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Urban Form and Urban Metabolism. Recent research and academic trends conducted at the Lisbon Metropolitan Area

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Abstract

Urban planning and urban design disciplines have been called to contribute for more sustainable communities. Approaching, describing, and measuring the urban metabolism calls therefore for the most appropriate tools to support the examination of the city from a sustainability point of view. Although prolific contributions have been advanced by the engineering disciplines, mainly in what regards the development of methods to quantify and measure the material flows that operate in the urban system, at the urban design sphere the study of the metabolism remains somehow obscure, delaying the necessary advances to guide the designing of the urban realm and of its necessary infrastructures to promote a sustainable city. This chapter summarises the research process promoted by the author of this manuscript, applied at Lisbon Metropolitan Areas, while promoting the study of the urban metabolism from a visualization perspective, for which the study of urban form proved to be fundamental. To do that, we examine the main contributions of the application of such visualization process, practiced in the past decade at Iscte - Lisbon University Institute, both in two specific financed research projects (MEMO and SPLACH) and at an academic domain, specifically at urban project studios of the Integrated Master of Architecture.

RESEARCH BACKGROUND

Developing a research project is naturally interrelated to the viewpoints and backgrounds of the researchers that outlined such project. Accessing a researcher's biographical note obviously allows to identify the researcher main thematic lines and research questions. The research work that is here described makes part of a continuous research process, constructed throughout approximately one decade, which counted with the support of researchers from several disciplinary areas, including, architecture, anthropology, sociology, economy, geography, history, civil engineer, and environmental engineer, with whom the author of this chapter had the opportunity to collaborate and build together her research path. Therefore, the results provided by the two research projects which will be here discussed do not result from a single researcher, but from a collective work, developed within two specific research teams, coordinated by the author of this chapter between 2013 and 2015 for Project MEMO, and between 2017 and 2021 for Project SPLACH, respectively. Both projects were financed by the Portuguese Science Foundation and other European Community funds and involved other university institutions. However, for the purpose of this chapter, our analysis focuses on the work coordinated by the author of this chapter at Iscte - Lisbon University Institute, more precisely at the DINÂMIA'CET research centre.

The author is an architect (Faculty of Architecture of the University of Lisbon, 1994) with a MSc in Land Use Planning and Environmental Planning (Faculty of Science and Technology from the New University of Lisbon, 1999) and a Ph.D. in Architecture (The University of Nottingham, 2002). In 2003, the author, recently appointed as an Assistant Professor at Iscte, developed for the Architecture course of the Department of Architecture and Urbanism, more precisely for its 4th year degree Urban Project studio, her first academic course syllabus for a design studio regarding the study of urban form from a sustainability perspective. This course offered the opportunity to apply at an academic domain a methodological framework promoted at a PhD research, and therefore engage architectural students with the study of urban form (analysis + proposal) through a more critical interest towards the processes of change associated to its inherent historical, socio-economic, and environmental contexts throughout time, which ultimately determine the levels of sustainability of urban form (Marat-Mendes, 2002, 2004). The identification of the ground rules, or the Plan Principles, emerged therefore as important requisites to allow students to determine the physical conditions that assisted the urban plan was when this was implemented and evaluate them in terms of change over time. Consequently, 'change' and 'time' emerged as the central features to evaluate urban form performance, according to several contexts under analysis (Marat-Mendes 2015a, 2015b). Adaptability, flexibility, resilience, and continuity emerged as the possible capacities of urban form to evaluate its performance throughout time and change, and consequently determining levels of sustainability to be ascertained. The application of this methodological framework

at the Iscte Urban Project studios was promoted through an analysis of a territory, familiar to the students and located in Lisbon Metropolitan Area (LMA).

Specific urban proposals developed and implemented for the city of Lisbon and its environments were considered key urban planning examples to promote such urban form analysis. Notably, it included urban proposals from the 1930's, 1940's and 1950's, conceived by architect-urbanists Étienne de Groër and Faria da Costa, namely the residential neighbourhoods of Alvalade, Almada, Areeiro, Costa da Caparica and Restelo, which are currently considered as remarkable examples of sustainable urban design, but also for the Urban Plan for Costa do Sol, the first approved urban extension of Lisbon (Marat-Mendes and Oliveira, 2012; 2013). Furthermore, such methodological approach also proved to be effective when analysing change within urban-rural realities, including the management of natural resources such as water, land, and crops (Marat-Mendes and Cuchí, 2008). Water and green spaces, alongside the study of urban form emerged as the main elements of analysis, for which the analysis of the Urban Plan for 'Costa do Sol' proved to be very useful (Marat-Mendes, 2008).

The academic work developed at Iscte Urban Project studios was naturally intrinsically connected to the research conducted by the author of this chapter during the same period, in what regards the study of the territory from the perspective of natural resources management, which corresponded to her first approach to the study of urban metabolism (Marat-Mendes, 2009), in what concerns water and green spaces. Such approach to the urban metabolism, first explored in collaboration with colleagues from the Universitat Politècnica de Catalunya, notably with the research team led by Albert Cuchí and his students, for example Elena Albareda (Cuchí et al., 2008, 2010) provided the first important inputs to advance the study of urban metabolism from the perspective of urban material analysis. The results would then be applied in a study for Santiago de Compostela (Cuchí et al, 2008) but also explored at the LMA (Marat-Mendes and Cuchí, 2008), through the analysis of pilot cases located at the territory of 'Costa do Sol' (Marat-Mendes and Cuchí, 2007).

It was precisely with this background, that the author of this chapter, then a Professor of Urban Project studios but also of History and Theory of Contemporary Urbanism and Ecology and Territory and a researcher at the DINÂMIA'CET research centre, had just accomplished her first research projects applied on the study of Lisbon Urban Planning and its region, from the perspective of urban form and its impact of water resource management on Lisbon territory. Thus, she was looking for new scientific challenges in which the previous experience could be further applied and gain greater thickness at the domain of Urban Metabolism. Furthermore, it was precisely in the urban metabolism field that she identified a great fragility in urban planning studies, greatly alerted by what Kenedey et al. (2011) and Oswald and Baccini (2003) had already argued, which is that to improve urban design, greater acknowledgment of the metabolic functioning of the urban is mostly required.

However, the challenge to explain urban metabolism to architectural students but also to a general audience, demanded fewer complex tools to visualize it and ultimately to understand its strategic role to promote more sustainable urban environments. It was with these concerns in mind that the author of this text kept on her research journey, while linking of the study of urban form with urban metabolism in practice and theory, i.e., on academic level of urban project studios and on research projects. Today, Teresa is an Associated Professor with Aggregation in Architecture, and have concluded the coordination of two research projects, financed by public funds, dedicated to the specific thematic of urban metabolism, urban form, and sustainability: Project MEMO - Evolution of the LMA Metabolism. Lessons towards a Sustainable Urban Future (PTDC/EMS-ENE/2197/2012) and Project SPLACH-Spatial Planning for Change (POCI-01-0145-FEDER-016431). These are the projects which will now be introduced and discussed in terms of their main contributions to reinforce ecological concerns through the study of urban form.

PLACING URBAN METABOLISM INTO A RESEARCH AGENDA

Discussing research results at national and international conferences plays a key role on explaining main contributions as well as to foster further dialogues with research peers. That was precisely the case with the discussion of the research results conducted at the Lisbon territory (Marat-Mendes & Cuchí, 2007, 2008). Applied at a specific case study, the Barcarena water basin of Costa do Sol, the research findings provided the opportunity to use methods of territorial visualization while justifying specific metabolic processes occurring in the territory. Thus, encouraging its further use on the analysis of larger territory, such as the overall Lisbon metropolitan region.

MEMO - Evolution of the Lisbon Metropolitan Area Metabolism. Lessons towards a Sustainable Urban Future

It was precisely in this situation that the author of this chapter, when discussing the possibilities of the visualization processes to benefit the metabolic accounts of the contemporary urban landscapes but also from a historic ones, while exemplifying with the specific case of Lisbon Territory (Cuchí and Marat-Mendes, 2011) met, at the 7th Virtual Cities and Territories Conference in October of 2011, the engineer Samuel Niza, a researcher from Instituto Superior Técnico, well known for the metabolic studies conducted for the Lisbon city (Niza et al, 2009). Exploring the opportunity to link the visualization characterization of the metabolic processes with the accounting of the material flow accounts occurring in the territory emerged therefore as a promising opportunity to join the two researchers work. Subsequently, the successful financial support for the research proposal project, 'MEMO - Evolution of the Lisbon Metropolitan Area Metabolism. Lessons towards a Sustainable Urban Future' (PTDC/EMS-ENE/2197/2012) submitted by the researchers for the Portuguese Science Foundation would provide the means and the opportunity to combine their research methodological approaches towards the study of urban metabolism of the LMA. Therefore, the research team would benefit from knowledge acquired from previous research but also provide new data and systematizations to advance with new research in the field. The research project was built by two research teams. Samuel Niza research team was based at the University of Lisbon and the research team coordinated by Teresa Marat-Mendes was based at Iscte- Lisbon University Institute, at the DINÂMIA'CET research centre.

The principal goal of MEMO project was to develop a comparative analysis of the metabolic behaviour of the LMA in two specific historical periods (a pre-industrial period and the present time). Additionally, it envisioned to identify what elements of urban form for each historical period were determinant to transform the material and agriculture and water flows in the territory. The urban metabolism was assessed based on methodologies provided by (i) urban Material Flows Accounts (Niza et al., 2009) and (ii) visualization assessment of the morphological evolution of the territorial and built forms associated to water and agriculture uses (Marat-Mendes, 2010).

While Samuel Niza applied the Material Flow Accounting method, with data for Lisbon retrieved by the two teams for 1900 and 1940, the visualization method suggested by Teresa Marat-Mendes aimed to assess urban form versus water and agriculture uses based on a historical characterization of the Lisbon region in a comparative manner for 1900 and 1940 as well; somehow in what can be considered a similar procedure to the historic-geographic approach proposed by urban morphologists such as M. R. G. Conzen (Conzen, 2004). Therefore, three main steps were contemplated: (i) Evaluation of cartographic maps, in order to evaluate the urban and territorial characterization of the LMA evolution, but also identification of the water infrastructures (natural and artificial) identified in the cartography in terms of uses relation and evolution; (ii) Relate the practices of water management against the LMA Region

population growth, uses, economy, territorial arrangements, agriculture exploitations and works practices and identify the situations of urban metabolism for LMA to be measured. Such situations were justified through the historical characterization of Lisbon Region to determine specific period of Lisbon urban History that need to be differentiated throughout its socio-economic history; and (iii) Evaluate the urban metabolism of Lisbon Region for each identified historic moment.

The two-year research work conducted for MEMO Project, between 2013 and 2015 provided therefore an opportunity for the team to apply specific methodological approaches, previously attained, but also to adapt such methodologies to specific constraints placed by the project itself, such as the lack of both cartographical and statistical data for LMA, for the overall period under analysis (1900-2000), in terms of agriculture and water uses. Therefore, one of the main decisions was to limit the periods under analysis to two specific periods of time which were supported by both cartographic and statistical data, but that at the same time exposed two distinct metabolic periods of time, i.e., a preindustrial one (1900) and an industrialized one (1940) (Marat-Mendes et al, 2014, 2015).

The MEMO Project provided a new perception of the LMA metabolic study, and in particular for the Lisbon Municipality in what regards the accounting of its urban metabolism also from an historic perspective (Niza et al, 2016); but also the opportunity to apply combined methodologies to further expand the metabolic processes that perform over the urban realm (Marat-Mendes et al, 2014, 2015; 2016). Regarding the ambition to visualize the metabolic functioning of LMA, in terms of territorial organization in terms of water and agriculture we shall recall the assembly of the 'Water and Agriculture Atlas: Lisbon Region in 1900-1940' (Marat-Mendes et al, 2015). This publication was important to systematize all the visualized data about agriculture and water elements in the Lisbon region for the two specific periods of time under investigation, and to better portrait the correlation of the spatial organization of the territory and the metabolism that operates in the LMA, concerning the management of territory and natural resources (water and agriculture). Furthermore, the linking of such visualization procedure with the Material Flow Account approach, allowed for one specific moment of Lisbon urban History, 1900, to account the metabolism of the municipality of Lisbon in 1900 and relate it to the spatial organization of its territory (Niza et al, 2016), as well as the built forms associated to access to water in LMA (Marat-Mendes et al, 2016).

SPLACH – Spatial Planning for Change

In 2017 a new project, SPLACH - Spatial Planning form Change was financed by the Program Compete P2020 together with the Portuguese Science Foundation. This project aimed to inform future public policies on how to promote a sustainability transition for urban planning practices. The project was run by three Portuguese University Institutes, University of Porto, University of Coimbra, and Iscte-Lisbon University Institute. For the purpose of this chapter, we shall focus our analysis on the work produced at Iscte, which was coordinated by Teresa Marat-Mendes. Likewise, MEMO, the SPLACH Project was prepared while taking advantage of previous knowledge acquired by its research teams. For the Iscte team, previous research conducted at the LMA, regarding Urban Sustainability and Urban Metabolism as well as the results provided from MEMO (Marat-Mendes et al 2016), proved paramount to progress on the study of the LMA from the perspective of its Food System, while aiming to inform urban planning on how to promote its Sustainability transition. The food system – the pattern across which food is produced, transformed, distributed, commercialized, consumed, and disposed (Pothukuchi and Kaufman, 2000; Steel, 2008) – has inherent spatial implications, as it relates to land-use systems, infrastructure, as well as the built and natural environments of cities. Therefore, it is strongly related to the socio-metabolic patterns implied by urban planning.

Thus, a sustainability transition of such patterns, if one considers them unsustainable requires a change of current planning priorities. It was precisely with this ambition that the research conducted at Iscte for SPLACH Project targeted the study a possible sustainable transition of the LMA territory organization, in terms of its uses but also activities.

Furthermore, the links between food systems and urbanism are gaining further attention (Parham, 2015; Fuertes & Gomez-Escoda, 2020). Yet, in what regards the study of urban form, despite marked by their individual lines of thought, the leading schools of urban morphology (English, Italian and French as identified by the International Seminar on Urban Form) have consistently focused on open spaces, street systems and buildings, which in the end can also be identified as belonging to the different phases of the food system. For example, production is mostly based on open spaces; distribution occurs through systems of roads and streets, whereas commerce, transformation and consumptions generally occur in buildings. Taking this into consideration, the SPLACH Project, while focusing its analysis on the food-related activities, promoted further research applied into the LMA to improve the visual characterization of the metabolic functioning of the territory and depict future spatial (urban form) opportunities for planning improvement. Likewise for MEMO Project, the SPLACH Project conducted a new Atlas for the LMA, while responding to such metabolic visualization challenge. The new Atlas focusses on the Food System of the LMA (Marat-Mendes et al, forthcoming), while depicting the historical and the contemporary built forms that operating in the Lisbon Region have manages the access to resources and ensure the necessary healthy and nutritious conditions of its population. Acknowledging such existing resources, but also the physical and non-physical structures and the practices that make them available allow us to better perceive the metabolic functioning of a given territory, such as the Lisbon one promoted by the above identified Atlas. It is expected that such recognition will ultimately provide: (i) decision-makers with a greater support for their planning decisions; (ii) planners with the necessary tools to better decide what solutions are more appropriated and should be followed; or (iii) students with a more critical background to promote further creative solutions for the real problems that affect the urban landscape.

Again, likewise for the urban project studios taught by Teresa Marat-Mendes at Iscte, the SPLACH Project applied its analysis of the LMA urban planning, based on the most paradigmatic plans of XX century, which have been proposed for the improvement of the Lisbon Region territory. Notably, i recalled the work produced by Étienne de Groër for the Lisbon region, as it was withdrawn on the model of Garden City envisioned by Ebenezer Howard (Marat-Mendes, 2009). Despite its historical precedent, such model suggested a greater acknowledge of the territory, while articulating the several scales that operate within it. This is an issue that prove to be important for SPLACH Project, and therefore understood as paramount requisite for the sustainability transition of the current LMA food system (Marat-Mendes et al, 2021a, 2021b, 2021c).

EDUCATE FOR SUSTAINABILITY

Bringing the thematic of water, agriculture, and the food systems into the Urban Project courses of Iscte by Teresa Marat-Mendes proved to be a very rich pedagogical experience, while linking it to the research lines under investigation. This chapter focus in particular at the food system thematic, as it congregates the other two (water and agriculture) in a more comprehensive manner and indicates already methodological advances regarding the first pedagogical attempts. As already stated, these experiences took place at Iscte, Department of Architecture and Urbanism, more specifically at the Integrated Master of Architecture. The thematic of Food system was conducted at the Urban Project III module, which run on the first semester of the 4th year of the Integrated Master Course of Architecture, at the 2016/2017 academic year. This was a theoretical-practical course which contained a strong analytical and design focus. Furthermore, it was an ambition of Urban Project III, for students to focus not only on the

physical dimension of urban form, but rather to better relate it with other specific dimensions, such as the social, the economic and the natural one. Furthermore, it was aimed to identify through a specific thematic lens, the analysis of the food system, how does the city work and relates to such system. The main goal would be to make students more aware of the implications of different dimensions on the urban form solutions as well as to become more conscious of their own design options to improve the food system operation and ultimately the urban metabolism of the urban realm. To guarantee that, the urban project studio was organized for students to acquire the following goals:

- 1) Understand the relationship between the food system and the urban space;
- 2) Recognize the various types of urban form, relate them to the food system and the possible symbiosis established between them;
- 3) Address the various components of the urban system and determine the existing relationship between them;
- 4) Acquire knowledge of urban morphology and metabolic assessment;
- 5) Identify the principles of urban design that allow making communities, while designing successful public spaces and create responsive and vital urban areas;
- 6) Develop an urban strategy for the city of Lisbon, in particular to the study area in question, while taking into account the public space, the urban fabric, the existing and planned infrastructures, in order to unify the whole and at the same time that integrate the food system within the urban space, to guarantee a more efficient metabolism for the city.

To respond to these six goals, the Urban Project III program was organized according to three stages. The first stage aimed to contextualize the student within the thematic under analysis: the food system. The second stage aimed to focus the student within the design proposal for a specific case study, wherein informing them about how the food system does operate and guarantees that the design proposal could contribute to improve the identified food system. The third and last stage aimed for the student to present a design solution that could contribute to improve the overall food system of the case study under analysis. Several design solutions were proposed by the studio students. Most of them are related to more conventional solutions, such as the proposal of new green urban areas within the city, within buildings roofs or empty areas within the city. Other solutions indicate the need to improve public space, wherein integrating the local population in specific collective activities. For these solutions, temporary markets and ambulant food stores were proposed. Other examples assemble however more ambitious strategies, which implies the construction of a cultural transition towards current practices. For example, the proposal of an electronic mobile application, which would allow food distribution in a more convenient manner for elderly people. Other solutions pointed out the proposal of a Good Practice handbook for local people in the different Lisbon neighbourhoods to maintain their public space and guarantee the good functioning of the whole food system. Given the time available for the development of the exercise LX Design with Food, in one semester of 12 classes, each one with 3 hours, one should emphasize the interesting results that emerged from the different design proposals. Finally, one should also stress the importance of the comparative strategy that this exercise involved, allowing for the compilation of several examples for future reference by the students. Finally, it is notorious that a greater conscious of the food system and the metabolism of the cities acquired by students was succeeded while urban form was being examined (Marat-Mendes, 2018).

CONCLUSIONS

The study of urban form is paramount to better support urban planning policies, pedagogic practices and improve the present and future conditions of our cities and of the urban realm. However, to properly respond to such tasks, it requires a vigorous and continuous update of the paradigms and the concepts related to urban form (Marat-Mendes et al, 2021a, 2021b) as well as the problematics that affects the urban realm, imposed by society and environmental constrains.

Sustainability has urged society to universally acknowledge the meaning of a sustainable development (UN, 1987) and three decades later to perceive new urban agendas (UN, 2017) to effectively concretize such ambition on the urban realm. Nevertheless, as demonstrated in this chapter, advances at the urban design spheres are still a minority when compared to the engineering fields. Nevertheless, as also demonstrated urban design exposes a prominent area for the advances of the metabolic perception of the urban realm. For example, the visual characterization methodological approaches conducted in the past decade, in academic and research domains, have demonstrated feasible methodological resources to articulate distinct disciplinary areas while discussing common urban problematics. The MEMO and SPLACH projects conducted at the Lisbon metropolitan Area are good examples of such developments, as well as their applicability at the academic domain experienced at the urban Project studios of Isete Architecture courses, when integrating thematic such as the Food System and Urban Metabolism.

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