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Reconnecting green: Towards a multi-dimensional biophilic city

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Abstract

Densification and greening of cities seem to exclude one another. How to deal with this? This research shows a first exploration of how city green can be optimized by integrating the facade-and rooftop green into the neighbourhood landscape. To do this, biophilic design principles were applied from a landscape architectural perspective. Due to the many green roof interventions as well as the existing big surface area of flat roofs, the city of Rotterdam in the Netherlands, was the main focus. Seven steps which can turn an unhealthy city into a biophilic one are described. Ecosystem services are related to these steps and serve as an indication for valuing ideas and design implementations for a city wide greening vision as a first step towards a multidimensional biophilic city.

Keywords: Biophilia; ecosystem services; facade green; rooftop green; landscape architecture, Rotterdam

1. Introduction

Many large cities in the world have an unhealthy stressful urban climate: air pollution, lack of water retention, lack of biodiversity, urban heat island effects, etc. There is also a lack of space in the urban environment and predictions are that urbanization and densification will increase (DESA, 2008). This is a huge problem for cities and very difficult to plan and design for. Urban green is regarded as big part of the solution for the environmental challenges that cities are facing. Ecosystem services, the benefits human populations derive from ecosystems (Bolund & Hunhammar, 1999), in cities should be planned for. Physical needs, security of existence, social and psychological needs can all benefit from

green interventions (Hop & Hiemstra, 2013). Therefore, it is very important that local governments have ambitious green policies.

"*Nature seems to bring out the best in us* (Beatley, 2011). *As it turns out, even small nature places can help just do that* (Kaplan & Kaplan, 2005)"

A densified city lacks an abundance of open space. There is a competition for space, between different functions such as new dwellings and green developments. Since the 1980s rooftop green has been introduced on a large scale in urban areas. The motive was to bring the maximum vegetation possible into the urban setting (Kohler, 2008). Projects were developed which resulted in beautiful green roofscapes. There are some critical remarks though: First, they primarily occur in the private sector. Second, public green roofs are often unknown by citizens, as they are hardly seen from ground level and often have bad accessibility. Since mid-2000s, green façades began to emerge and green architecture became a fact. The advantages of green façades, in contrast with green roofs, is that they are visible from the street level. However, one cannot walk through a green façade. The third problem of vertical green and rooftop interventions is that they are implemented on a small scale scattered all over the city, with little to no interaction with the ground level. The effects of those green interventions are still very local, many potential synergies are unused.

Green roofs and façades are mainly architectural projects and connected in isolation of the building. There is not enough attention for this type of green interventions yet from a landscape architectural point of view. This research shows an exploration of how city green can be optimized by integrating the facade-and rooftop green into the neighbourhood landscape. Rotterdam, the Netherlands, will be the main focus due to the many green roof interventions and number of flat roofs. The results of this research is a stepwise approach how an existing city can transform into a biophilic one.

2. Methodology

The approach consists of seven steps starting from analysing the city and its potentials. From this analysis, a vision can be made that results in a concrete plan for the development of a biophilic city. The link with existing biophilic projects is made to show what a biophilic city can look like. The analysed layers are: existing green, water and public space, existing green rooftops and potential rooftops, and the urban challenges (such as densification), and opportunities. The next step is to create a vision for the city based on the previous analysis. Spatial requirements for the development for reconnecting green are partly extracted from this vision as well as from local context. The last step is an action plan and will be illustrated with example projects.

1. Look for available spaces and analyse existing green areas
2. Map existing green roofs
3. Analyse buildings for potential green development
4. Analyse urban challenges and opportunities
5. Create a city wide greening vision
6. Reconnect green
7. Action plan

3. Towards a biophilic city

"*Nature in our lives is not optional, it is essential. It is not a thing or place that we periodically visit but a surrounding condition, an ideally ubiquitous context that delights, relaxes, soothes, replenishes, inspires, and uplifts us in our daily urban lives. A biophilic city is a city that looks for opportunities to repair and restore and creatively insert nature wherever it can* (Beatley, 2011)."

3.1. Look for available spaces and analyse existing green areas

To design for a biophilic city it is important to take advantage of the existing green-and public spaces, infrastructure, water ways, and other connections in a city. These green infrastructures form the backbone of the city. They can and do support a diversity of human uses as well as environmental functions, and their vitality influences quality of life as much as it does the integrity of land, air, water and forest resources (Girling & Kellett, 2005). We can look at available spaces in different scales from regional to street level. Existing green areas and available areas for green development on a regional scale are regional parks, large conservation areas, greenways and rivers. The regional parks create space, landscape and a peaceful environment and show the identity of the city and typology of soil, history and landscape type (Tillie, 2016, Municipality of Rotterdam, 2005). Rivers are the core areas for the landscape, ecology, history and recreation and create connections on different scales; city, regional, national and international scale. City-or community parks, cemeteries, play fields, greenways and city gardens are the existing community green areas in a city and are an important connection with regional parks. On a neighbourhood scale, green sites are school yards, neighbourhood parks, playgrounds, and drainage ways (Girling & Kellett, 2005). It is of great value that the available green spaces and spaces for green are easily accessible and coherent. These are ecological and recreational routes through a city where there is a direct experience and accessibility of green. Other available spaces are (abandoned) alleys, streets, tram tracks and parking lots. Places that you don't need or want to visit but have great potential for green or biophilic development. Quays and riverside trails are perfect locations for green connections as well dike trails and road sides. On a street level scale, medians, street trees and planting strips create green corridors through a city. In Rotterdam, the river Maas is an icon of the city and the multiple canals play an import role for cultural history, usage and living quality. Three regional parks surround Rotterdam and form an important part of the urban structure: Rottemeren, Midden-Delflanden and IJsselmonde. Due to these big ecological areas and the number of smaller waterways like canals, ponds, and other greens, Rotterdam is very suitable to become a biophilic city.

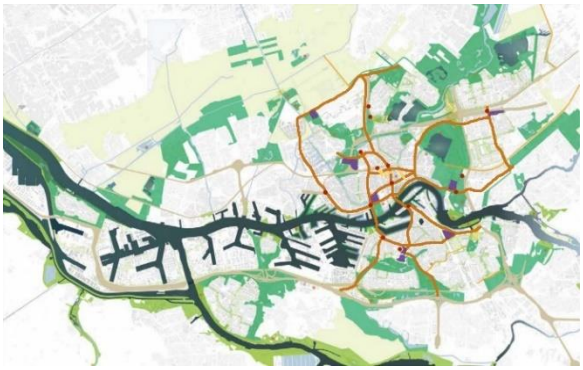

Fig. 1. Public green Rotterdam (Municipality of Rotterdam, 2012 & 2014)

Fig. 2. Current green rooftops in Rotterdam (Municipality of Rotterdam, 2007)

3.2. Map existing green rooftops

The first step to create a multi-dimensional green space is to map all the existing green roofs. Answering questions such as: Where are they located, what is the level of the intensity of green, are they accessible, do they relate, are they connected with the ground level, etc. Analysing these rooftops gives direction for planning new green rooftops. Rotterdam has the highest amount of green rooftop development in the Netherlands, with over 235.000 m2 of green roofs (Municipality of Rotterdam, 2017) and the most potential to create a multi-dimensional landscape, as it has a big amount of post WWII real-estate. Only a small percentage of the existing green rooftops are always accessible.

3.3. Analyse buildings for potential green development

There are several important aspects of potential recreational green rooftops. Rooftops have to be flat for recreational green development. Due to accessibility and visibility it is wise to focus on rooftops that have a maximum of 12 meters. It is a bonus if a rooftop has the possibilities for an intensive green rooftop. Especially dense neighbourhoods with little green and little potential for ground level green development, can have enormous benefits from green rooftops. For the development of green facades another approach is made. Green facades have great visibility and work really well in dense areas. Especially small streets where there is no space for trees and other green can have great benefit from green facades and hanging green.

Fig. 3. Potential green rooftops in Rotterdam (Municipality of Rotterdam, 2007)

3.4. Analyse urban challenges and opportunities

Every city has to cope with specific challenges. Global warming and densification are key subjects of tomorrows city planning for almost every city. Water restoration, urban heat island effects, air pollution, as well social problems such as stress, and disconnection with nature, are huge problems. The difficulty is the lack of space in cities for creating solutions. Healthy ecosystems are the foundation for sustainable cities (TEEB, 2011). For example, trees and green rooftops serve to address the urban heat island effect and moderate and reduce urban heat and reduce air pollutants (Getter & Rowe, 2006). To connect urban challenges to green opportunities we can look at ecosystem services. Urban green and healthy ecosystems can solve many city challenges. The effects of climate change are also visible in the city of Rotterdam; sea level rise, intense rain, dynamic water levels in the rivers, and longer periods of drought and warmth (Rotterdam Climate Initiative, 2018). The city's effort is to create and maintain a balanced green infrastructure of parks, gardens and other green areas with a high quality providing different ecosystem services ranging from recreation, ecological qualities to water storage and so on (Tillie, 2016). It is necessary that Rotterdam will adapt itself to climate change and its goal is to be climate-proof by 2025. If we look at the case of Rotterdam, another challenge is the experience of green in the city. Rotterdam has more green per dwelling than the other 3 big cities, Amsterdam, The Hague and Utrecht. However, the citizens don't experience this as such. The Reasons for this is the quality of green, monotonous (or not) and its usability (Tillie, 2016). Therefor it's not only important to create more green, it is also valuable to increase the quality of existing green in the city. The implementation of green is a step in the right direction. Which kind of problem does the service contribute to or solve? What ecosystem elements are involved in the generation of the service and where are the opportunities in the city to create this?

3.5. Create a city wide greening vision

Key is to set goals for the city. What are the most important challenges of this city? Is it the air quality, water retention or is it the mental wellbeing of its citizen, etc.? From this challenge, (or these challenges) we can create a vision for the city. The places in the city that need the most green because of its lack in green, dwelling density or other problems. For the Netherlands the green standard per dwelling is 75m2 and the accessibility of green is 500m2 (Bezemer et

al., 2002). Map the surface of green in the city and determine the minimum amount of green that is needed. Start at the ground level, what is already there? What is the function, and how is the quality of the green? A connection of neighbourhood green with regional green should be made in order to address weekly green and stimulate citizen to visit the nature areas outside of the city. Look for available places for green development and link this with existing green. How do they relate and, more important, how can they strengthen each other? Use the extra dimensions in the city, facades and rooftops and link these with the ground level green. Create artistic and aesthetic roof accessibilities that will attract people to the rooftops.

3.6. Reconnect green

"Reconnecting may be appropriate not only with respect to our relationship with nature, but in terms of many other reasonableness-supporting aspects of life (Kaplan & Kaplan, 2005)*"*

'Daily contact with urban nature places can foster greater self-esteem, trust, and hope. It stimulates the reconnection with nature of the urbanites' (Beatley, 2011). To create a well-connected green infrastructure which adds to daily green, it is valuable to have at least street green; trees, sidewalk gardens, courtyards, within 100m (Beatley, 2012), and larger green areas; neighbourhood parks, pocket parks, gardens, within 500m (Bezemer et al, 2002). For connecting green it is helpful to look for more solutions than only from a ground level perspective. Other dimensions are green facades and green roofs. They are the higher reaches of a city and harbour nature. Potential benefits of green facades- and roofs include green-space amenity, habitat for wildlife, air-quality improvement, and reduction of the urban heat-island effect (Oberndorfer & et al., 2007). It is important to approach them as two different interventions as they have in common the covering of building surfaces with vegetation, but there are key differences in the application and structure of these technologies and the resulting impacts on urban ecosystems (Köhler, 2008). To make rooftops more valuable it is of great significance that they are part of a bigger green infrastructure. The difficulty of integrating green rooftops is its accessibility and the place to create accessibility. The green rooftop of the Nanyang School of Art in Singapore and the green roof of the Delft University of Technology Library in the Netherlands managed to make a whole of the rooftop and ground level to increase its accessibility. These curved and sloping roofs were part of the architecture and make a good inspiration for creating accessible rooftops on existing buildings.

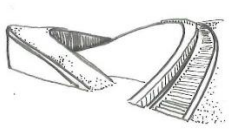

Fig. 4. Nanyang School of Art.

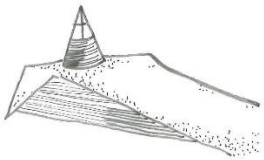

Fig. 5 Delft University of technology.

We can distinguish three types of accessibility for rooftops. The first one is based on the green slopes of architectural buildings and can be implemented at places where there is enough space. The advantages of this kind of ascent is that it is part of the green rooftop in its appearance and vegetation and functions as an extension of the roof garden. The second type is a stair which can be implemented where there is no room for a slope. This stair, depending on the size, can harbour extra commercial functions, like small shops. The last type of ascent is a tower with stairs or elevator in it. Its compact size makes it possible to reach roof gardens where there is a lack of space on the ground level. Both can be vegetated to link it with the green roof and infrastructure.

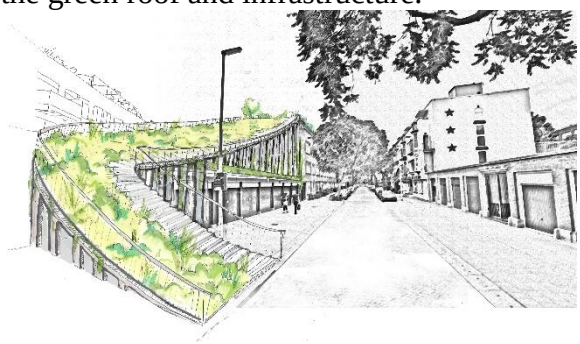

Fig. 6. Type 1: Slope

Fig. 7. Type 2: Stairs

Fig 8. Type 3: Tower.

4.7. Action plan

The goal of Rotterdam is that it will be climate-proof by 2025 (Municipality of Rotterdam, 2017). The city should function as a sponge, green should have more value and it should be social and flexible. A multi-dimensional green connection can be made which is of great value. This principle can easily be applied in the inner city of Rotterdam. For instance the Lijnbaan, which has a great amount of low (under 10m) flat rooftop buildings where a second pedestrian layer can be added to. Every 10-25 year a building has to be renovated which is a perfect timing to transform this building into a sustainable green one. When there is place for new urban development, make sure that it will be a biophilic space with enough green areas and green buildings.

Creating urban landscapes using native plants restore the ecological function and value. Native vegetation is low in maintenance and supports local ecology and evolved to live with the local climate, soil type and animals. There must be areas where

residents can see and experience native wild or semi-wild nature and native vegetation (Beatley, 2011) which links with the surrounding landscape of the city. Our urban streetscapes, city parks, regional greenways and vegetative storm water facilities are ideal spaces for incorporating native plant communities. Native plants help to capture and infiltrate storm water thus improving water quality while providing habitat and biodiversity. The biggest benefit: they complete the picture by enhancing the aesthetic values of urban neighbourhoods. A good example of a project that used mainly native species is Corktown Common in Toronto. It opened with over 700 trees an thousands of shrubs and grasses that are native to Southern Ontario's Carolinian forest ecosystem.

Fig. 9. Chaise Urbaine, Germany

Fig. 10. Biesbosch, the Netherlands.

Fig. 11. EVA Lanxmeer, The Netherlands.

Fig. 12. Corktown Common, Canada.

4. Conclusion

An attractive green city is not only beneficial for its citizens as a contribution to strengthen the economy. Green attracts firms and offices because of the pleasing setting, room for strolling and view (Tillie, 2016). Therefor it is of great value that we start now with designing our cities differently. Start by analysing the ground level for existing green and potential green. Add the second dimension analysis of (potential) green facades and rooftops. This is the base for a biophilic development. Subsequently

determine what the challenges and opportunities of the city are and link those with ecosystem services, the type of ecosystem that can treat the problems in the city. Set goals and create a vision based on the needs of a city, and the available spaces to design for. Reconnect those places with existing green and create physical, aesthetical and biological networks between the ground level and rooftop for a multi-dimensional biophilic design. At last set guidelines for architectural development. Biophilic design should at least add to air filtering, biodiversity, aesthetics and a better physical and psychological health. A biophilic city is a city where its citizens and itself can be healthy and happy. As nature in our cities and lives is not optional, it is essential.

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