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ID 1629 | BUILDING URBAN PLANNING FOR A SUSTAINABLE FUTURE THROUGH URBAN METABOLISM

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1 INTRODUCTION

In the last years, we have been tackling such challenges as rapid population growth, increased materials and energy consumption, growing resource scarcity, climate change, loss of biodiversity, increasing social inequality and poverty (Bina et al., 2016). Cities are the centre of all these challenges, as world population is more and more urban: some 70% of the world's population in 2050 will live in cities (UNDESA, 2015). As a consequence, the combination of urbanization and sustainability results one of the crucial challenges of the coming years (Girardet, 2003; Agudelo-Vera et al., 2011; Musco, 2011). Understanding the relationship between the city planning, urban life style, and the availability of necessary environmental, social and economic resources, is only the first step to build a sustainable and resilient future. City and urban planning become respectively a place and a privileged tool for achieving these two goals (Bulkeley & Betsill, 2003; Pickett et al., 2013).

In recent decades, Urban Sustainability (US) and Urban Resilience (UR) have been two concepts widely studied, both theoretically (WCED, 1987; Jabareen, 2008) and practically (Jabareen, 2006; Jabareen, 2013; James, 2015). However, despite the world scientific community shares a number of issues regarding the achievement and development of sustainable and resilient cities (for example: integrated approach and management, green cities, dense and compact cities, use of renewable energy sources, equity and participation, etc.), it has not yet defined a unique methodological framework. In this regard, in recent years, a series of studies have been developed on the Urban Metabolism (UM), which could represent the nexus able to develop an integrated approach to planning, capable of contributing to the achievement of both US and UR (Kennedy et al., 2011; Thomson & Newman, 2017), also in ecological terms. Nevertheless, these studies remain very generic in connecting UM with spatial planning, and in most cases dealing only with very specific themes like energy and transport (Pincetl et al., 2012).

Within this context, this paper aims to suggest an approach to fill this gap, exploring how the UM can be used as scientific framework, within designing specific plans and policies for cities having as main objective to build US and UR. The theoretical framework presented in this paper stems from researches and studies developed in a Horizon 2020 Project (URBAN_WINS). The URBAN_WINS objective is to develop and test methods for designing and implementing innovative and sustainable Strategic Plans for Waste Prevention and Management as to enhance urban environmental resilience, in 7 different urban areas (Turin, Cremona, Rome, Bucharest, Sabadell, Manresa, Lleira), located in 4 EU country (Italy, Romania, Spain, and Portugal), according to an inter-disciplinary and participatory approach. Specifically, the development of Strategic Urban Plans will be built on the basis of improved knowledge of the factors that influence the UM of the cities.

The work is organized in 4 sections: first, the analysis of relationship between US and UR in urban planning approach; second, introduction to UM; third, analysis between metabolic flows and sustainable and resilient urban planning features. Finally, implication for urban planning and introduction of a new planning paradigm.

2 URBAN SUSTAINABILITY AND URBAN RESILIENCE

'Sustainability' appears as a concept in 50s for the first time, but only in 1987 with the UN World Commission on Environment and Development, it is acknowledged as a development paradigm that minimizes the use of environmental resources and reduces the anthropic impact on the environment, through processes which simultaneously stimulate economy and improve quality of life (Newman, 1999). Since that moment, the link between sustainability and cities became clear, and in 1992, Yanarella and Levine suggested that all sustainabilityrelated initiatives had to be embodied in design, recovery and urban development strategy. Over the years, the concept of US has consolidated as an urban transition process rather than an ultimate and optimal goal: it is a steadily moving target, as knowledge, technologies and capabilities are always improved. Therefore, the US is the concept that crosses and links all plans and measures that insist on a city, creating a flexible support structure and a continuous process of change (van Timmeren, 2014). After a 30-year-debate, US remains unclear in practical and operational terms and recently has been flanked by the concept of UR. Resilience can be defined as the ability of a system, community or society to resist, absorb, tolerate disturbance while retaining its structure and function. Thus, ideal urban resilience can be understood as a city that can easily live and cope with an ever-changing and sometimes risky environment (Fiksel, 2003; Wamsler, 2014). The adaptive capacity, which may lead to new equilibria, is highlighted, and in a resilience perspective, sustainability is not about maintaining a system at its equilibrium state, but rather it should focus on the capacity to create and test opportunities and maintain adaptive capabilities (Holling, 2001). Thus, resilience has become the key to achieve sustainability: there was a shift from a perspective oriented around stability, optimality and predictability to a perspective focusing on inherent uncertainty.

Finally, we may argue that:

- resilience is a prerequisite for sustainability;
- all sustainable systems must be also resilient, but not necessarily always stable;
- in order to achieve US, we should focus on creating and maintaining UR.

As far as implications for urban design and planning are concerned, despite there is no universal design for all cities, as envisioned by Walker and Salt (2006), resilient systems could be characterized by the following features:

1. Diversity: promoting diversity in all its dimensions, from biological to economic, and encouraging multiple components and resource uses to balance and complement homogenizing trends.
2. Ecological variability: Seeking to understand and work with the boundaries of the inherent variability of ecological and socio-ecological systems; attempting to tame such variability is often a recipe for disaster.
3. Modularity: maintaining modularity can help hedge against dangers of low resilience caused by overconnectedness in system structure and function.
4. Acknowledging slow variables: managing for resilience means understanding the slow or controlling variables that underpin the condition of a system, especially in relation to thresholds. By recognizing the importance of these critical variables, we can better avoid shifts to undesirable stable states and possibly enhance the capacity of a desirable regime to deal with disturbances.
5. Tight feedbacks: tightening or maintaining the strength of feedback loops allows us to better detect thresholds. The weakening of feedback loops can result in an asymmetry between our actions and the consequences stemming from them. Salient examples of such dynamics include pollution and overconsumption.
6. Social capital: promoting trust, social networks, and leadership to enhance the adaptive capacity for better dealing with the effects of disturbance.
7. Innovation: embracing change through learning, experimentation, and promoting locally developed rules. Instead of narrowing our range of activities and opportunities, we should be seeking to explore and cultivate new ones.
8. Overlap in governance: developing institutional arrangements that manage for cross-scale influences. Developing redundancy and overlap in governance frameworks enhances response diversity and flexibility.
9. 9. Ecosystem services: recognizing and accounting for ecosystem services while managing and designing for resilience. The benefits society derives from nature are regularly underprized and ignored. Such services are often lost as socio-ecological systems shift into different, less desirable regimes. Considering cities as complex systems, only pursuing a comprehensive and

general UR will be possible achieve US in an uncertain world. Thus, urban planning must be able to consider all these features and turn them into strategy, policy, action and design.

3 URBAN METABOLISM

The concept of metabolism emerged in the 19th century in order to describe the exchange of matter between an organism and its environment. The application of this concept to the city, namely, the concept or Urban Metabolism, is more recent, and it was developed in the industrial ecology field by Abel Wolman (1965) to determine the urban metabolism of a typical American city. UM is used as a metaphor for the resource consumption of cities, and it includes systematic studies of the inputs, outputs and storage of energy, water, nutrients, materials and wastes for a city. UM can be defined as "the total sum of the technical and socioeconomic processes that occur in cities, resulting in growth, production of energy, and elimination of waste" (Kennedy, et al., 2007). In the last decade, following the seminal work of Wolman, many other metabolism studies have been conducted to cities worldwide (Newcombe et al., 1978; Newman, 1999; Barret et al., 2002; Chrysoulakis, 2008). These studies, from the industrial ecology and urban ecology fields, point out particular aspects (such as urban form, material supplies, infrastructure network supplies, or groundwater withdrawals) in the calculation of the overall UM. Within the UM concept, US is considered as a problem of flow (material and energetic) between urban community and its environment. Currently, cities' UM is mostly linear: for their resources, cities depend on hinterlands and other cities for water, energy, goods import and waste export. The uses of these resources in such linear way is inefficient and unsustainable on long-term, and the external dependency makes cities more vulnerable (Cola et al., 2005) and less resilient. This model is not sustainable and it is associated with two main problems: a) the high rate of resource consumption threatens resource availability; b) massive disposal of waste causes pollutions (Agudelo-Vera et al., 2011). Opposite to linear metabolism, there is the circular one, that is similar to the metabolism of natural ecosystem, has a low consumption rate, and includes reuse and recycling of different urban flows. Circular metabolism has less impact on the environment and contributes to the urban resilience. In the purpose to design more resilient and thus more sustainable cities, UM is also a platform to base a comprehensive urban analysis (Pincetl et al., 2012), and a useful framework for urban planning aimed at UR and US development. As far as our knowledge, all previous studies and researches about UM and urban planning have been vague, or focused only on very specific aspects of planning.

4 FLOW AND URBAN PLANNING

Resource consumption patterns in cities are closely linked with land use and urban functions. But despite it is possible to estimate consumption of different material and energy categories, after establishing 'the system boundaries', it is not possible to take for granted the geo-localization of flows in the urban fabric, or establishing the direct links among economic activities, resource final uses, and life cycle impacts. However, material and energy flow analysis (MEFA) is the scientific methodology used to account any kind of flows within a system, and it has already been successfully implemented in several cases with different scales (Browne, et al. 2011). Mapping flows of a city is only the base of the work aimed at reducing consumption and waste production is a resilience and (strong) sustainable-based perspective. After that, the central issue is the capability of assessment environmental impacts of material and energy flows, due to anthropic activities in urban areas, and their qualitative differences among sustainability conditions in different social and economic setting (Fiksel, 2006). This deals with the life cycle approach, and in particular the life cycle impact assessment, that can be used to estimate a large range of impacts, and so, contribute to the environmental strategic assessment, the definition of environmental integrated policies, and monitoring their implementation, even through complex impact indicators. The Life Cycle approach is also useful to define the multi-scalar system boundaries of an urban area, because it permits to include all the other systems and sub-systems connect to the target one. Generally, they are all the systems where input flows originate, and where output flows end. At the same time, not only flows move through a complex of multi-scalar systems and sub-systems, but also the impacts can be effective at different levels at the same time, not only local or global, with different features. In order to understand the behaviour of cities, as complex systems, interactions among flows, urban patterns and ecological and socioeconomic processes operating at differing temporal, spatial, and organizational scales. Cities are driven by a huge number of processes, facilitated by various institutions, and operating at different levels. Dealing with any single issue separately is not sufficient to address the UR of the city as a whole.

5 CONCLUSION

Even according to an urban metabolism approach to city planning and management, cities are more than a mechanism that processes resources and produces waste. In fact, they are places where opportunities are created (Newman, 1999), and, as a consequence, the US can not only concern the reduction of metabolic flows (input & output) and related impacts, but must also aim at the improvement of living conditions.

Cities, as complex systems that consume energy and material and produce waste, have the possibility and capacity to became resilient and sustainable, producing their own renewable energy, reuse and recycle their waste as internal new resource. To achieve this sustainable future a new urban planning approach must be developed. UM can be used as a useful framework to support and inform urban planners and policy makers. Moreover, we believe that using UM framework is fundamental to construct real and effective strategic planning, able to work at the same time and in a coordinate manner on the several features of UR, in order to improve US.

The challenge for urban planners will be understood in each different case how UM flows are related with city characteristics, such as urban form, infrastructures networks, social and economic situation, in order to build strategic plans, through a combination of new technology, city design and community based innovation, which together will create a resilient city for a more sustainable future.

In this perspective, we have to mention other two other mainstream ideas, both, stemming from the Europe 2020 strategy related to urban systems deal with UM: the Circular Economy and the Smart Community.

Both of them, they require a community-based approach in policy definition and implementation, and a complex vision of sectoral integration, which can be easier achieved at community level, through local institutional cooperation, urban stakeholders' involvement, and citizens' direct participation.

The above mentioned UrbanWINS EU project represents an exceptional example for the definition of strategic urban policies aimed at a more sustainable urban waste management, and reduction in resource consumption. On the one side, these policies are based on the metabolic approach, and are built on the UMAN model, provide by the University of Chalmers (Sweden), aimed at accounting urban material flows, on the other are designed since the idea of circular economy at urban scale, and since the idea of a smarter management of cities, which finally result 'systems', according to such different points of view, as the social, economic, ecologic, territorial, and technological.

The high number of above mentioned fields of work, and research, demonstrates how contemporary city management is complex, and multidisciplinary, and how necessary is the integration of competences in planning, but also in implementing and monitoring 'sustainable' urban development policies.

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