4. Strategie di adattamento al cambiamento climatico

Towards Urban planning based on Urban Metabolism: a new strategic approach for European cities

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Abstract
Cities consume increasing amounts of water, materials and energy. Resource scarcity as much as environmental impacts require the international community to reduce the resource consumption and emission production, in order to ensure a more sustainable urban management, and to adapt urban areas to new global environmental conditions. In this perspective, the Horizon 2020 UrbanWINS project focuses on the definition and experimental implementation of Local Strategic Action Plans for urban waste prevention and management. This project is based on the idea of urban metabolism, which is defined since such scientific methodologies as the material and energy flow accounting, and the life cycle impact assessment of urban flows, and promotes the circular economy, i.e. reusing, recycling and adapting waste materials and disused products. In 8 European pilot municipalities, Albano Laziale and Pomezia (Rome, IT), Turin (IT), Cremona (IT), Bucharest (RO), Sabadell and Manresa (Barcelona, ES), and Leiria (PT), territorial quantitative and qualitative data are collected, environmental policies are analysed, discussion sessions within the public administration on municipal priority agenda are carried out, urban stakeholders' agoras are activated, and Strategic Planning Frameworks are designed, in order to build the base on which prepare the Local Strategic Action Plans. Finally, a set of pilot actions will be implemented to test the methodology used in the redaction of the plans.
More in detail, Urban Metabolism is used as an analytical framework to define and implement innovative urban strategies oriented to the waste prevention and management, and this paper presents the first achievements in the domain of urban strategic planning based on Urban Metabolism. The project is leaded by the Municipality of Cremona, is carried out by 27 European partners, and is targeted to other urban area in a European city network logic. After this end of the project each city will be able to embed the metabolic approach in urban policies.

Keywords: Sustainability, Environment, Strategic planning.

1 | Introduction

World rapid population growth has been increasing material and energy consumption and the world urban population will be increasingly higher, reaching the proportion of 70% (UNDESA, 2015). After all, in Europe today about 74% of population already lives in urban areas. For these reasons, one of the main global challenges in the future will be the capability of making sustainable the urban development

(Girardet, 2003; Agudelo-Vera et al., 2011; Musco, 2011), and to do so, it is necessary to connect city planning, urban life style, and availability of environmental, social and economic resources (Bulkeley & Betsill, 2003; Pickett et al., 2013).

A comprehensive accountability of urban resource flows was originated by industrial ecology which introduced the concept of urban metabolism (UM), 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", to be analysed "in terms of four fundamental flows or cycles—those of water, materials, energy, and nutrients" (Kennedy et al. 2007, pp 44-45). In particular, metabolic processes threatening the sustainability of cities include, among others, altered ground water levels, exhaustion of local materials, accumulation of toxic materials, summer heat islands, and irregular accumulation of nutrients.

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 is more recent, and it was developed in the industrial ecology field by Wolman (1965) to determine the urban metabolism of a typical American city. However, more recently, particular aspects in the calculation of the overall UM, such as urban form, material supplies, infrastructure network supplies, or groundwater withdrawals were investigated (Newcombe et al., 1978; Newman, 1999; Barret et al., 2002; Chrysoulakis, 2008), and two related, non-conflicting, schools of urban metabolism have emerged. The first following Odum (1996) and describing metabolism in terms of energy equivalents; the second more broadly expressing a city's flows of water, materials and nutrients in terms of mass fluxes (Kennedy et al. 2011).

With reference to the latter, material and energy flow analysis (MEFA) is the scientific methodology used to account different flows within a system, which has already been successfully implemented in several cases at different scales (Browne et al. 2011). After accounting materials and energy flows, the consequent environmental impacts can be assessed as well as their qualitative differences among sustainability conditions in different social and economic setting (Fiksel, 2006), in a life cycle perspective. This can make possible to estimate a large range of impacts and contribute to the environmental strategic assessment, the definition of environmental integrated policies, their implementation and monitoring phases. A series of studies have been developed on the nexus between UM and urban planning (Kennedy et al., 2011; Thomson & Newman, 2017), but they appear very generic in connecting UM with spatial planning, in most cases dealing only with very specific themes like energy and transport (Pincetl et al., 2012). This paper presents the approach, elaborated in the UrbanWINS Project (UW)[1], to use the UM (illustrated in figure 1) as the main framework to design sustainable urban plans and policies.

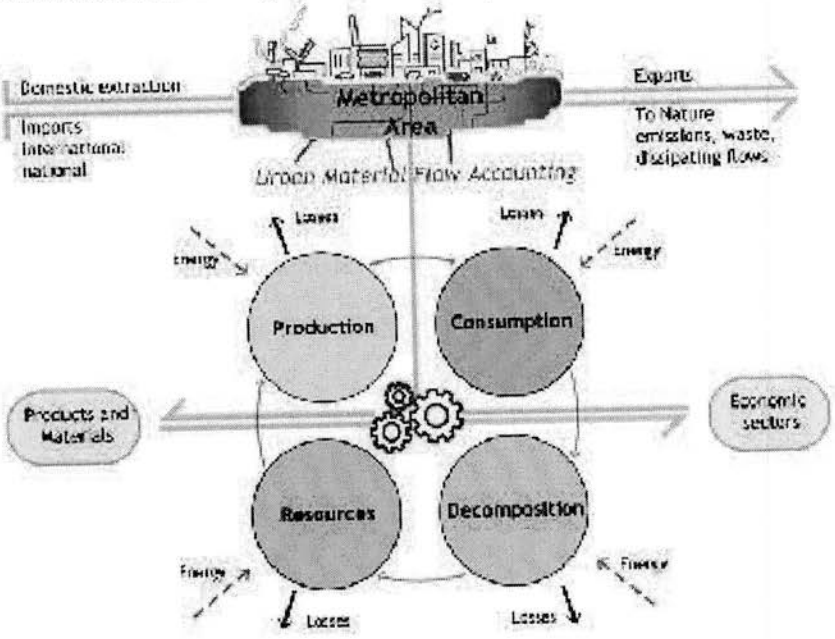

Figure 1 | Urban Metabolism theoretical framework
Source: elaboration by the authors for the UrbanWINS project based on Rosado et al. (2016)

[1] UrbanWINS, INNOVATIVE STRATEGIC PLANS FOR URBAN WASTE REDUCTION AND MANAGEMENT www.urbanwins.eu Project funded from the EU Horizon 2020 research and innovation programme (grant agreement No 690047).

UW Project's purpose is to develop and test a methodology for designing and implementing innovative and sustainable strategic plans for waste prevention and management, capable of enhancing urban environmental resilience, in a range of different urban areas. UW represents an exceptional occasion to define strategic urban policies aimed at a more sustainable urban waste management, and reduction in resource consumption. On one side, these policies are based on the metabolic approach, and are built on the UMAn model analysis, provided by the University of Chalmers (Sweden)[2], for the urban material flow accounting. On the other hand, policies are designed starting from the idea of circular economy at urban scale and of a smarter management of cities. Following the UW project after defining a Strategic Planning Framework for EU cities based on the UM, Local Strategic Action Plans (LSAP) are prepared. Within the framework main issues, objectives and priorities are identified throughout a participatory and enabling decision-making process, whereas the plan is operative and gathers all the (strategic) actions, identified on the basis of the established priorities, declared within the framework.

2 | The UrbanWINS methodology

In this section, the UW methodology for the construction of the Strategic Planning Framework (SPF) in each city is presented. It is summarized in the workflow in figure 2.

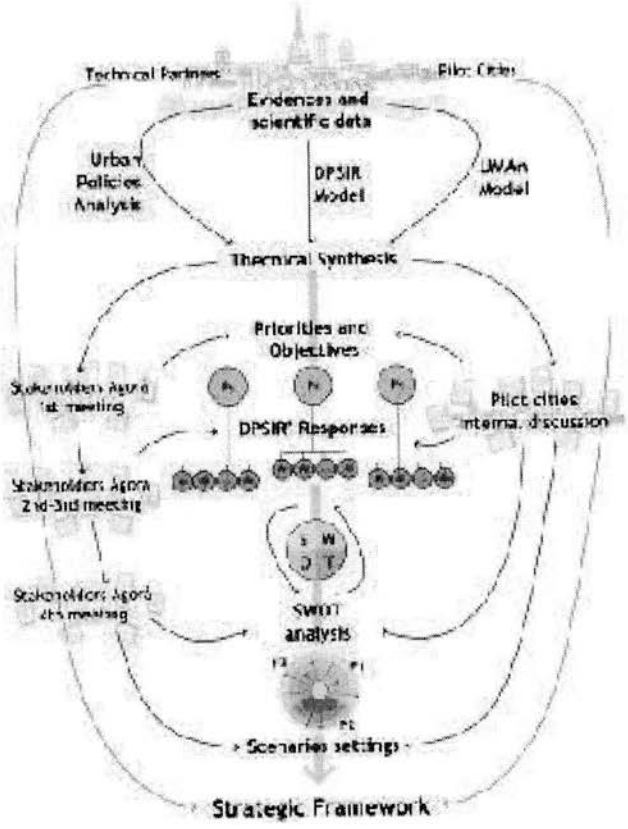

Figure 2 | Strategic Planning Framework
Source: elaboration by the authors for the UrbanWINS project

This methodology includes all the activity clusters that the UW partners and target groups have to carry out whose main goals are:

- building quantitative and qualitative knowledge of the urban system (analysis of urban policies, implementation of DPSIR and UMAn models);
- involving the local administrations and stakeholders in defining priorities and objectives (Pilot Cities Internal Meetings, Urban Agoras);
- involving stakeholders, including municipalities, in providing proposals to shift from priorities to actions definition (Pilot Cities Internal Meetings, Urban Agoras);
- assessing and integrating proposals through a SWOT analysis;

[2] For the UMAn model analysis, compare Rosado et al. (2014)

• creating the basis to prepare the LSAPs in each city;
• assessing actions on the basis of alternative scenarios.

The analysis

This initial phase is composed of 3 elements: the urban policy analysis, the analysis performed in the UMAn model and in the DPSIR model. After collecting all the results, a technical synthesis is provided, as illustrated in figure 3.

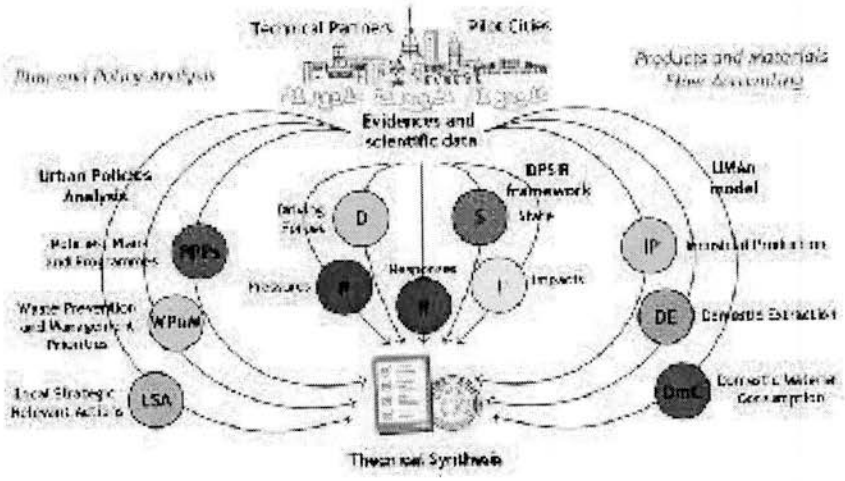

Figure 3 | Technical Synthesis
Source: elaboration by the authors for the UrbanWINS project

The urban policy analysis is the preliminary analysis carried out in each city, in order to raise the awareness of municipal representatives and urban stakeholders on all the existing planning tools.
Information and data, contained in plans, documents and reports, are collected for building the state of art of the urban and metropolitan strategic planning in each pilot city. Sectoral as well as multilevel strategies and initiatives are accounted and analysed, in order to identify what could impact on resource consumption and waste production.
After that, in order to account urban material flows, the project applies the UMAn model to each pilot city, consisting in:
• a general overview on consumption patterns in the city, in order to highlight the most important category of products that are consumed;
• accounting results, classified by groups of products;
• accounting results, classified by disaggregated flows per specific product/s;
• accounting results, classified by economic activity/sector origin (NACE).
With reference to the targeted flows prioritized in the previous phases, in order to take into consideration the economic and social factors, the DPSIR[3] model is implemented. It consists in a causal framework describing the interactions between society and environment. For the UrbanWINS project the DPSIR model was designed by Fundació CTM Centre Tecnològic (Spain) as follows. Urban activities are the driving forces and the corresponding outputs represent the pressures. The main activities characterising a city have to be taken into consideration, i.e. what activities determine the main material flows within a system' boundaries, and then if these activities are able to improve the efficient use of resources. Apart from this, and according to the intensity and the composition of those pressures, changes occur in the state of environment with consequential impacts on ecosystems and society. At the end of this interrelated process, waste prevention and management policies and strategies represent the "responses". They can aim to change determinants (prevention), to reduce pressures (prevention/management), to mitigate changes of the environmental state, and impacts or to adapt to them (management).

[3] DPSIR: Driving forces, Pressures, States, Impacts, Responses.

The participatory meetings

As illustrated in figure 4, the analysis is combined with a participatory process: internal to the public administration on one side, including local stakeholders throughout the establishment of urban agoras[4] on the other.

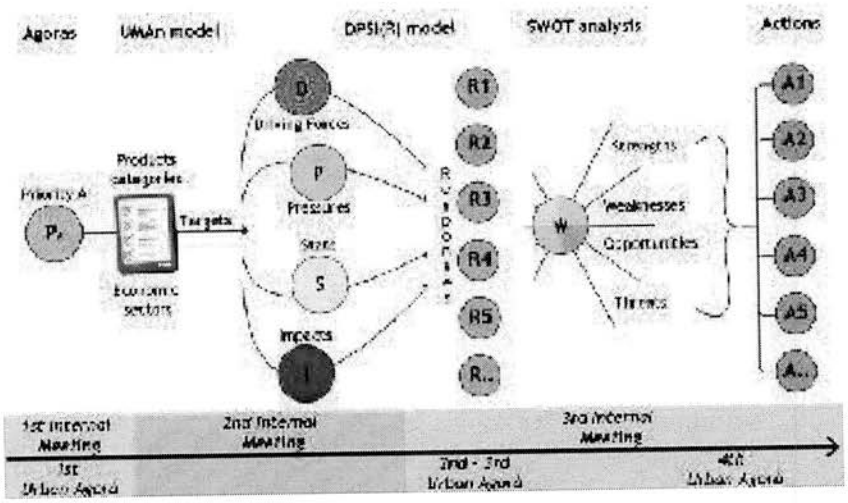

Figure 4 | The strategic planning process carried out by internal meeting and agoras
Source: elaboration by the authors for the UrbanWINS project.

A series of meetings inside the local administrations are carried out. They include officers and technicians from different sectors, departments and levels, and aim to push the internal debate on the UW issues. At the same time, in each city, a local stakeholders' agora is set.
In the first internal meeting, each municipality is expected to define the municipal priorities with respect to waste prevention and management and to describe them with reference to their objectives. For each objective, actors involved, responsibilities in implementation, necessary resources, expected impacts and time frames are defined.
In the second internal meeting the UMAn model results and the DPSIR components are expected to be taken into consideration: such process should contribute to reorder different needs, opinions and contributes emerged from the first urban stakeholders' agora. In the third internal meeting, a preliminary SWOT analysis is applied to each priority.

As already introduced, in parallel to the municipal internal meetings, physical stakeholder agoras are established in each pilot city. They are face-to-face sessions held with stakeholders to debate, analyse and produce joint solutions addressing the issues identified by UW in a friendly and constructive environment. The physical urban agoras primarily assess the specific local waste management measures, building a common problem definition and vision. Then, they gather the main local stakeholders on waste prevention and management in periodical meetings to co-design the SPF, to adapt them to their city and develop joint methodologies for implementation.
In the first agora meeting, stakeholders build a participatory list of shared priorities. The second and the third agora meetings discuss and integrate Responses emerged from the DPSIR analysis.
In the last agora a list of actions is proposed, on the basis of the SWOT analysis results. This allow to point out strengths, weaknesses, opportunities and threats for each priority, objectives and actions, and facilitate the identification of the list of proposed actions.

Strategic Planning Framework

As a result from all the activities presented so far, in each city a Strategic Planning Framework is ready to be prepared. This document supports policy-makers and represent the basis for the redaction of the LSAPs afterwards. The main steps of the SPF are presented below.

[4] Agoras activities, modalities and approach were defined by NOVA.ID.FCT (the Faculty of Sciences and Technology, Nova University of Lisbon)

The framework starts with a general overview on the city profile and on the state of the art on resources, land uses, social and economic aspects, and it contains an urban analysis to integrate and assess information resulting from the technical synthesis of urban policies, UMAn Model and DPSIR implementation.
The SPF also includes priorities and related-objectives discussed and shared during the municipal internal and agora meetings. For each objective it is useful to provide a description, the list of the actors involved, the responsibility for the implementation, the expected resources required, and of the consequent impacts and timeframes.
Besides, each city can link and integrate each objective to the existing policies, plans and programmes, in order not to reiterate efforts already made.
After that, with reference to the adopted definition of "Urban Metabolism", municipalities can also identify the set of urban flows (energy, water, waste, land uses, air pollution) related to each objective.
Referring to the results from the analysis of the UMAn and DPSIR models, each objective should relate to one or more specific economic sectors: both priorities and objectives can focus on one or more sectors, affect specific economic activities and target certain flows.
Once verified which priorities and objectives, emerging from both internal and agora meetings, focus on waste prevention and management, a first list of targeted waste streams (according to the European Waste Catalogue) can be compiled in order to recall the corresponding materials accounted from the UMAn model.
Finally, pilot cities should consider and assess which strategies can be used as a reference among the ones suggested in the European Waste Hierarchy (adapted from Gharfalkar et al. 2015) and Circular Economy System (based on Ellen MacArthur Foundation models).

Scenarios setting
For each priority and objective, the most influent variable factors can be identified. These variable factors are called 'drivers', and represent the elements whose measure marks the progressive development level. For each driver, both quantitative and qualitative indicators are defined. Each pilot city defines the related series of drivers, and prepares a series of scenarios, at different terms. The simultaneous presence of different priorities and related drivers also deals with the fact that higher impacts can be achieved if integrated policies are implemented simultaneously.
A scenario arises from the definition and the development of a range of drivers in each pilot city, characterized by these elements:

- time spans and horizons,
- multiplicity of involved policy sectors per priority,
- mix of actions to implement to reach the priority,
- mix of material and energy flows targeted and involved by the action,
- impacts,
- available funds and costs.

The figure 5 shows the scenario conceptualization used in UW.

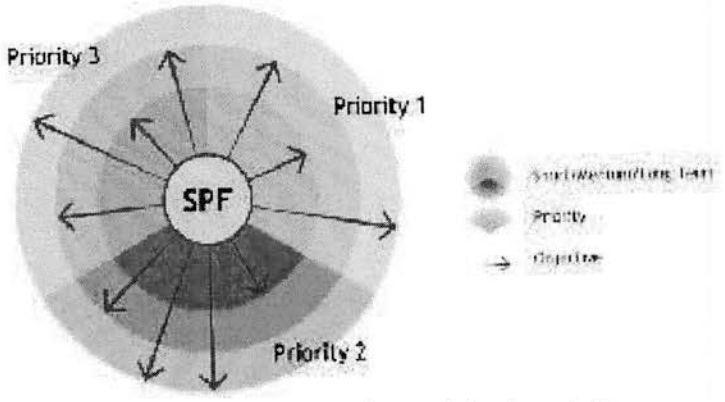

Figure 5 | Conceptual diagram of a scenario based on priorities
Source: elaboration by the authors for the UrbanWINS project.

Furthermore, a certain scenario is composed of short list of basic priorities. Each of them pursues a certain number of objective, which are reached at a short / medium /long term. Each specific objective is reached by the development of one or more corresponding drivers. Anytime an objective is reached, a

number of impacts are provided. Moreover, this conceptualization can also be downscaled, and show all the involved sectors per priority, as shown in figure 6. In this case coloured lines represent the execution of specific actions along the time.

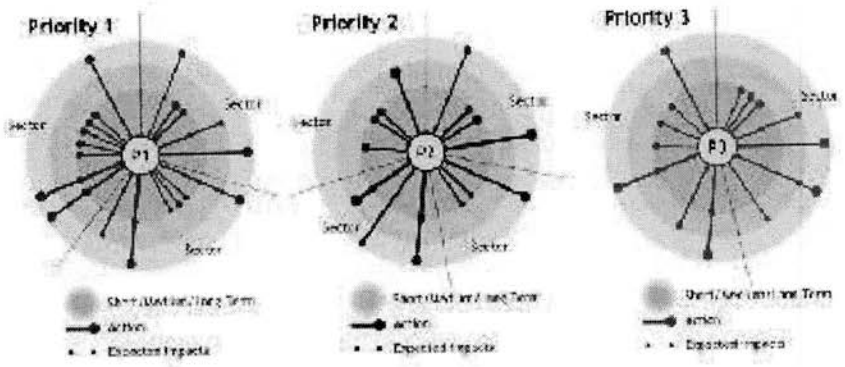

Figure 6 | Conceptual diagram of alternative model scenarios based on sectors
Source: elaboration by the authors for the UrbanWINS project

3 | Discussion and conclusion

This paper presents a part of the first-year of UW project's work concerning the planning process capable of promoting the inclusion of sustainable waste prevention and management in urban policy-making.
An overall pragmatic approach has been chosen for the UW pilot cities in the participatory definition of priorities and actions, following a "methodology" that tries to match different spheres: stakeholders' participation in decision making processes, urban strategic planning, European policies tailored to city-scale, urban metabolism.
The first match is related to participation in policy-making and decision processes. On the one side, the role of the municipalities, and so, their public function, has been preserved by building the internal administrative capacity in working on waste prevention and management, formally setting the municipal internal meeting, which were expected to the define the "municipal" priorities.
On the other, the role of local stakeholders has been corroborated, and the active involvement of any entity or group who is not coincident with the local government, and so, the deliberative democracy has been supported, by setting urban stakeholders' agoras, and giving them the opportunity to take effective decisions, at least with respect to the UW policy-making process. Thus, in each city, neither the municipality nor the stakeholders have been prevented to influence decisions. On the contrary, this methodology tries to match the public contribution with the one coming from the local community, moving them towards a common vision.
The second match is related to the urban strategic planning process. On the one side, a strategic planning process is a long, articulated and complex series of steps, aimed at defining strategic objectives and, on the basis of the latter, providing strategic initiatives, each of them implying various activities and efforts. It usually covers a wide range of policy sectors. In fact, in the case of the UW project, a wide and complex range of policy sectors are involved and not just the strategic objectives related to waste prevention and sustainable waste management. On the other, pursuing various strategic objectives require to think long terms and to set a priority order.
The third match is related to the scale of the European action. On the one side, it is evident and often shared that a place-based approach in policy-making is the more effective, at least because of the numerous differences in among cities in different countries. On the other, the EU need to promote the same idea of sustainable, smart, and inclusive development in all the EU territories. In this perspective, the UW project has proposed a sort of "soft" methodology to build strategic planning framework in EU cities, able to guide the efforts on the local actors, but also to leave them a certain level of autonomy, both in formal and substantial aspects.
In addition to that, interesting development of the UW work on the integration of the urban strategic planning with the metabolic approach could result in a more ecology-based idea of smart city, and could contribute to building resilience of cities, in the perspective of building capacity in connecting policy efforts stemming from such different environmental impacts as, for example, climate change and resource scarcity.

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