, bioengineer, philosopher and planner Philippe Vandebroecq situates the reason for this incomplete approach in the industrial ecologist’s objectivist worldview.¹⁹ The industrial ecologist, placing himself outside the intervention field and focusing on performance, carefully calculates industrial ecologies, such as optimizing material flows in smart cities through digital infrastructure or the processes of sharing by-products and resources in exemplary projects like the Danish Kalundborg industrial symbiosis.²⁰ However, industrial ecology makes abstractions of resources’ places of origin, the quarries and water reserves in distanced hinterlands, as well as the stakeholders and agents involved in material flows.²¹

A worldview opposed to that of the industrial ecologist is the constructivist one of the spatial practitioner, who considers space as a medium in which he embeds himself, while focusing on its potentials. According to Vandebroecq, engaging with spatial and temporal manifestations of the site or with material, cultural, temporal and political ‘situational resources’, constructivist approaches consider people as resources that should be allowed to develop.²² In line with Vandebroecq’s framework, the constructivist worldview can be seen as inherently present in urban landscape design. Historian and sociologist Lewis Mumford reminded us that landscape architect Ian McHarg, whose book *Design with Nature* gained iconic status in ecological planning, saw the world holistically, a whole in which he was an actor and participant and that he could observe ‘from within’.²³ Nowadays, contemporary urban landscape design practices, such as New York-based Scapestudio, demonstrate urban landscape architecture’s activist agency²⁴ by designing territorial water metabolisms holistically

intertwining with, for example, context embedded cultural and educational purposes.²⁵ Similarly, Toronto's Lateral Office expands the notion of metabolism by considering synergetic combinations of urban biochemical processes and sets of spatial and cultural practices as a key challenge for design.²⁶ Furthermore, landscape urbanists deeply engage with the dependencies between urban resource flows and their hinterlands. They recognize watersheds, water purification, wastelands and resource hinterlands as crucial fields of disciplinary intervention to restore sustainable interplays between landscape and future development.²⁷

Systemic design and interpretative mapping in an iterative co-production process

Using the transition to circular economy of the Belgian Central Limburg region as a design exercise in urban metabolism, this paper suggests that urban landscape design's constructivist approach has the potential to embed social and economic dimensions in urban metabolism practice. Operating 'from within' its intervention field, urban landscape design can facilitate transdisciplinary dialogues in urban metabolism. The design research into the region of Central Limburg consisted of a sequence of design studios, on-site fieldwork, stakeholder consultation and desktop research, culminating in an intensive international urban landscape design workshop with stakeholders in February 2016.²⁸ It applied regional interpretative mapping in the research area and zoomed-in systemic design explorations in Houthalen-Helchteren (Fig. 1).

First, the paper describes how the interpretative mappings from multiple perspectives and the research into history, the contemporary situation and current data with diverse methods offer diachronic and synchronic understandings of context and site relating to the particularities of places and situations in Central Limburg.²⁹ Secondly, it demonstrates how systemic design in Houthalen-Helchteren tests urban landscape design's capacities to embed social and economic dimensions in specific sites.³⁰ Finally, the paper reflects on urban landscape design's potential for a 'bridging' role in urban metabolism spatial practice.

The gradual disconnection of Central Limburg from its regional resource landscape

Since pre-industrial times, resource extraction has been an important driver of Central Limburg's development. The following diachronic interpretative mappings (Figs. 2, 4 & 6), reconstruct the consecutive relations between urbanization and the use of resources.³¹ They depict the urbanization process that extended its once regional hinterland to a global set of hinterlands step by step.³²

In pre-industrial times, economies and settlements were anchored to the local resources of the regional hinterland. Around 1850, Central Limburg was basically a sandy plateau covered with heathland and fertile plateau edges and valleys (Fig. 2). A sequence of finger-like streams penetrated the west side of the plateau. The Meuse River defined the north-south direction of its steeper east border. Settlements and land cultivations were located on the alluvial grounds in proximity to waterways that supported fish production and the first trade routes. Small villages had developed along the streams, tapping off water for irrigation or to fill artificial fish ponds. Before the First World War, iron ore and peat were dug along the Demer basin streams before turning these grounds into meadows (Fig. 3).³³

At the turn of the twentieth century, coal mining started to generate a specific techno-cultural landscape, with impressive excavated subterranean tunnel systems and aboveground slag

heaps, coal processing plants, conveyor belts and remarkable garden districts for mine workers near the mining sites (Figs. 4 and 5). By the end of the 1960s, industrialization and urbanization had completely turned over Central Limburg's natural metabolism: the barren heath landscape was covered with pine forests for wood production that supported the mining industry. Large-scale infrastructures such as the Albert Canal and railways spanning the Campine plateau supported the export of coal. In 1992, however, the last coal mine closed. Although the mining industry had been in decline since the 1950s, the industrialization of the region it had catalysed was soon fuelled by the abundant availability of imported oil and the democratization of car use, which generated a drastic urbanization of the territory. The spatial conditions and material flows in Central Limburg shifted drastically. Massive industrial and infrastructural investments, sand and gravel extraction, car and other manufacturing and new techniques accelerated a 'shock wave' of urbanization that radically altered the environment and landscape (Figs. 6 & 7).³⁴ Roads and motorways spread out, by now covering the Belgian territory completely.³⁵ In Central Limburg this development started late, but proceeded faster than anywhere else in Belgium. While land-use until the 1960s intertwined seamlessly with the physical characteristics of Central Limburg and produced the landscape, now the landscape was being consumed. Land use simply abandoned its constructive relation with the territorial resources in favour of landscape and resource consumption, or rather destruction.

Whatever notion may be most suitable, the consecutive waves of infrastructural and industrial development blurred and distorted the original intertwining of urbanization and landscape. Central Limburg's metabolism increasingly became man-made, obstructing the natural metabolism rather than constructively making use of it.

Facilitating Central Limburg's circular economy transition by design

The consecutive maps of three resource eras in Central Limburg reveal that today's generic allotments indeed have little to do with their geographical context and locally available resources. (Figs. 2, 4 & 6) The region's metabolism is increasingly delocalizing and becoming more complex.

The mappings portray Central Limburg as a regenerative resource landscape driven by multiple socioecological changes that go hand in hand with radical shifts in the ways the territory is employed, inhabited and urbanized. From working 'with' the available natural resources, via extracting and exporting them, to importing resources and divorcing urbanization from territorial natural logics. The scale of dispersion of both extractive processes and effects, as well as the 'scaling up' of civil engineered infrastructures such as railway lines and storage tanks, distanced resources from consumption and development. With this, it reinforced deep entrenchment of the hierarchical dualism and perceived separation of land and life, hinterland and city, people and place, referred to by Marx as the 'metabolic rift'.³⁶

Today, policies in Central Limburg are aimed at its transition to a circular economy³⁷ in which waste, so to speak, no longer exists but is understood as a resource.³⁸ The intended shift to a circular economy is obviously an open invitation to relink the region's urban development with its landscape characteristics and to reconnect to the territory's resourcefulness. In the urban landscape design research presented here, the government's envisioned transition to a circular economy in Central Limburg is taken as a welcome occasion to explore how an intensive, landscape-based territorial reading can simultaneously induce and substantiate imaginaries for alternative future urban metabolisms. In the region, a wide range of research and development initiatives are tackling challenges of renewable energy and the recovery of waste as a resource.³⁹ They

do not necessarily translate the envisioned transition spatially. The design research, however, advances that Central Limburg's next circular development era should to a large extent be about reconfiguring the interdependency between the region's urbanization and its local resources, including the reuse of existing infrastructure inherited from the past. As demonstrated with the case study of Houthalen-Helchteren, this design research considers Central Limburg's transition to a circular economy as an opportunity to reorient urban development from the linear and devastating land- and resource-consuming process towards a more conscious cyclic interaction between human occupation and the environment. An interaction that constructs and produces landscape rather than consumes it.

Envisioning future urban metabolisms in Houthalen-Helchteren

Houthalen-Helchteren is a municipality in full transition to a circular economy. Remo Milieubeheer, the company in charge of its enormous landfill, pioneers in 'enhanced landfill mining', converting waste into new materials. Additionally, the former mining administration building incubates clean technology start-ups on the previous mining site, of which the conversion into a circular business park is currently a pilot project for the Flemish Government. Furthermore, following a quantitative study on the potential of biomass recovery from landscape management waste in Limburg (Fig. 1),⁴⁰ Houthalen-Helchteren is developing a biomass hub in collaboration with Regional Landscape Low Campine, a government institution that reinforces the regional cultural landscape and nature, and with industry park Europark. The biomass hub will collect, sort and redistribute biomass 'waste' that results from regional landscape management as raw material.

An intensive and immersive international urban landscape design workshop with architects, urban designers and landscape architects organized on site in Houthalen-Helchteren in 2016 proved to be an essential stepstone in the design research.⁴¹ Informed by the historical mapping described above, it explored how the municipality's metabolic shift to clean technology and a circular economy could simultaneously steer future developments while including social and ecological dimensions. The urban landscape design workshop preparation included intensive exchange with local stakeholders working on the terrain, such as the municipality, the Regional Landscape Low Campine and the social housing agency Kempisch Tehuis. The workshop itself started with extensive fieldwork followed by an iterative process of creation and feedback. Stakeholders shared their intentions, projects and knowledge and participated actively in the cocreation of integrated spatial scenarios for a socioecological circular economy.

Evidently, envisioning a socioecological metabolism in Houthalen-Helchteren goes hand in hand with reorienting linear flows into interconnected circular flows and waste into resources. Strategic sites where, for example, waste flows such as residual heat or water could be connected to productive programmes for the municipality, were investigated. A buffer zone bordering an industrial park on a flattened mining slag heap in Houthalen-Helchteren was identified as a critical node in its material flows (Fig. 8). Squeezed between a congested national road and a 12-metres-higher industrial platform, this open space is well-positioned to buffer excess rainwater from the platform. Simultaneously, its neglected but necessary vegetation maintenance can be inscribed in the collection of landscape waste for the biomass hub under development just a few kilometres away. In the eighteenth century, hedgerows bordering agricultural fields in the south characterized this site. To date, a few of these century-old hedgerows are still

present in the overgrown landscape. Additionally, the site's biodiversity is important. It is, however, under development pressure, as it borders a main traffic artery.

One of the workshop proposals for initial interventions⁴² concentrated on diverting rainwater from the industrial platform to the buffer zone, mitigating the current runoff problem causing erosion of the industrial platform edges (Figs. 9 & 10).

Simultaneously, water-purifying vegetation was to be planted at the edges of the rainwater collection point. Thus, waste(d) water would be reintegrated in a water cycle instead of discharged into a sewer (Figs. 9a & 10a). Public access from the grey and monofunctional industrial park to the buffer zone should be realized, adding a social dimension and turning the buffer into a meaningful public space. In the clean and clear buffer zone landscape additional crops supporting the regional biomass economy would be planted (Figs. 9b & 10b). Such a robust green-blue landscape structure frames potential development sites, where new programmes can be accommodated, by transforming the buffer zone into a productive public park, while performing a number of ecosystem services steering new developments along the Grote Baan while preserving the buffer zone's ecological value (Figs. 9c & 10c). This urban landscape design integrates economic dimensions, biomass harvesting and room for new development, as well as public space and job creation. The mentioned integration goes hand in hand with turning former linear consumption patterns (of water for example) into cyclic processes of reuse and self-regeneration. As such, the design works with material flows of biomass, converging water and people in this site.

Essentially, the scenarios shown in the sketches for the buffer zone resulting from the design research are reinterpretations of the landscape structures that supported the region's first settlements, water and vegetation, into a twenty-first century context-embedded, locally supported cyclic landscape. Depending on the site specificities, social, economic and/or ecological dimensions take the forehand. Figure 11, for example, envisions a heated public swimming pond along the recycled coal track, combining the use of excess water from mining subsidence areas with locally collected geothermal or industrial residual heat supplied by the regional coal track network. Simultaneously, the pond along the coal track marks Houthalen-Helchteren as a worthwhile recreation destination along the coal track.

Altogether, the future imaginaries envision how specific contextual characteristics could support an optimal energy and materials transition. At the same time, they depict how this transition could contribute to the optimization of the context's spatial, social, ecological and economic structures in a low-resource consumptive way. Understanding that accommodating an economic transition simultaneously requalifies the urban context, the design scenarios capitalize on the potential of flows and infrastructures to spatially integrate different socioeconomic agendas.

Systemic design recalibrating Central Limburg's metabolism

The systemic design⁴³ strategy applied in the buffer zone strongly relates to Tillman Lyle's 1994 regenerative design concept and its recognition that any plan for a piece of land that seemingly only alters it in a minor way is in fact designing an entire ecosystem.⁴⁴ The strength of systemic design lies in recombining elements from different underlying landscape structures, water, waste, energy and people, 'a combination of local realities and conditions and regional flows forged together to make intelligent landscapes'.⁴⁵ Obviously, the systemic design strategy always has to be tailored to the specific landscape conditions. For this purpose, the design research in Houthalen-Helchteren engaged with the mapping of, among other things, CL's four

landscape types: mixed woodlands, forested wetlands, managed hedgerows and heath (Fig. 12). Close collaboration with Regional Landscape Low Campine, which is responsible for the regional biomass hub development, unlocked the local and expert knowledge on growth and maintenance cycles of these different vegetations and made it possible to co-elaborate a phased strategy for the future regional biomass system. The plan proposes the gradual integration of the municipality's four landscape types into a regional circular landscape economy, while simultaneously delivering a spatial framework for future development (Fig. 10).

Waste(d) resource flows in the contemporary resource landscape of Central Limburg

In Limburg's upcoming circular economy, any waste flow will be considered a resource. Besides biomass from landscape management waste, the region houses many other waste(d) or inefficient resource flows, forgotten spaces and oversized or underused infrastructures. A set of them are synthesized in a series of synchronic interpretative mappings (Figs. 13 & 14) revealing wasted resource flows in the contemporary landscape of Central Limburg. The mappings identify and spatialize a number of its untapped, underused or wasted local resources: geothermal energy potential, heat producing industries, former landfills, water pumped out of mining subsidence areas and landscape waste from landscape management. The waste(d) materials mappings (Fig. 13) locate current waste and resource practices and indicate possibilities to close material flow cycles and recycle places in the Central Limburg territory. To date, Limburg's circular economy is mainly being shaped by companies that recycle, convert and repair waste (Fig. 13a). However, waste from landscape management also holds potential for a regional biomass economy. Vegetation and wood can be collected and sorted and reinserted into a productive biomass economy (Fig. 13b).⁴⁶ Outdated infrastructures are often oversized, like the Albert Canal, abandoned, or underused, such as the Coal Railway Track (Fig. 13c). Former peat, gravel, sand and coal extractions created substantial re-orderings of the landscape. Some of them were repurposed as recreational lakes or parks that play an important role in the regional water cycle management, such as the recreational lake Kelchterhoef (Fig. 13d). The renewable energy mappings (Fig. 14) indicate that Central Limburg has abundant untapped local resources for renewable energy, while Flanders' aged energy infrastructure encounters many technical shortcomings.⁴⁷ Creating more decentralized energy infrastructures, especially in dispersed territories like Flanders, seems evident (Fig. 14a).⁴⁸ The future energy landscape could radically combine innovative technologies and unexpected, local renewable resources. The region has a high potential for geothermal energy as well as heat exchange between industries (Fig. 14b).⁴⁹ The future energy infrastructure is also expected to be complex, hybrid and patchworked, composed of multiple energy sources, with 'smart' virtual and physical components. There is quite a bit of solar and wind energy potential (Fig. 14c) and Limburg is proving to be a strategic region for recovering biomass from landscape waste (Fig. 14d).⁵⁰ Mapping the territory's contemporary resourcefulness in synchronic resource mappings, as the ones sketched above, creates a playing field for engineering the next resource extraction wave, yet this time with a circular instead of a linear mindset. The design case study in an industrial buffer zone in Houthalen-Helchteren presented here, applies Alan Berger's theoretical systemic design framework in practice. Following the same systemic design method, the mapped waste(d) water and material flows as well as forgotten spaces can be recombined and integrated in systemic strategies for specific urbanisation and development sites (Fig. 15). The systemic design

method anchors future development to the territory, considered as a renewable resource in itself, while restructuring space and consequently increasing spatial quality.

Three lessons from a design exploration: interactions between urban landscape design and urban metabolism

1. *Mapping the resourcefulness of landscapes serves as an analytical tool*

Diachronic and synchronic mapping substantiated the urban landscape design research for Houthalen-Helchteren. They deliver historical and spatial understanding of Central Limburg's complex interplay between uses of resources and their flows, of flows guided by infrastructures, of settlements and associated socioeconomic situations and practices. The developed diachronic resource mapping method allows designers to link the abstract urban metabolism model to spatial practice. Tracing the distancing of resource extraction processes and effects, from a direct interplay between settlement patterns and landscape resources to an urbanization supported by imported fuels and materials, adds value to the disciplinary orientation of urban landscape design. The mappings of Central Limburg as a waste(d) resource landscape contribute to the analysis of the territory now that the region is at the verge of circular redevelopment. They foreground territorial structures, such as waste sites or landscape structures, that can become part of infrastructural networks supporting biomass recovery from landscape management, as potential guiding structures for future circular urbanization. The mappings locate the resources in the landscape and reveal their complex interconnectedness with other systems and territorial characteristics such as topography and water systems.

In short, the mapping of Central Limburg's territorial resourcefulness offers an analytical basis for envisioning new lifecycles as a driver for the future development of the region's energy and materials transition. Pinning down the biophysical territorial 'resource' context of this transition, the mappings form the starting point for systemic design in municipalities such as Houthalen-Helchteren.

2. *Urban landscape design can reconfigure urban metabolisms*

The design examples illustrate the capacity of urban landscape design to lead the way to an evolving understanding of the way in which flows and infrastructures connect different socioeconomic agendas.⁵¹

The designs presented in this paper reframe the possible convergence of water, biomass, heat and people flows in various sites in Houthalen-Helchteren. While designing 'with' these flows, the proposals simultaneously restructure the urban fabric, as for example between the infrastructural trajectory of the Grote Baan and the adjacent industrial platform. Even though it was not the main design focus, the suggested approach transforms the area's metabolism, giving room to water storage, creating a spatial structure for biomass harvesting from landscape management, and facilitating public accessibility, economic activity and spatial quality. While landscape urbanists are hesitant to foreground urban metabolism,⁵² this design research explores, in a 'learning by doing' process, the possibility of urban landscape design to reframe sustainable resource management assignments, while embedding social, economic and ecological dimensions in explorative spatial proposals.

Starting from multiscale site knowledge based on mapping, fieldwork and stakeholder input, in the presented example designers identified relevant material flows that allowed them to intervene in the buffer zone, such as the biomass from landscape waste and the flows of rainwater and people. Experts brought in detailed site and flow knowledge, for example Houthalen-Helchteren's different landscape types, their maintenance cycles

and types of machinery and harvesting equipment. A design proposal for a concrete local intervention reconfigures the community's urban metabolism, inscribed in regional material flows such as the watershed or the biomass harvesting from landscape management waste. The resulting design framework for the buffer zone enables the identification of following steps that can realize future flow management in this site, such as fine-grained quantitative data collection for biomass and water flows in the buffer zone, or identification of site-specific public space needs. As such, the future imaginaries clarify where to start digging for data, rather than the other way around. This approach is extremely relevant in Flanders' data-scarce context and probably in most parts of the world where complete resource flow datasets most likely do not exist.⁵³ The suggested site-specific approach gives material flows a spatial, social, ecological and economical context, prior to or while precisely quantifying them. As such, it can contribute to grounding industrial ecology's top-down quantitative material flow analysis approaches. Moreover, urban landscape design can integrate the urban metabolism agenda in ongoing urban and landscape developments, instead of mapping all flows before intervening in them.

3. *Urban landscape design facilitates intradisciplinary dialogues*

The design exercise in Houthalen-Helchteren stretches the role of the urban landscape designer from a spatial specialist to an integrator of complex flows and mechanisms that impact a place's urban metabolism. The multiscale future imaginaries for Houthalen-Helchteren absorbed input and feedback from stakeholders such as the municipality, business developers, the representatives of the social housing company and the industry park, as well as experts such as landscape ecologists in an open co-productive design process. Design drawings became mediators by integrating knowledge, shaping coalitions and their ability to generate collaboration and action.

The connection of disparate circular economy initiatives with landscape management and public space creation in integrated spatial scenarios for Houthalen-Helchteren shed a new light on how the municipality might intervene in its urban metabolism. Rather than approaching the transition to a circular economy as a purely numbers-driven question, the urban landscape design approach essentially recombined material flows in space as the starting point for a more resource-efficient spatial planning. As such, the imaginaries substantiated the stakeholders debate, based on qualitative data and design research.⁵⁴ At the time of the design exploration, no exact data on the material flows of water and biomass in the buffer zone were available. To this purpose, qualitative appreciations and assumptions were made with experts, such as the identification of landscape types and the assessment of the platform wall erosion caused by water runoff. The exploration of Houthalen-Helchteren demonstrated the world of possibilities that space contains and as such functioned as an eye-opener for all involved. This motivated the municipality to see infrastructural investments as a lever for a more sustainable urban metabolism. The municipality continues to revisit the co-produced future imaginaries when tackling infrastructure projects such as the development of its biomass hub or setting up a pilot project for a sustainable industry park.⁵⁵ Being envisioned spatial projections, the proposed imaginaries serve as media of integration. They highlight the advantages of integrated and systemic design, while reframing infrastructure assignments as questions of urban metabolism and gradually reconstructing cyclic territories. By evoking and simultaneously substantiating and demonstrating how different urban dimensions can be integrated, the developed future imaginaries for Houthalen-Helchteren do not fix spatial futures. Instead they give

direction, while being a tool of mediation and integration. They are eye-openers, synthesizing the integration of ecological, social and economic possibilities in possible spatial constellations. By integrating expert knowledge of different domains in future imaginaries with recognizable elements for each, they facilitate dialogues between different actors such as resource managers and planners, policymakers and developers. Designing 'with' urban metabolisms,⁵⁶ urban landscape designers complement the currently dominating engineering approaches that solely focus on material flows themselves and consequently struggle with the integration of social and economic dimensions. In this way, they can bridge designers' and engineers' very different methodological presuppositions and diverging positions, working towards temporary closure of different worldviews through design.⁵⁷

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Biographical notes

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Engineer-architect and urban designer Julie Marin is currently a PhD candidate at the University of Leuven in Belgium. Her doctoral research by design focuses on the potential of transitioning geographies of waste and resources to (re)structure the Flemish diffused territory. At the University of Leuven, she is a teaching assistant in multiple courses and urban design studios collaborating with public authorities and private stakeholders. Before joining the University of Leuven in 2014, Julie was an urban designer at Scape/Landscape Architecture in New York City and an associate in architecture at the Urban Design Program of Columbia University.

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Bruno De Meulder studied civil engineering-architecture at the Department of Architecture, University of Leuven in Belgium, where he also obtained his doctoral degree, and where today he teaches history, theory and practice of urbanism. His teaching takes place through urban design studios that he also cherishes in research and practice. He regularly publishes on issues of urbanism in the postindustrial and postcolonial era. His urbanism practice and research attempt to reconnect with today's socioecological agenda. He coordinates the MaHS and MaUSP programmes at the University of Leuven and heads OSA, the research unit urbanism and architecture.

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1 Philippe Vandenbroeck, *Whither Urban Metabolism*, presentation in Urban Design Strategies Course 2017, University of Leuven Master of Human Settlements and Master of Urban Strategic Planning programme, Department of Architecture.

2 Ibid.

3 Maarten Hajer and Ton Dassen, *Smart about Cities: Visualizing the Challenges for 21st Century Urbanism* (Rotterdam: nai010 publishers and PBL publishers, 2014).

4 Vanesa Castan Broto, Adriana Allen and Elizabeth Rapoport, 'Interdisciplinary Perspectives on Urban Metabolism', *Journal of Industrial Ecology* 16/6 (2012), 851–861. The authors write that many disciplines besides industrial ecology make use of the term 'urban metabolism' in different ways when referring to resource scarcity, but what they all have in common is that they use the term 'urban metabolism' because they try to push their own disciplinary boundaries. However, the different disciplines stay disconnected.

⁵ Reference: 'Urban Design. Condensed report of an invitation conference sponsored by Faculty and Alumni Association of Graduate School of Design', Harvard University, April 9-10, 1956. *Progressive Architecture*, 8, 97-112. Jane Jacobs, Lewis Mumford and Jose Luis Sert were among the attendants of the conference.

6 Daniel Ibañez and Nikos Katsikis (eds.), *New Geographies 06: Grounding Metabolism* (Cambridge, MA: Harvard University Graduate School of Design, 2014). Prior to the book's publication, the editors organized a conference on the same topic, entitled 'Projective Views on Urban Metabolism', in February 2014.

7 Among others Peter Baccini, 'A City's Metabolism: Towards the Sustainable Development of Urban Systems', *Journal of Urban Technology* 4/2 (1997), 27–39.

8 Among others: Matthew Gandy, 'Rethinking Urban Metabolism: Water, Space and the Modern City', *City* 8/3 (2004), 363–379 and Steven Graham and Simon Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London: Routledge, 2003).

9 Daniel Ibanez and Nikos Katsikis, 'Grounding Metabolism Editorial', in: Ibanez and Katsikis, *New Geographies 06*, op. cit. (note 5), 2–9: 5.

10 Arjan van Timmeren, *The Concept of Urban Metabolism (UM)* (lecture transcript ReciproCities. A dynamic Equilibrium. ETD, 2014), https://urbanmetabolism.weblog.tudelft.nl/files/2016/07/05a_UrbanMetabolism_VanTimmeren.pdf. Based on Marina Fischer-Kowalski, 'On the History of Industrial Metabolism', in: Robert Ayres and Leslie Ayres (eds.), *A Handbook of Industrial Ecology* (Cheltenham Glos, UK/Northampton, MA: Edward Elgar Publishing: 2003), 16–26.

11 Abel Wolman, 'The Metabolism of Cities', *Scientific American* 213/3 (1965), 179–190.

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- 12 Michael Braungart and William McDonough, *Cradle to Cradle* (Maastricht: Scriptum, 2007).
- 13 City of Stockholm, *Hammarby Sjöstad*, <http://vaxer.stockholm.se/omraden/hammarby-sjostad/>, accessed 1 December 2017.
- 14 Garry McDonald and Murray Patterson, 'Bridging the Divide in Urban Sustainability: From Human Exemptionalism to the New Ecological Paradigm', *Urban Ecosystems* 10/2 (2007), 169–192.
- 15 Paul Duvigneaud, *La synthèse écologique: populations, communautés, écosystèmes, biosphère, noosphère* (Paris: Doin, 1974).
- 16 Among others: Peter Baccini and Paul Brunner, *Metabolism of the Anthroposphere: Analysis, Evaluation, Design* (Cambridge, MA: MIT Press, 2012).
- 17 Chris Kennedy, Stephanie Pincetl and Paul Bunje, 'The Study of Urban Metabolism and Its Applications to Urban Planning and Design', *Environmental Pollution* 159/8 (2011), 1965–1973: 1967; Peter Newman, 'Sustainability and Cities: Extending the Metabolism Model', *Landscape and Urban Planning* 44/4 (1999), 219–226.
- 18 Kennedy, Pincetl and Bunje, 'The Study of Urban Metabolism', op. cit. (note 16), 1971.
- 19 Vandenbroeck, *Whither Urban Metabolism*, op. cit. (note 1).
- 20 Kalundborg Symbiosis, www.symbiosis.dk/en, accessed 1 December 2017.
- 21 Sabine Barles, 'Society, Energy and Materials: The Contribution of Urban Metabolism Studies to Sustainable Urban Development Issues', *Journal of Environmental Planning and Management* 53/4 (2010), 439–455.
- 22 Vandenbroeck, *Whither Urban Metabolism*, op. cit. (note 1).
- 23 Ian McHarg, *Design with Nature* (New York: John Wiley & Sons, 1992); Lewis Mumford, 'Introduction', in: ibid., vi–viii.
- 24 Kate Orff, *Toward an Urban Ecology* (New York: The Monacelli Press, 2016).
- 25 This refers to Scapestudio et al.'s design proposal for Rebuild by Design, a federally funded reconstruction effort in the aftermath of 2012 hurricane Sandy put American and European urban (landscape) designers in charge of developing integrated multiscale rebuilding solutions involving community groups as well as experts (www.rebuildbydesign.org).
- 26 Lola Sheppard, 'Territorial Metabolisms: Far Flung Urbanisms', in: Philippe Vandenbroeck, *Summary Report Masterclasses Designing With Flows. Towards an Urban-Metabolic Agenda for a Circular Future* (Brussels: OVAM / .Fabric / VMM / MIRA / Team Vlaams Bouwmeester / Metabolism of Cities, 2017), 10–12.

27 Among others: Kelly Shannon et al., *Water Urbanisms* (Amsterdam: SUN, 2008); Dirk Sijmons, 'Utopia's Practical Cousin', in: Alan Berger, *Systemic Design Can Change the World* (Amsterdam: SUN, 2009), 88–98; Alan Berger, *Drosscape: Wasting Land in Urban America* (New York: Princeton Architectural Press, 2006); Felipe Correa, *Beyond the City: Resource Extraction Urbanism in South America* (Austin: University of Texas Press, 2016).

28 The design results, stakeholders and participants lists can be consulted in the following workshop and studio reports: (1) Christian Nolf, Bruno De Meulder and Huig Deneef (eds.), *Landscape and Urban Design Workshops de Wijers* (VLM, 2015)

https://issuu.com/christiannolf/docs/design_workshops_de_wijers_2012_13_;

(2) Julie Marin, Matteo Motti and Bruno De Meulder (eds.), *Waste(d). Connecting Cycles, Rethinking Infrastructures* (KU Leuven, 2015),

https://issuu.com/juliemarin5/docs/booklet_campine_studio_2015_email; (3)

Julie Marin, Erik Vandaele and Bruno De Meulder (eds.), *Upcycling Limburg. Evisioning Transition along the Coal Track* (University of Leuven, 2015),

https://issuu.com/juliemarin5/docs/upcycling_limburg_mahsmausp_fall201; (4)

Julie Marin, Matteo Motti and Bruno De Meulder, 'Atelier # 1', in: Joeri De Bruyn et al. (eds.), *Het Kolenspoor getest* (Mechelen: Public Space en Ruimte Vlaanderen, 2016), 189–248,

https://issuu.com/toplimburg/docs/atlas_iabr_final_v3_13-04-2016.comp.

29 Kelly Shannon, 'The Agency of Mapping in South Asia: Galle-Matara (Sri Lanka), Mumbai (India) and Khulna (Bangladesh)', *Footprint* 2 (2008), 105–119: 106, 118.

30 Draft versions of part one and two were presented at the 2016 Landscape Architecture as Necessity Conference in 2016. Reference: Julie Marin (2016), 'Central Limburg's Regenerative Landscape: A Laboratory for Resource Urbanism', in: Alison Hirsch and Kelly Shannon (eds.), *Landscape Architecture as Necessity Conference Proceedings* (Los Angeles: University of Southern California, 2016), 117–130.

31 This mapping methodology builds on previous mapping research in the OSA research group at the University of Leuven. See David De Kool, Joris Moonen and Bruno De Meulder, *Centraliteit In-Tussen* (Brussels: Steunpunt Ruimte, 2012).

32 Peter Baccini, 'Understanding and Designing the Metabolism of Urban Systems', in: Ibanez and Katsikis, *New Geographies 06*, op. cit. (note 5), 28–37: 31.

33 Joël Burny, *Historisch-Ecologisch Onderzoek in De Lage Kempen, Deelstudie De Wijers* (Provincie Limburg: het Regionaal Landschap Lage Kempen & Erf-goedcel Mijn-erfgoed Communicatie & Ecologie, 2014).

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- 34 Maarten Van Acker, 'Colonizing the Campine', in: Maarten Van Acker, *From Flux to Frame: Designing Infrastructure and Shaping Urbanization in Belgium* (Leuven: Leuven University Press, 2014), 31–188.
- 35 Bruno De Meulder et al., 'Patching up the Belgian Urban Landscape', *OASE, Journal for Architecture*, 52 (1999), 78–113.
- 36 Marx regarded urbanization as a key process leading to the 'metabolic rift', because of the reduced interaction between humans and the earth resulting from population migration from rural to urban areas. John Foster, 'Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology 1', *American Journal of Sociology* 105/2 (1999), 366–405.
- 37 T.OP Limburg, 'Re-mine poort Limburg', www.toplimburg.be/re-mine-poort-limburg, accessed 20 October 2017.
- 38 Ellen MacArthur Foundation, *Towards the Circular Economy vol. 1*, www.ellenmacarthurfoundation.org/publications.
- ³⁹ Research institutes support transition to renewable and sustainable energy and materials use, such as Energyville (www.energyville.be) and Greenville (www.greenville.be).
- 40 Jeroen Gillabel et al., *Onderzoek naar de Ecologische, Maatschappelijke en Economische Haalbaarheid van Bio-energieregio's in Vlaanderen*, www.mipvlaanderen.be/file.aspx?mode=download&id=2028.
- 41 The workshop was organized by University of Leuven's research group on Architecture and Urbanism (OSA) in collaboration with Houthalen-Helchteren municipality, the Flemish Spatial Planning Department (Ruimte Vlaanderen, today Departement Omgeving) and Z33.
- 42 All workshop proposals are co-productions directed by Julie Marin (OSA/KUL), Matteo Motti (DASTU/Politecnico di Milano), Bruno De Meulder (OSA/KUL) and Bertien Buntinx (Houthalen-Helchteren). With Andrea Bortolotti, Bart Claassen, Manuel Clasadonte, Wout Collart, Racha Daher, Wenbo Fu, Dominiek Lens, Kees Lokman, Alice Mento, Michael Stas, Charlotte Timmers, Benjamin Van Brabant, Janneke van der Leer, Hanne Van Gils, Tran Trung Vinh, Maria Zoroudi. Guest speakers: Andrew Vande Moere (KUL), Alvin Chua (KUL), Bart Paesen (RLLK), Erik VanDaele (KUL), Liesl Vanautgaerden (RV), Ciel Grommen (Z33), Martina Muzi (Space Caviar), Yves Tielemans & Ludo Van Doninck (Remo Machiels), Dirk Eerdekens (Limburgs Landschap vzw). For more details, see: Marin, Motti and De Meulder, 'Atelier # 1', op. cit. (note 28 (4)).
- 43 Alan Berger, *Systemic Design Can Change the World* (Amsterdam: SUN, 2009).
- 44 John Motloch, 'Book Review: Regenerative Design for Sustainable Development: John Tillman Lyle, Wiley, New York, 1994', *Landscape and Urban Planning* 32 (1995), 198–201.

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- 45 Berger, *Systemic Design*, op. cit. (note 43), 36.
- 46 Gillabel, *Onderzoek*, op. cit. (note 40).
- 47 Flanders' aged energy infrastructure and political quarrels on the where and how of energy production have culminated in energy outage plans since the winter of 2014. And since 2012, cracks in the nuclear power plants in Doel and Tihange have necessitated temporary plant closures.
- 48 Since energy efficiency and CO₂ emissions strongly correlate with road transportation, a return to local energy sources seems evident.
- 49 51N4E, *Atelier Diepe Geothermie* (Brussels: R.V. Team Vlaams Bouwmeester/ VITO, 2015).
- 50 Gillabel, *Onderzoek*, op. cit. (note 40).
- 51 Vandenbroeck, *Summary Report*, op. cit. (note 26), 25.
- 52 Vandenbroeck, *Summary Report*, op. cit. (note 26), 22.
- 53 Local governments such as the City of Antwerp and design researchers studying urban metabolisms in Brussels, Antwerp and Limburg experienced Flanders as a 'data desert'. Data about material flows are scattered, incomplete or not useful at the micro level of the project at hand.
- 54 Andrea Bortolotti and Marco Ranzato, 'On Ecology and Design: Heritage and Emerging Perspectives on Brussels' Urban Metabolism', in: Carola Hein (ed.), *International Planning History Society Proceedings vol. 7, 17th IPHS Conference, History-Urbanism-Resilience* (Delft: TU Delft Open, 2016).
- 55 Collaborations with the municipality's civil servants and policymakers continue through design studios and the project direction of *Pilootproject terug in Omloop*, a Flemish subsidy, to continue the research by design for a pilot project on industry park Centrum-Zuid in Houthalen-Helchteren.
- 56 Vandenbroeck, *Summary Report*, op. cit. (note 26), 25.
- 57 Vandenbroeck, *Whither Urban Metabolism*, op. cit. (note 1).