Chapter 16
Contemporary Urban Biotopes: Lessons Learned from Four Recent European Urban Design Plans

Martin Knuijt

Abstract Increasing urbanisation requires rethinking what liveable cities are about. Within the next decade, both climate change and the shortage of resources on water, energy and nutrients will have strong effects on the urban environment. The challenge is to create 'healthy cities'. Bringing landscape to the cities can strongly contribute to making cities healthier, more resilient, and more vibrant, to accommodate all its citizens. The key to providing this new perspective is discovering how to create healthy cities in densely built areas, and strengthen the urban metabolism, while also addressing externalities, such as urban heat island effects, increased storm events, and sea level rise.

The objective of this paper is to gain insight in the new complexity that arises from the increasing relevance of landscape and planting in dense urban environments, in order to set a contemporary agenda for urban green space design. The increasing need to develop healthy, circular, and climate adaptive cities leads to new demands on urban green spaces (Knuijt 2013). A journey along recent urban plans for Rotterdam, Athens, London, and Utrecht demonstrates that, by rebalancing traffic in cities, a vibrant and green public realm can be realised. Re-balancing transportation and a shift to multimodal mobility have a large impact on spatial qualities of cities and provides creating access for all. The public realm can be transformed into a green and blue network, and will set the scene to activate public realm for vibrant city centres.

The complexity that arises from the new demands on green space in dense urban environments is explained through the analyses of four case studies in Rotterdam, Athens, London, and Utrecht and literature reviews. These four 'research by design' projects are discussed and evaluated to reveal the increasing (societal) relevance of urban green space.

These projects offer new perspectives on the integration of climate adaptive design and circularity. Toolboxes for heat mitigation and for water sensitive design are developed and applied in the designs. Today's complexity to increase the degree

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of self-sufficiency within city limits and regions as well as climate adaptation requires continuous monitoring of the level of incorporation of the different aspects of 'healthy living' into the realized development and assessment of the standards each year. Adding today's aspirations on including biodiversity calls for the idea of 'urban biotopes', turning the green into an urban ecosystem that can evolve over time. Creating a circular economy within the dense urban development, plus climate adaptive design and aspirations on creating an urban biotope, make urban development complex. It requires careful consideration about how to balance energy production and green and how to integrate underground infrastructure, in order to make sure that the proper conditions for urban green are set.

Keywords Urbanisation · Healthy cities · Resiliency · Climate adaptation · Circular economy · Biodiversity

16.1 Introduction

An increasing number of people are living within city limits; the world is becoming rapidly urbanised, and adjacent natural resources are being exhausted at an unsustainable rate. The quality of our lakes, rivers and streams is decreasing due to run-off. Ecological and agricultural areas are being developed to accommodate the population shift, resulting in a loss of 'green.' At the same time, we are facing climate change due to which contemporary cities are faced with the task of providing fresh water and access to restorative naturalised areas, while protecting citizens from natural disasters like flash floods, coastal storm surges, heatwaves, and droughts.

In the European densely built mega polis and metropolitan areas, there are urgent questions on how to develop healthy (peri-)urban environments with integrated water and drought management, and heat island effect mitigation solutions. Within the cities, the fundament for change lies in creating efficient transportation systems, connected to the urban network of spaces. A decade ago, the agenda for improving the quality of the public was set. Successful transformations of infrastructure into green structures, such as the Cheonggyecheon River in Seoul (Kodukula 2011), and urban transformations of the industrial to post industry cities in Bilbao (Areso 2009) and Melbourne (Adams 2009), have shown that large scale transformations are possible.

The challenge is to create 'healthy cities'. Following up to the change towards a direction of creating green landscape cities, our contemporary challenge is to incorporate the 'metabolism of the city' within the context of the densely built urban environment. The challenge is to manage the exchanges of energy, material, and population in a responsible and sustainable way—considering and strengthening the urban metabolism. Being aware of the growth of the world's population and the ongoing increase of percentage of people living within city limits, it will be imperative to find answers to unhealthy living conditions and to increase the degree of self-sufficiency within city limits and regions.

Creating a healthy living environment requires the reduction of distances between working and living, plus rebalancing traffic into a shift towards public transport and slow movement. Furthermore, it includes climate-proof cities and landscapes, addressing the issues of storm water management (Lenzholzer 2015). Other topics can be related to strategies for energy transition, the shift from fossil fuels to sustainable energy management, and for re-thinking waste, nutrients, and food production within the city limits (Troy 2012). The increasing need to develop healthy, circular, and climate adaptive cities leads to new demands for urban plans. In that context, the role of green spaces in the development of cities will change and become more relevant (City of Copenhagen 2016). To gain insight in the new complexity regarding urban green space design, four recent urban plans for Rotterdam, Athens, London, and Utrecht were analysed on how different demands on green space were integrated in the designs. This paper describes lessons learned from these four urban design projects, in order to set a contemporary agenda for dense urban environments as 'urban biotopes'.

16.2 Methodology

The new perspective on creating healthy cities can strongly contribute to make cities healthier, resilient, and more vibrant, in order to accommodate all of its citizens. Via 'research by design projects', new perspectives arise on integrating climate-sensitive design and circularity, and insights are developed on how to achieve substantial improvements in the public realm. Three recent urban design projects in Rotterdam, Athens, and London are discussed and evaluated as to the way in which they offer integrated solutions for urban challenges, regarding climate change, circular economy, and mobility. The contribution of these three case studies to these challenges is evaluated through assessment of the design projects' output and through literature reviews. Moreover, a currently ongoing urban design project in the Dutch city of Utrecht is reviewed as a pilot project for the application of the concept 'urban biotope'.

16.3 Results

16.3.1 Rotterdam, the Connected City Centre

The first step to the transformation of cities is to change mobility. The strategy for urban change in Rotterdam, and later for London and Athens was based on three pillars: creating access for all and rebalance transportation, transforming the public realm into a green and blue network, and activate the public realm to create vibrant city centres.

Re-balancing transportation has a large impact on spatial qualities of cities. With increased mobility, the quality of life of our cities is under pressure. Mobility is an

issue in contemporary metropolitan regions and in rapidly growing cities. In many cities, auto-centric city planning has led to vehicular movement exceeding maximum capacity of road space, resulting in congestion and low-quality anonymous space, lacking identity. Prioritizing automobile transportation results in a lack of safe pedestrian and cyclist networks. It has a negative impact on quality of life; air pollution takes a heavy toll on our health. Being aware that about a third of the total amount of air pollution comes from motorised traffic, development of clean transport to improve air quality will help to increase livability of cities.

The shift from vehicular mobility to multimodal is part of the strategy for Rotterdam city centre, focusing on expansion of pedestrian networks, public transit, and cycling. The idea of space needed to change, not by simply removing lanes of traffic on the main boulevards and roads, but by shifting from vehicular orientated space to pedestrian orientated space. For the city centre, an area of four by four kilometers, the switch from hard traffic (car-oriented) space to 'soft traffic' (pedestrian, cyclist and public transport oriented) space allows the centre to become accessible in a different way—the public realm itself to become a catalyst for urban revitalisation. Focal points in the city were connected, and the old pre-WWII streets were activated, so that pleasant and attractive networks for slow traffic could be regenerated. Resulting into a connected city, the ground is set for greening the space, and to create inviting places to stay (Knuijt 2008).

16.3.2 Re-think Athens and a Toolbox for Heat Mitigation

Creating space for pedestrians and cyclists sets the ground for a resilient and climate proof public realm (Bulleri 2018). The proposed transformation of Athens' city centre interlinked infrastructural change with the built environment, and created a basic framework for a blue-green network (Salles 2013). Changing the heart of Athens into a true contemporary metropolitan city centre required transformation of the city triangle into a lively part of the city. Newly gained space, as a result of the major step towards a walkable city by reducing car traffic in this area, will transform it into a vibrant, green, and accessible heart of the city (Knuijt 2013). The combination of water solutions was key to make the city more resilient, adaptable, and dynamic. The blue-green network served a multifunction purpose—storm-water and drought management and heat island effect mitigation (Figs. 16.1 and 16.2).

To mitigate urban heat island effects urban measures to improve the urban microclimate, energy consumption and thermal comfort of citizens are required and integrated into the design principles of the public realm. A heat mitigation design toolkit was part of the proposal of OKRA landscape architects: the addition of greenery, use of light materials, and integration of open water helps reduce the urban heat island effect. A contextual approach defines where the tools for different categories can be applied. Trees and other vegetation provide shade and allow of

Fig. 16.1 Heat mitigation toolbox Athens—measures and spatial distribution. (Knuijt 2013)

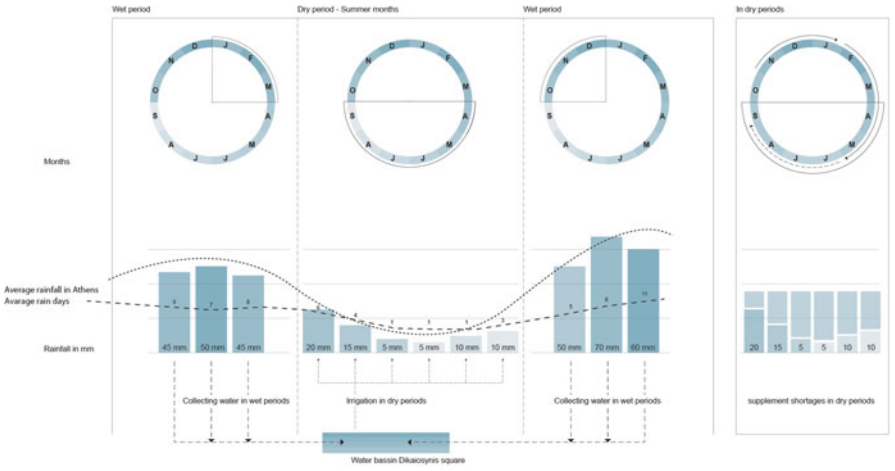

Fig. 16.2 Rainfall in Athens, seasonal change. (Knuijt 2013)

evapotranspiration, both having a cooling effect. Providing water for the trees stimulates transpiration, and contributes to cooling as well. Europe's largest rainwater retention system allows the area to be self-sufficient on water for irrigating green areas.

Parallel to the design process, monitoring of the results has taken place. Similar to the technical aspects, such as traffic modelling, aspects of climate adaptive design can also be calculated (Santamouris et al. 2012). It is not quantities indicating the amount of green and water of the design; it is the performance that can be indicated in figures. The broad notion 'sustainability' gets precision. For the Re-Think Athens project, the heat mitigation toolbox was evaluated and translated into the design for public realm. Measurements on site were executed (University of Athens 2013) and during the design stages the outcome on heat reduction of the proposals were calculated via using ENVI-met simulations A cooling of 1.5 °C plus 20% of the thermal comfort index on a typical summer day was the aim. Results of 1.5 up till 3.0° was; the outcome. (Werner Sobek GT 2013).

16.3.3 London Meridian Water and a Toolbox for Water Sensitive Urban Design

To adapt to climate change and prevent urban areas from the negative effects of flooding and drought, consideration of these aspects needs to be integrated at an early stage of planning for urban developments. Regenerating the water system is key to a contemporary and healthy relationship between nature and culture (Hoyer et al. 2011).

For London's largest building development, Meridian Water, situated on a brownfield area, OKRA landscape architects developed a water sensitive urban design toolbox. This was a result of considering that water solutions and green in public realm in the River Lee valley could work as an 'urban water machine'. A coherent set of tools was developed, contributing to healthy cities by integrating (Figs. 16.3 and 16.4).

The first category of tools is about preventing areas from flooding. The second category is about ensuring that integrated water management capturing and reuse is of essence. The green areas are designed to act as flood storage system within the built environment. Additional water storage can be designed into parks and squares serving dual purposes—leisure, recreation, and sport most of the year, and storm-water storage during intense storm events. Storm-water can be stored in above or below ground containers, used as an alternative for irrigation. Storm-water ponds can be seen as attractive natural elements that also serve as habitat to urban flora and fauna. Canals and pools within the public realm can hold water while not only providing something beautiful to look at, but also allowing for evapotranspiration to occur, thus lowering the urban temperature. Capturing as much rainwater on site as possible is one way in which we can ensure climate proof cities. The third category related to sound water management includes tools to filter, to infiltrate and to

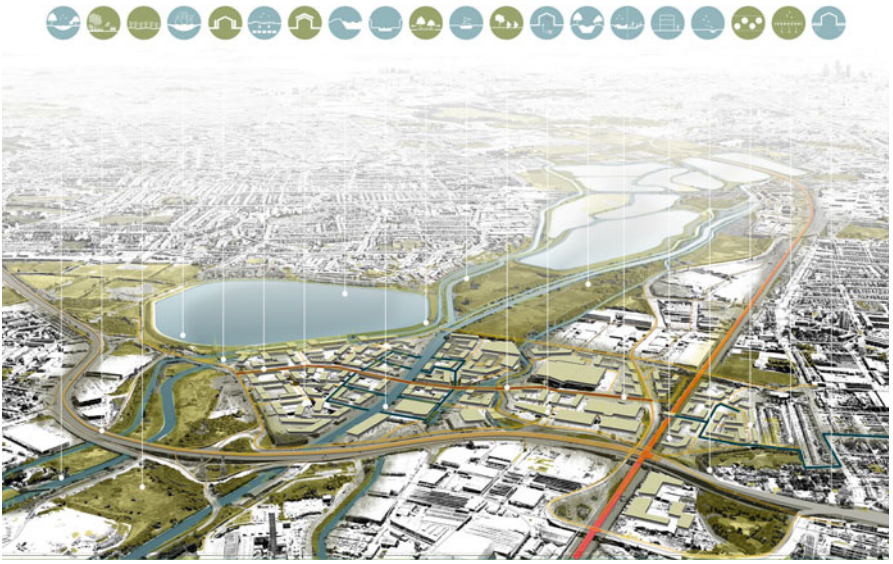

Fig. 16.3 Toolbox for water sensitive urban design, London Meridian Water (Knuijt 2016a, b) water into the public realm by storing, filtering, and infiltrating (Knuijt 2016a, b)

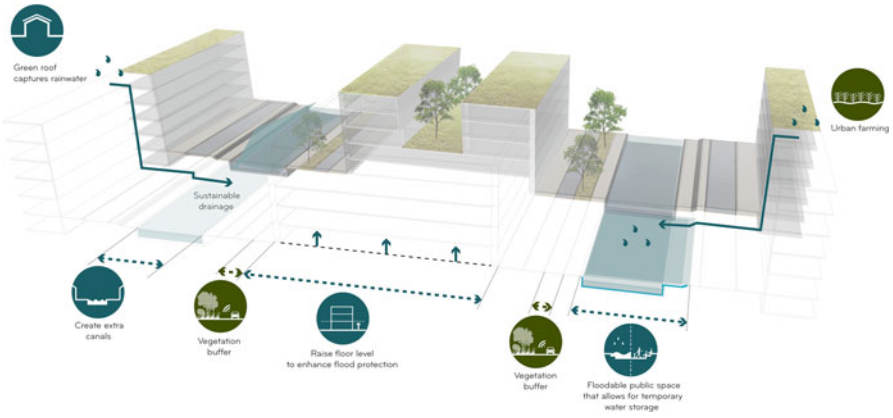

Fig. 16.4 Toolbox for water sensitive urban design translated into typical section for one of the waterways, London Meridian Water. (Knuijt 2016a, b)

recharge. The last category of tools is about the educational aspect of water. In addition to rain gardens, swales, ponds, streams, and channels, other water elements within public areas such as water-squares, fountains and interactive play elements can serve as protection, by providing additional temporary storage and/or reuse. Moreover, creating hydro-centric recreational opportunities is a way to bring people into contact with water; providing these opportunities is essential for education and awareness. Within the design of public realm, water and green can be integrated in multiple scales, resulting in attractive public realm.

16.3.4 Merwedekanaalzone, Utrecht: A New Horizon

Improving biodiversity in the urban context and preventing diseases brings nature close to people living in the city. In the most recent urban design project of OKRA landscape architects, the Merwede area in Utrecht, a large brownfield development along the Merwedekanaal, 'urban biotopes' are designed in the public realm and on inner courts plus rooftops. The concept of urban biotope, in this case, means to design a resilient urban planting plan with a balanced nutrient and water supply system for planting. Based on the existing trees in the area, a selection of additional species is made to create variety in size of trees, understory planting, groundcover and perennials. Part of the planting is edible green, providing nuts and fruits for birds and insects.

Within the context of high density urban development, improved water sensitive solutions, waste management, and energy neutral developments are included. Creating a circular economy within the dense urban development, plus a climate adaptive design and aspirations of creating an urban biotope make the situation complex. It is so complex, that choices have to be made where energy production can take place and at what place green on roofs has priority. It even requires re-thinking and integrating underground infrastructure, to avoid that at a late design stage it becomes clear that part of the green can't be realised.

The project itself is regarded as a 1:1 design lab and requires monitoring of the results, executed by research institutes. Most likely, today's highest standards will be normal standards in a few years, and might be outdated standards within 10 years. This requires continuous monitoring of the level of incorporation of the different aspects of 'healthy living' into the realised development and assessment of the standards each year. Results during construction will be set against today's baseline, and include achievements during the next 10 years, thus being able to evaluate the different aspects on water sensitive solutions, heat mitigation, carbon reduction, energy circles, and waste management for a longer period (Fig. 16.5).

16.4 Conclusion: Towards Healthy Cities

The base of the above mentioned urban strategies is to enhance green and connected cities. Firstly, fundamental change is possible via rebalancing a city's mobility system, creating access for all, transforming public realm into a green-blue network and activating public realm to create vibrant city centres.

Secondly, the role of planting in this green-blue network is beyond aesthetics and has increased societal relevance. Planting is becoming increasingly important to tackle big societal, urban challenges, such as climate adaptation, biodiversity, and heat mitigation. While traditionally, cities can be regarded as petrified landscapes, the integration of landscape and city can result in the creation of holistic cities.

Moreover, increasing urban densification and complexity caused by the need to design and organise cities in a circular way, demands holistic green strategies. In

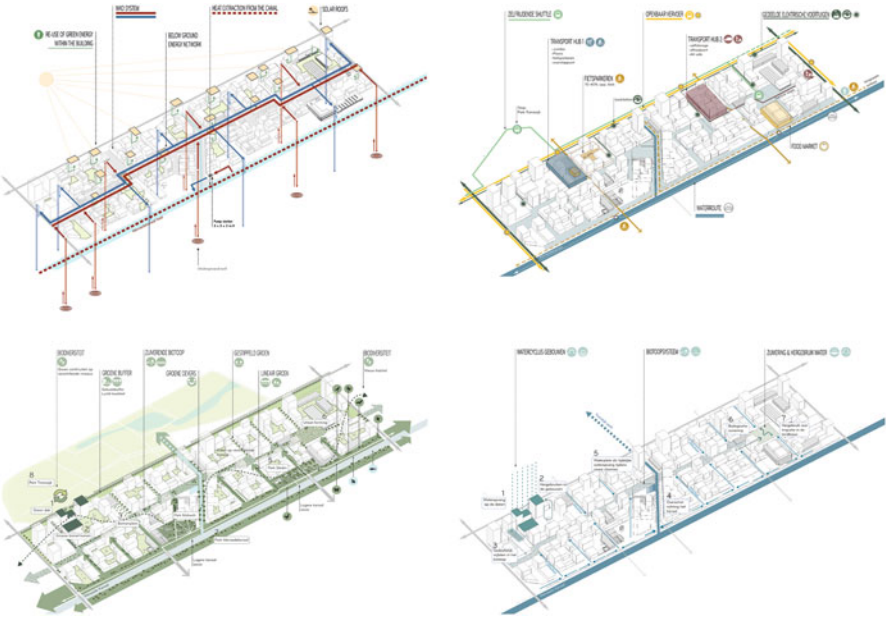

Fig. 16.5 Climate adaptive solutions and circular integrated in the plans for Merwede. (Owners collective Merwede, 2017)

fact, the city should be regarded as a system, connecting places with multi-modal and multi-functional corridors. Cities, like organisms, require inputs, such as water, energy, people, and produce outputs, such as waste. The continuous exchange of energy, material, and population is essential to the way a city functions, and can be regarded as a metabolism.

Finally, today's aspirations on including biodiversity in highly urban environments calls for the concept of 'urban biotopes'. The concept of urban biotopes regards a holistic approach in which planting, nutrients, and water together form new urban ecosystems. Urban biotopes seem promising for designing cities, in such a way that a balanced and holistic green system can evolve over time. Although urban biotopes require careful consideration about how to integrate energy production, underground infrastructure, and mobility in such a way that proper conditions for urban green are set, the concept is very promising for the necessary development of long lasting green networks and resilient cities.

The design task today is to manage those exchanges in a responsible and sustainable way—considering and strengthening the urban metabolism and creating healthy cities. Entering a new era will require that once more the interaction to other fields of expertise will be key to find strategic solutions to new challenges. Mixing up and integrating all disciplines seems a fairly logic approach when working in this context. To find answers to today's complex challenges, a clear vision and a strong collaboration between dedicated people on different fields of expertise is required.

Universal are the qualities that emerge from the landscape and that do connect us with mother earth. The qualities of change are the new programs that will be drivers for spatial adaptation. The creation of landscape cities today, being healthy and sustainable leads to interesting cities of tomorrow. It goes beyond blue-green networks: creating green that enhances urban biodiversity and brings nature to cities even in the densely built urban environment will be the next step in ensuring that cities are resilient enough to be a good place for working and living tomorrow.

References

Adams R (2009) From industrial cities to eco-urbanity; the Melbourne case study. In: Radovic D. (ed) Eco-urbanity: towards well-mannered built environments. Routledge, New York

Areso I (2009) Bilbao's strategic evolution. From the industrial to the post-industrial city. In: Instituto Cervantes. 'Restoring, regenerating, rethinking: the urban transformation of Madrid. In: Barcelona and Bilbao

Bulleri A (2018) Esercizi di riscatto urbano; Considerazioni sulla riqualificazione degli spazi aperti a Atene da Piazza Monastiraki a "Re-Think Athens" – Exercises in urban redemption; Considerations on the redevelopment of open spaces in Athens, from Monastiraki Square to 'Re-Think Athens'. In: Paesaggio Urbano (urban design) 2018-2, pp 124–133

City of Copenhagen (2016) Climate adaptation and urban nature. Copenhagen

Group of Building Environmental Studies, Physics Department, University of Athens (2013) Thermal and wind measurements performed in the Panepistimioy street in the city of Athens (final report). Athens

Hoyer J, Wolfgang D, Kronawitter L, Weber B (2011) Water sensitive urban design; principles and inspiration for sustainable stormwater management in the city of the future. (Research in the context of the European research project SWITCH.) Jovis, Berlin

Knuijt M (2008) The connected city, the metamorphosis of Central Rotterdam's public space. Topos (64) pp 50–55

Knuijt M (2013) One step beyond, a new city center for Athens. In: Topos, vol 85, pp 62–69

Knuijt M (2016a) Stadtentwicklung in Wassersensibelen Bereichen / Urbanisation en zone aquatique sensible. In Anthos 4-2016, pp 20–23

Knuijt M (2016b) Stadt als Stoffwechsel; Gemischte Netzwerke aus Stadt und Landschaft, TU Berlin, Heft 35, 2016

Kodukula S (2011) Reviving the soul in Seoul: Seoul's experience in demolishing road infrastructure and improving public transport. A joint case study by GIZ and KOTI. In: Case studies in sustainable transport, volume 6. GIZ, Deutsche Gesellschaft für Internationaler Zusammenarbeit, Eschborn

Lenzholzer S (2015) Weather in the city; how design shapes the urban climate. nai010, Rotterdam

Salles A (2013) Athènes rêve d'une coulée verte pour lutter contre la pollution et les embouteillages. Le Monde, Paris

Santamouris M, Gaitani N, Spanou A, Saliari M, Gianopoulou K, Vasilakopoulou K (2012) Using cool paving materials to improve microclimate of urban areas – design realisation and results of the Flisvos project. Build Environ 53, pp 128–136

Troy A (2012) The very hungry city; urban energy efficiency and the economic fate of cities. Yale University Press, London

Werner Sobek Green Technologies (2013) Final report 'Microclimatic simulation II design conclusions'. Athens