

Towards urban transition: implementing nature-based solutions and renewable energies to achieve the Sustainable Development Goals (SDG)

Valentina Oquendo Di Cosola^{ab}, Francesca Olivieri^{abc}, Lorenzo Olivieri^{abd}, Jorge Adán Sánchez-Reséndiz^{ab},

^a Department of Construction and Technology in Architecture, Universidad Politécnica de Madrid, Spain

^b Innovation and Technology for Development Center (itdUPM), Universidad Politécnica de Madrid, Spain.

^c ABIO UPM research group

^d GEDIRCI research group

valentina.oquendo@upm.es

francesca.olivieri@upm.es

lorenzo.olivieri@upm.es

adan.sanchez@upm.es

Abstract. Cities today are the scene of major problems linked to air pollution, resource consumption, and inequality. The Agenda 2030 for Sustainable Development proposes a roadmap for the transition to more resilient and sustainable city models. This challenge can only be met through systemic innovation, which produces technological, social, environmental, and cultural changes. The integration of nature-based technologies is a tool for the transformation of the current city model. This essay analyses the international context of sustainable development in cities, and the different possibilities for transforming urban space, with the final aim of making a concrete contribution to solutions that guarantee the fulfilment of the Sustainable Development Goals (SDGs), decarbonise the current model, and ensure the participation of citizens in the process.

Keywords: Cities; Nature-Based Solutions; Renewable energy; Sustainable Development Goals; Systemic approach.

Research and innovation to achieve the Sustainable Development Goals (SDG's)

The United Nations ensures a population growth from 55% today to 75% in 2050, which means that vulnerability to the consequences of climate change will

increase and there will be a greater need to ensure economic productivity, social inclusion and resilience (Nations, 2015b).

The importance of the social, economic and environmental effects of urbanisation, such as the lack of education and equality in access to services; the gap between the health and well-being of people linked to population growth; the energy consumption and the emissions associated, among others, are evidence of the challenges we face. Against this background, cross-cutting measures are needed, with emphasis on the multi-stakeholder approach.

These challenges are addressed in the Agenda 2030 through the 17 Sustainable Development Goals (SDGs) (Nations, 2015a) and the Paris agreement, in which members of the United Nations have developed a framework for action and international cooperation to achieve sustainability through a systemic approach that encompasses prosperity, people, the planet, peace, and partnerships. This will require profound changes and the participation of all sectors of society: governments, universities, businesses and civil society. Jeffrey Sachs, in his work *"Six transformations to achieve Sustainable Development Goals"*, argues the importance that SDGs have over global development, and how the goals set can achieve a complex model beyond mere objectives. However, for this to happen it is necessary to promote deep structural changes (Sachs *et al.*, 2019).

Along these lines, on 3 December 2013 the Horizon 2020 Programme (H2020) was approved, the main source of European funding for research and innovation in the European Union (European Commission, 2014) with a mission-oriented approach. Theorised by Mariana Mazzucato (Mazzucato, 2018), Professor of Economics of Innovation and Public Value at the University College of London (UCL), the approach is based on an innovative policy, which must be oriented towards one or more specific missions, in order to define an ambitious objective and long-term policies.

Sustainability-oriented missions in urban environment will require investments in energy, transport, health, water management, and waste reduction. Cities, because of the complexity involved and the crucial role they play in the transition towards a more desired future, offers an extraordinary opportunity for experimental research based on interdisciplinary approaches, aimed at finding solutions to the complex problems we face.

It is well known that the urban space and the energy model we have must change. In this sense, we should reflect on lines of action that generate visible and permanent changes. On the one hand, the decarbonisation of the current energy model requires holistic approaches to the generation, transmission and use of energy, which is framed by three different levels of action: the substitution of fossil fuels by zero carbon sources (solar photovoltaic, wind, geothermal), energy efficiency in the final use of energy (heating and cooling of buildings and transport) and the electrification of motorised mobility and industrial processes (Irena, 2018). On the other, achieving resilient and sustainable cities requires investment and development of urban infrastructure, services and technologies, in which nature-based solutions can play a key role.

Hence, research through the scientific community plays a key role in this process, as it can take up the challenge of developing, monitoring and quantifying tools, methods and technologies that demonstrate the technical and economic feasibility of certain actions in the medium and long term.

It is, therefore, the aim of this paper is to define the framework for international action in terms of innovation and sustainable development in cities, and to analyse the lines of action that are being implemented today in the field of nature-based technologies, in order to finally make a concrete contribution to urban space design models that meet the global agenda and demonstrate that the design of isolated actions does not produce a genuine transformation.

Fostering nature and energy values

Urban space is made up of a complex network of actors and elements that require a

broad integration approach when thinking about transforming it into a sustainable model. Some authors, such as Tara Mohtadi, call this systemic approach "hedonistic sustainability" (Mohtadi, 2016). Addressing climate change issues will highlight the role of architects and urban planners in shaping the city and building resilience.

Urban space, nature and people are interconnected, which is confirmed by the proven benefits of nature in cities, ranging from mitigating the urban heat island effect, to absorbing sound waves, improving air quality, managing rainwater, increasing biodiversity and reducing carbon emissions. In addition, they provide psycho-

perceptual benefits that improve people's well-being and health (Lee *et al.*, 2015).

Considering that cities must work to mitigate climate change and, at the same time, taking into account the relationship with the urban landscape and citizens, it is necessary to devise solutions that provide cross-cutting values, such as nature-based solutions and the use of renewable sources.

Green infrastructure

The changes that cities are undergoing today mean that Nature-Based Solutions can have a fundamental role to play through the implementation of green and blue infrastructures, due to their capacity to restore ecosystems and at the same time provide benefits to society.

In 2015 the European Commission published the report "Towards an EU Research and Innovation Policy Agenda for Nature-Based Solutions and Re-Naturing Cities", a document that presented the opportunities for innovation and research in the use of nature as an instrument for urban planning for sustainability. This highlights the growing value that nature has acquired in facing the environmental, social and economic challenges we face, defining them as «solutions inspired and supported by nature, which are cost-effective, provide simultaneous environmental, social and economic benefits and help build resilience» (European Commission and Union, 2015).

The term Nature-Based Solutions (NBS) arises through the concept of ecosystem, used by the scientific community since 2000, considered as a tool to solve social and environmental problems. Through the European Commission's new approach, the economic dimension is increasingly part of this concept, thus becoming part of European policies and strategies based on biodiversity conservation, climate change adaptation, natural disaster reduction, and human well-being (Lafortezza and Sanesi, 2019).

The quantification and evaluation of the benefits provided by the NBS to address the challenges we face is part of current research. It is important to identify not only benefits and costs, but also interactions with social, cultural, economic, biodiversity and climate factors. Cities, therefore, need to be rethought through sustainable planning that takes into account these complex interactions. Under this approach, NBS can be seen as a technological innovation focused on nature and on the objective of improving the natural capital of cities (Frantzeskaki, 2019).

Energy infrastructure

To achieve the main objective of decreasing the temperature of the earth below 2 °C in relation to the pre-industrial levels fixed by the Paris Agreement, renewable energies must develop six times faster than what has been done so far.

The urban model is the inflection point on which the parameters, dimensions, and methodology necessary for a large-scale energy

transition can be established, allowing the current energy model to be modified.

The concept of the energy transition, in addition to being technological, places the citizen at the centre of the system, transforming his or her role as a passive consumer into an active actor, capable of rationalising, self-producing and managing his or her energy needs. This transition must consist of aligning public policies with private investments in a framework of cross-cutting action.

The growing role of cities in climate action

The introduction of sustainable solutions in cities depends largely on new models of governance, through which innovation is encouraged, whether through long-term funding programmes in collaboration with businesses; the creation of an economic framework; or the monetisation of the benefits offered by nature.

Some indicators such as: the rate of growth of jobs related to green infrastructure; access to energy from renewable sources; the percentage of total surface area of green spaces; reduction of the rates of insecurity linked to the recovery of degraded spaces; levels of population exposed to outdoor air pollution; waste water treatment; the proportion of renewable energy produced and investment capacity, can be public policy instruments for quantifying the effectiveness of these solutions.

The value of green infrastructure and the reconfiguration of the current energy model are increasingly recognised by civic authorities and local citizens. Evidence of this is the growing number of local, national and international initiatives for the sustainable use of natural capital in urban areas, among which some priority lines of action have been developed, linked to the points listed below.

- Enhancing sustainable urbanisation through new technologies and business models: sustainable urban planning requires the development of technologies focused on human well-being and public health. An example of this is green roofs, which are capable of providing benefits in reducing energy consumption, contributing to rainwater management, reducing the urban heat island effect, creating opportunities for work and social interaction, as well as improving public health (Xing, Jones and Donison, 2017).
- Restoring degraded ecosystems by environmental restoration: as a result of human activities, some ecosystems have been degraded or lost, especially due to air and soil pollution, the modification of water bodies and the intensity of forestry practices, resulting in the interference of the functions that nature exercises in urban environments such as water purification, carbon sequestration, flood and drought prevention, among others (Kabisch *et al.*, 2016).

Some NBS, such as Sustainable Urban Drainage (SUD), can contribute to flood mitigation and water quality, as well as re-

duce the risk of flooding in cities.

Some solutions, such as plant façades, can contribute to generating economic and environmental value. The opportunities to green the grey infrastructure, the design of exterior and interior spaces, the development of business models around spaces, such as urban gardens, can guarantee a positive and multiplying effect in the search for sustainability and urban resilience (Nesshöver *et al.*, 2017).

- Power grid decarbonisation: energy transition must be drawn inside and out from the cities, from their different consumer sectors, buildings, industry, and services. The transport sector is one of the most influential, and the promotion of electrification of mobility can be one of the strategies that can help decarbonisation.

Some estimates claim that a combination of solar, wind and hydropower by 2030 would capture between 35% and 45% of the sector's total emissions. Therefore, this will not be possible without promoting demand for renewables and energy efficiency through utilities and policymakers (McKinsey Center for Business and Environment, 2017).

- Promote the expansion of distributed renewable energies: solar energy is considered one of the main strategies for sustainability in cities and forms part of only 0.1% of the world's electricity mix. Despite development and innovation, there are still barriers in the renewable energy market, such as lack of legislation, tax incentives and the exhaustion of available areas adaptable to solar energy production.

Photovoltaic technologies are a potential contributor to both small and large-scale energy in response to the challenges of 2050. Unlike centralised renewable energies, smaller and more distributed installations can be more economical for public services and can be faster to implement. Energy resilience is important, not only at the scale of buildings but also in urban space (Renewable and Agency, 2018). In the building sector worldwide, heating and cooling accounts for 35% to 60% of total energy demand, and is expected to increase by 70% by 2050, despite the energy efficiency measures that have been implemented. Several opportunities, such as Building Integrated Photovoltaics (BIPV), offer the possibility of reducing emissions from buildings (Kiss, 2012).

Building the urban transition: the holistic aspect of urban space

A great deal of the scientific research developed so far has focused on identifying the causes of urban social in-

equality and the unsustainability of the current urban model, and on understanding the connections between these problems.

While certain tensions in cities are considered to be connected, the loss of biodiversity, air quality, the impact this has on water quality, climate, and human health, are part of a chain of consequences that

lead us to reflect on the need for holistic and cross-cutting solutions that can address these interconnected problems.

We are convinced that NBSes are a tool that can contribute to the improvement of urban environments in vulnerable neighbourhoods. Among other ways, through citizen participation and attention to the specific needs of disadvantaged groups. Evidence is provided by the European project CLEVER Cities, which proposed the rehabilitation of an area of the city of Madrid through the creation of "habitable itineraries" in the Usera neighbourhood.

Similarly, projects such as Nature4Cities, Naturvation, or Think Nature, investigate the new political and economic models of NBS to provide evidence at European level of the scalability potential of NBS, as well as to provide a sound assessment framework for spreading the value of nature in cities. Such projects contribute to synthesising current knowledge and influencing local and European policies towards more sustainable and resilient cities.

Likewise, if we look at the field of renewable energies, nowadays there is a significant disproportion between population density, the energy intensity this entails, and the surfaces available for the installation of technologies, such as solar photovoltaic. This scenario raises the question that beyond the installation of systems on roofs and façades, it is necessary to promote another type of innovation and technology in the field of distributed energy offering alternatives to the current market under the premise of more production and efficiency with less surface area.

The incessant growth of the cities requires a commitment to the development of new systems that can be adapted to the territory, not dependent on the surface area of the buildings, and which can also offer different systemic and transversal solutions, including light, urban furniture, charging points for electric vehicles, contact with nature, and recovery of the sense of belonging to a community.

The design of complex and interconnected urban spaces that have solutions based on nature and energy production technologies from renewable sources can become tools, among many others, capable of activating a series of social, ecosystemic and economic mechanisms and processes, valuable for the transformation of the cities of today and tomorrow.

Addressing the current complexity of urban spaces requires the definition of spaces that, on the one hand, define strategic actions in cities, and on the other, involve cross-cutting solutions to address current challenges. Considering the city as an ecosystem allows us to achieve models of efficient, complex, interconnected, and socially cohesive cities.

Conclusion

This study reflects on distinct aspects that characterise the current urban scenario. It starts with the awareness that urban settlements have the most important environmental impact in terms of energy consumption, natural resources, and CO₂ emissions. For

this reason the challenge of climate change must be met by promoting economic, social, environmental, and political initiatives, involving society and government in co-creation models aligned with the SDGs. Through this work, the aim is to provide a strategic and interdisciplinary vision in the transformation of urban space, giving rise to concrete actions focused on processes of an ecosystemic and social nature.

The creation of an innovative model requires the creation of spaces for debate and consultation processes that are the basis of collaborative design. This requires, on the one hand, promoting solutions compatible to achieve zero net emissions, preserve biodiversity, and improve citizens' well-being in the short term. On the other hand, it is necessary to promote the integration of renewable energies through innovative technologies required to reduce emissions. As architects, we are called upon to promote urban planning approaches that allow citizens to enjoy the benefits and services that nature offers, without prejudice to the environment.

Indeed, one of the main challenges of our time is to achieve sustainable urban ecosystems. Although much progress has been made in recent years, we can consider that we are only at the beginning of a long journey. In this sense, the study supports the hypothesis that the combination of nature-based solutions and renewable energy production technologies can give rise to integrated urban spaces, potential activators of social, ecosystemic, and economic processes functional to the transformation of today's and tomorrow's cities.

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