



BIOTOPE CITY – VIENNA AS A CONTRIBUTION TO SUSTAINABLE, CLIMATE-SENSITIVE URBAN OPEN SPACES

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The ongoing population growth leads to urban densification which results in a loss of urban green and open spaces and an increase in building mass. In addition, changing climate conditions and the urban heat island effect pose challenges for cities. New approaches are needed to maintain and improve the quality of life, especially for urban population. The urban planning model “Biotope City – the city as nature” is a promising strategy. It promotes the increased use of urban green infrastructure, and, therefore, has a positive impact on the microclimate and creates quality living space for people, flora, and fauna. This paper follows a case-study design, with in-depth analysis of changes in building-related, urban open spaces during the planning process. The plan comparisons show an increase in sealed surfaces from master plan to submission plan and a decrease in urban green infrastructure. The material and vegetation shift have a major impact on the overall ecological assessment of the “Biotope City – Vienna” area. Although the project is based on the urban planning model “Biotope City – the city as nature”, there are qualitative and ecological losses during the planning process. These results further support the idea of binding quality assurance and implementation in formal planning instruments to support quality, climate-sensitive urban open spaces.

Keywords: urban green infrastructure, quality assurance, Biotope City – Vienna, climate-sensitive urban planning

1 Introduction

As more than half of the world’s population lives in cities and urban migration is ongoing globally, cities face some difficulties. The increase in population leads to urban densification. Cities must stand up to population pressure, which results in an increase in building mass and sealed surfaces. Due to limited space within the city, urban densification puts pressure on green and open spaces, leading to a loss of unsealed areas. In addition, there is a constantly increasing number of days of excessive heat due to the interaction of the Urban Heat Island (UHI) effect and climate change-related rising temperatures (Kromp-Kolb, et al., 2014). Due to the constant migration into cities, the general vulnerability increases as people live in areas most affected by the UHI effect (Lemonsu et al., 2015).

Vienna is confronted with precisely these difficulties. It is a rapid-growing city with an estimated population increase of 20% until 2050 (Statistik Austria, 2016) and experienced noticeable changes in climatic conditions in the last decades (ZAMG, 2012). This means that the

current standards for the population must not only be maintained, but also improved. The densification of urbanity and the loss of unsealed open spaces require structural measures with regard to long-term sustainable settlement design in order to provide a high quality of living.

1.1 Aims and objective

In addition to these changing, verifiable, and measurable physical requirements, the need to ensure high quality of life poses numerous challenges for urban development. The discussion of high-quality open spaces in the city and the current relevance of the increased use of green infrastructure as an option for adaptation to climate change and the reduction of urban heat islands raise the question of how this is applied in current planning projects.

This study is unable to encompass the entire field of the usability of green and open spaces and inter- and transdisciplinary planning processes, but it is embedded in a broader research context. Preliminary work was done



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in a one-year research project “Biotope City is smart”¹. One major issue was, if and how the amount and quality of greening measures change along with the progressing planning status. The master thesis “Zukunftsfähige städtische Freiräume” (in English; “Sustainable urban open spaces”) (Ring, 2018) dealt more comprehensively with the topic of plan comparisons, the definition of quality criteria, and their implementation in everyday planning life.

The two main goals of this study are:

1. to investigate which greening measures exist in the planning area (case study “Biotope City – Vienna”);
2. to ascertain how these can be secured along the planning process in order to obtain quality open spaces.

Firstly, this paper gives a brief overview of the benefits of urban green infrastructure, as they bring ecological, economic, and social advantages and are indispensable for sustainable urban open spaces. The second chapter is concerned with the methodology used for this study. Chapter three analyses the results of the plan comparisons on the basis of the case study “Biotope City – Vienna”, an urban development area in Vienna with the promising approach of increasing the use of green infrastructure. Research question 1) is dealt with in Chapter 3.1 and the second question is discussed in Chapter 3.2. It is of particular concern to identify alterations in the planning process so that negative outcomes can be prevented in the future. The findings make an important contribution to the field of landscape planning by highlighting the importance of building-related open spaces and the need for mandatory quality assurance.

1.2 Urban green infrastructure and ecosystem services

A large and growing body of literature has investigated urban densification, climate change and urban green infrastructure (UGI). The following is a brief description of the state of the art, in order to highlight the relevance of the link between high-quality urban open spaces

and urban and climatic changes, as it is of particular interest for the research topic.

■ Ecological benefits

Green infrastructure as a strategy for achieving resilience and a sustainable, functioning urban system is essential in urban planning. “(...) green infrastructure (...) relates to a fine-scale urban application where hybrid infrastructures of green spaces and built systems are planned and designed to support multiple ecosystem services” (Pauleit et al., 2011). The term “infrastructure” illustrates the need to place green infrastructure (GI) on the same level as the structural infrastructure. Through the use of GI, not only ecological but also social and economic demands can be met. Nevertheless, GI currently still plays a *minor* role in urban development and is in conflict with scarce land resources and urban densification (Mell et al., 2016; Pauleit et al., 2011).

There is a large volume of published studies (Campbell-Lendrum and Corvalán, 2007; Coseo and Larsen, 2015; Qin, 2015; Sukopp and Werner, 1982; Susca, Gaffin and Dell’Osso, 2011; Wang, 2016) describing the role of green infrastructure and its positive impact on the microclimate, especially in cities. To sum it up, results show that vegetation cools and humidifies the air, and fine dust deposition filters the air and stores CO₂ (Hatvan et al., 2014). The larger the connected green area, the greater the effect on cooling the urban climate (Sutter-Schurr, 2008). Still, small-scale green structures and open spaces have an influence on the UHI effect and the microclimate of a city (Vienna Environmental Protection Department – Municipal Department 22, 2018). At the microclimatic level, the effects of the urban green infrastructure (UGI) mainly includes shading, wind, and evapotranspiration (Wang, 2016). This can primarily be achieved by façade greening, roof greening, and planting trees. The radiating surface of the buildings is decreased and thus the air temperature is reduced. Façade greening serves as a buffer zone for buildings, improves the indoor climate and thus reduces operating costs. In addition, the peak discharge into the sewage system is reduced by decreasing the sealed areas through water retention and evaporation (Hatvan et al., 2014; Kuttler, 2011).

Chosen materials also influence the sustainability of urban development projects. The material has an impact on thermal comfort and rainwater runoff. As already mentioned, the increase in building density is accompanied by an expansion of development areas and thus in sealed areas. There is potential for the reduction of greenhouse gases through energetic

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savings in flooring materials, through the consideration of their transport, repair capability and lifespan (Hatvan et al., 2014).

■ Social and economic benefits

The impact of UGI is not only ecologically valuable, but also very beneficial for the residents. Green spaces enrich the quality of life in many ways: they form a contrast to the built environment, they provide space for recreation, improve mental and physical health, well-being and enable social contacts. Green spaces and UGI have an aesthetic effect, but they do much more than simply embellish. UGI fulfils various ecosystem functions and thus provides ecosystem services for humans. The benefits that society derives from ecosystem services can be of a material, health, or psychological nature. There is no doubt that the use of green infrastructure in cities is essential for environmental and socioeconomic benefits, among others the mitigation of the urban heat island effect, improvement of air quality, increase of well-being (Ecosystem Services, Grunewald and Bastian, 2013; Millennium Ecosystem Assessment, 2005). In summary, UGI influences the urban quality of life and there is an interaction between UGI, ecosystem services, and social benefits, but the mere existence is not sufficient. UGI needs to be well structured to be both effective and beneficial to people (Böse, 1989; Sutter-Schurr, 2008).

The requirements for building-related open spaces in cities are high and diverse. On the one hand, there must be room for retreat, on the other hand, social contacts and communication should be promoted. Open spaces must be usable, (multi-)functional, aesthetic, of high quality and must not neglect ecological concerns (Brückner and Lüke, 2002; Schmitt, Sommer and Wiechert, 2014). However, these high standards must fit all users who have varying social affiliations, origins, cultural backgrounds, and different ages. The users' tastes and ideas of "their" open spaces are often diverse. In addition, they change in the course of their life situations. Open spaces must be able to meet all these demands and planners have to consider them. Well-functioning open spaces significantly contribute to housing satisfaction and in turn reduce tenant fluctuation (Fassbinder, 2017; Schmitt, Sommer and Wiechert, 2014).

The usability of open spaces is determined by their availability, accessibility and the possibility of appropriation – i.e. the possible behaviours of users within the open space. These conditions are linked to the spatial structures of the building since the position

of the buildings and their heights and shapes determine the size and proportion of the open space. Attribution to the buildings takes place, which determines the social character of the open space (public, semi-public, private) (Lička et al., 2012; Sutter-Schurr, 2008).

Urban planning and the development of building-related open spaces have to respond to people's subjective perceptions and demands. On the one hand, the composition of vegetation must be chosen in such a way as to create a functioning green system that can react to climate change and external influences by using nature's regenerative mechanisms (Fassbinder, 2017). On the other hand, the green and open spaces on the plot must not only be functionally designed, but also aesthetically harmonious.

1.3 Biotope City – the city as nature

The urban planning model "Biotope City – the city as nature" (Fassbinder, 2002) provides a promising basis in which it pursues the approach of using the regenerative mechanisms of nature (Fassbinder, van Helmond and Aarsman, 2004). It is a reaction to the changes in urban development caused by climate change and the increasing exposure to noise, particulate matter, and pollutants, especially in densely built-up areas. The urban development model includes quality guidelines as well as positive climatic effects, such as reduction of midsummer temperatures, rainwater retention, CO₂ emissions, and an improvement in biodiversity, through the increased use of greenery. Greenery as an integral component of the buildings, minimisation of sealing, green and open space design across all sites and tenant participation in planning and maintenance are among the quality approaches. The fusion of buildings and open space creates new urban typologies, which should form a resilient system against weather extremes. Thus, the quality of life should be improved sustainably and comprehensively.

The strategy of UGI to mitigate the effects of climate change is part of the urban planning model "Biotope City – the city as nature" (Fassbinder, 2002). It also calls for additional inter- and transdisciplinary planning processes in order to meet the challenges of the interfaces in open space. In this paper, the urban planning model "Biotope City – the city as nature" (Fassbinder, 2002) is analysed on the basis of the case study "Biotope City – Vienna".

2 Material and methods

Case Study “Biotope City – Vienna”

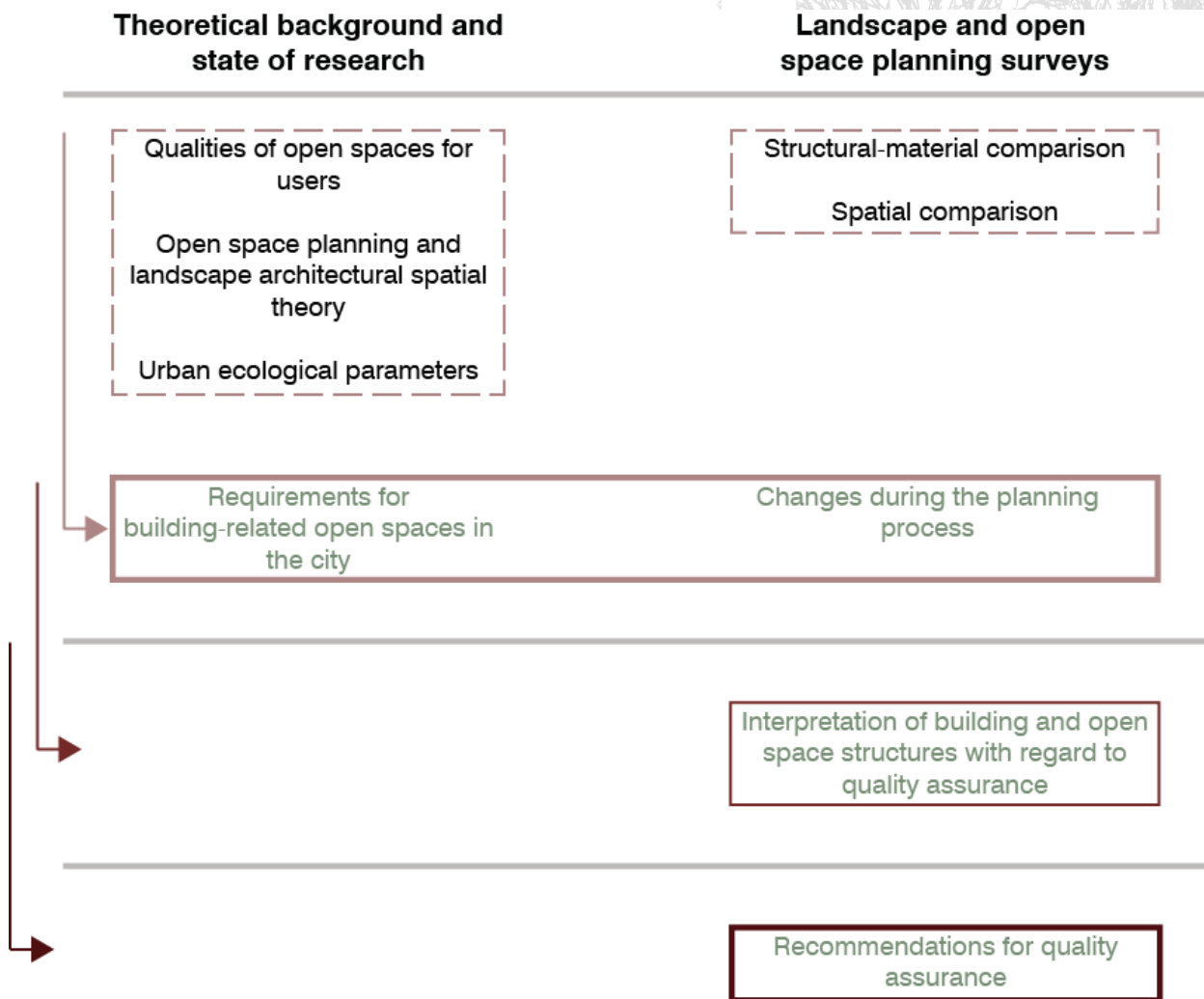
The planning area lies in the 10th district of Vienna. It is located in the former area of the Coca-Cola Company, on approximately 5.6 ha of sealed industrial area. The new urban quarter under the urban planning model “Biotope City – the city as nature” (Fassbinder, 2002) is the re-use of the industrial area and by 2020 approximately 950 new residential units, 730 jobs, areas for commercial use, community facilities, development areas, and a school, as well as a kindergarten, will be created (Glück et al., 2015; Studio Vlay, 2014).

The planning process for “Biotope City – Vienna” differs from conventional urban developments, because the urban planning model “Biotope City – the city as nature” (Fassbinder, 2002) was introduced from the very

beginning. Subsequently, an interdisciplinary planning team drew up a master plan with a quality catalogue in a cooperative planning procedure. The property developers have declared their willingness to comply with the criteria by making a voluntary commitment. The quality catalogue contains the Biotope City criteria – all those criteria that cannot be defined and prescribed in the zoning plan and development plan. The quality catalogue with the Biotope-City criteria can be regarded as a quality assurance instrument.

■ Methodological approach

The dimension of the study is the physical-material provision of urban open spaces on the basis of planning documents. This paper follows a case-study design, with in-depth analysis of changes in building-related, urban open spaces during the planning process (planning phases: master plan, preliminary



■ **Figure 1:** Research design
Source: Ring, 2018, own revision: 2019

draft, submission plan). The state of research, based on the theory of landscape and open space planning and urban ecological parameters, is combined with decomposition sketches as a landscape architectural method (Lička et al., 2012) to capture the different planning levels and elements of open spaces. The interdisciplinary approach was chosen to meet the complex requirements of ecological, climatic and social issues.

In the preceding Master's thesis (Ring, 2018), the requirements for building-related open spaces were developed on the basis of a comprehensive literature research. This paper summarises the most important findings. The literature research served as a basis for the selection of the criteria (path connections, materials, vegetation, spatial formation and division, and their zoning) for the plan comparisons. The three planning phases (master plan, preliminary draft, and submission plan) are divided into different components of the building and open space structures, which form the foundation for comparability and analysis. All three planning phases were compared with regard to these criteria in order to illustrate changes. Every single plan was prepared according to the relevant criteria by decomposition sketches. This paper focuses on material and vegetation comparison. In order to formulate suggestions for improvement in quality assurance, the changes were interpreted from the perspective of open space planning and contextualised with the theoretical background (planning theories) and the state of research regarding urban green infrastructure.

3 Results and discussion

3.1 Interpretation of building and open space structures on the basis of plan comparisons from the open space planning perspective

■ Material comparison

The structural-material comparison of each planning phase reveals changes in the planning process. Table 1 shows the main differences in numbers.

The proportion of vegetation is highest in the master plan and is reduced only slightly from the preliminary draft to submission plan, which is positive in terms of the importance of urban green infrastructure. The central result of the material comparison is the disappearance of the terraway and the increase in asphalt. As a result, the change in the surface materials increases the proportion of paved areas from the master plan to the submission plan from 38 to 51%. In summary, the unpaved area is reduced by 13 percentage points. As already explained, the choice of materials has an impact on the urban heat island effect and the sustainability of urban development projects (Susca Gaffin and Dell'Osso, 2011). The ecology and sustainability of construction projects can be controlled by the choice of materials, mainly because of the energy savings and the reduction of greenhouse gases (Hatvan et al., 2014). In addition to the ecologically negative feature that asphalt is a sealed surface from which the water must be drained, it has a higher energy balance, because it has to be heated for installation (Hatvan et al., 2014). According to a Viennese guideline (Preiss, 2011), asphalt has one of the worst ratings in terms

Table 1 Main differences of the materials

	Master plan	Preliminary draft	Submission plan
Asphalt (sqm)	4,299	3,785	8,751
In situ concrete (sqm)	8,255	7,383	693
Terraway (sqm)	2,625	2,449	–
Lawn (sqm)	17,663	11,616	9,711
Planting (sqm)	–	1,826	2,696
Concrete paving (sqm)	–	–	5,137
Paving (water-permeable) (sqm)	–	–	1,743
Total area of vegetation (sqm)	17,873	18,526	17,427
Sum of the sealed areas (sqm)	12,554	12,865	15,276
Sum of the unsealed areas (sqm)	20,711	16,689	14,856
Percentage of sealed areas	38	44	51
Percentage of unsealed areas	62	56	49

Source: Ring, 2018, own revision: 2019

of transport and fuel consumption, energy balance, durability, recyclability and runoff coefficient. Concrete pavement is also similar to asphalt from the ecological point of view. However, these are the two most frequently used materials among the sealed surfaces (see Table 1). This result is likely to be related to the cost pressure on open spaces and to cost-cutting measures. The change of pavement to asphalt, therefore, has a major impact on the overall ecological assessment of the “Biotope City – Vienna” area. There is abundant room for further progress in determining the reason for the change of pavement.

■ Vegetation comparison

What follows is an account of the different greening measures at the “Biotope City – Vienna” area and their interpretation. As can be seen from table 2 (below), the comparison reveals that the proportion of total vegetation is highest in the preliminary draft and lowest in the submission plan. The difference to the master plan is about 500 m². The number of trees, on the other hand, has increased in each planning phase up to the submission plan.

The comparison of plans shows that the “Biotope City – Vienna” quarter offers a broad spectrum of urban green infrastructure. In addition to lawns, shrubs, bushes, and trees, façade and roof greening is also used. A large part of the green areas is on naturally grown soil. The underground parking areas are located almost exclusively under the buildings. In some cases, they are two-storey in order to maintain as much pristine open space as possible (approximately 70% of the total open space). In comparison to other new

urban development projects, where often almost the entire open space is on underground car parks, this leads to positive effects on rainwater management and enables the use of large trees, since sufficient root zone is available.

■ Roof and façade greening

In the case of façade greening, the non-planted areas account for approximately 90%. The positive influence on the microclimate in urban areas can mainly be achieved by greening buildings (Kuttler, 2011; Wang, 2016). Façade greening is a complex system, as apart from fire police restrictions there are also uncertainties in planning and implementation with regard to technical execution, maintenance, plant knowledge and cost calculation (“ÖkoKauf Wien”, Arbeitsgruppe 25, Grün- und Freiräume, 2013). However, trough greening with trellises is being used more and more, as there is hardly any space for ground-based façade greening due to the shape of the buildings and the private gardens.

In the case of roof areas, the proportion of non-vegetated areas is smaller (~50%). A likely explanation is that roof greening, especially extensive roof greening, has been used in Vienna for several years and is state-of-the-art. Since June 2002, there is a green roof guideline “ONR 121131”. The construction method and costs are known and, therefore, minimise the risk for the developers in comparison to façade greening. However, the potential of green roofs has neither been fully exploited yet. In Vienna, only 5% of roofs suitable for green roofs, are greened (Hatvan et al., 2014). Green roofs and façades are particularly important in densely built-up urban

Table 2 Main differences in vegetation

	Master plan	Preliminary draft	Submission plan
Trees (new plantings) (pcs.)	223	271	295
Trees (existing) (pcs.)	–	20	15
Hedge (running metre)	597	808	830
Climbing plants (running metre)	–	–	596
Bushes (sqm)	–	1,405	1,241
Perennials and grasses (sqm)	–	716	1,455
Urban gardening (sqm)	210	221	123
Lawn (sqm)	15,837	13,374	10,980
Private gardens (sqm)	1,826	2,810	3,614
Total area of vegetation, ground floor (sqm)	17,873	18,526	17,413
Roof greening (%)	–	–	48
Façade greening (%)	–	–	12

Source: Ring, 2018, own revision: 2019



structures as they contribute to mitigating the UHI effect through shading and air purification (Vienna Environmental Protection Department – Municipal Department 22, 2018). They increase the proportion of urban green infrastructure in the city without taking up additional space. Their increased use should be encouraged. The comparison of roof and façade greening shows that there is a potential for increased use due to the high proportion of non-vegetated areas (90% and 50%).

3.2 Plan comparison with regard to quality assurance

The entire development project “Biotope City – Vienna” is based on the urban planning model “Biotope City – the city as nature” (Fassbinder, 2002), which involves the extensive use of urban green infrastructure and the use of nature’s regenerative mechanisms (Fassbinder, van Helmond and Aarsman, 2004). The project is new and innovative compared to other urban development projects in Vienna. By means of a quality catalogue, planners and developers have committed themselves to ensure that the “Biotope City – Vienna” criteria are actually implemented. In the implementation of innovative ideas or ideas that deviate from everyday planning processes, such as the urban planning model “Biotope City – the city as nature” (Fassbinder, 2002), the complexity of the coordination and cooperation process also increases (Reinwald et al., 2017; Selle, Sinning and Sutter-Schurr, 1997).

Open spaces are subject to high-cost pressure as they are built at the end of the construction phase. At this point, the money required has often already been used up (Lička et al., 2012). Especially because of the agreement to fulfil the “Biotope City – Vienna” criteria, there should be no loss of green infrastructure during the entire planning and implementation process. The plan comparison of the vegetation (see Table 2) has shown that from the master plan to the submission plan there is a decline in the total vegetation of around 500 m². Even though the compared plans are situated in the first third of the entire planning process, it was hypothesised that the greening measures changed successively with the progressing planning status. The most obvious finding of the comparison is that there is a reduction in vegetation areas even before the cost pressure on the landscaping work increases. This confirms that the mere existence of an urban planning model such as “Biotope City – the city as nature” (Fassbinder, 2002) is not sufficient to prevent a decline in green and open spaces. Taken together, these results suggest that the idea must be supported by the

entire team and above all by all external participants, property developers and property managers. This underlines the statement that the complexity of the coordination and cooperation process increases when innovative ideas, or ideas that deviate from everyday planning procedures, are implemented (Selle, Sinning and Sutter-Schurr, 1997). Therefore, quality assurance must be demanded by a formal planning instrument.

The differences in the level of detail of the plans (master plan, preliminary draft, and submission plan) can be attributed to the process-oriented development of urban development projects. For evaluation and quality assurance, it is, therefore, necessary to decide at which stage quality assurance measures should and can be taken. Difficulties arise, however, when an attempt is made to implement the urban planning model. It must be considered whether specifications can be given in adequate detail before the master plan is drawn up without negatively affecting the creative and innovative approach of the planners, or whether they will be introduced after the adoption of the master plan. If quality and quantitative requirements are demanded at a later stage in the planning process, it may be that the projects are so different that implementation of the required criteria is no longer possible. Taken together, these results suggest that the planning teams should be informed of the desired quality and quantitative criteria right from the very beginning. The recommendation is to embody the urban planning model at a strategic planning level. Then, the “Biotope City – Vienna” quality criteria should be introduced at the project level in order to be adaptable, specified and operationalized by the planning teams in the course of the planning process for the respective project. This grants design flexibility and more specifically, allows linking up with informal and formal planning instruments in order to demand and guarantee the desired quality. Despite these promising results, questions remain. Further research should be undertaken to investigate the challenges and potentials in coordination and, above all, the implementation of quality assurance for future urban development projects.

The main goal of the current study was to determine how to achieve quality assurance for quality and climate-sensitive open spaces. It seems as if the open space has to be able to do “everything” on various levels and for different users (see chapter 1.2). This shows that the mere presence of green is not sufficient without meaningful design and structuring. However, everything mentioned previously provides challenging conditions for urban planning and requires new approaches to provide high-quality open spaces. Open



spaces are important for people in two respects. They have an ecological function and a use value, if they can be used (Sutter-Schurr, 2008). From the point of view of open space planning, the residential location and the associated open space are seen as a place for coping with everyday life and as a space for human action (Böse, 1989). Consequently, the significance of open space must not be neglected, and it must not be ranked behind architecture. In order to meet the complex requirements of a sustainable open space, it makes sense to develop an instrument that includes quality and social criteria as well as ecological ones, since people and their demands are the central point of the open space planning theory. "When it is understood that nothing can be sustainably protected in urban landscapes where the majority of people live without the acceptance of these people the nature conservation research in cities must be orientated more to social aspects" (Breuste, 2004).

4 Conclusion

The effects of the growing population and the associated urbanisation lead to a decline in green and open spaces in cities. These results further support the idea of binding quality assurance.

As the plan comparisons showed, there are challenges in the implementation of some "Biotope City – Vienna" criteria and potential for more consistent adherence. The "Biotope City – Vienna" site is a pilot project and the added complexity of the planning process and the time and cost pressure on open spaces leave open questions regarding control possibilities. The sole requirement for checking is not sufficient. The quality criteria must be incorporated in formal planning instruments in order to be able to refer to them. The master plan with the quality catalogue is an informal planning instrument based on commitments. There is no clearly defined quality committee with decision-making authority to demand fulfilment of the criteria. Continued efforts are needed to make the importance of sustainable, urban open spaces more accessible to politicians, stakeholders, planners, developers, and residents in order to achieve a new way of thinking, and thus support implementation.

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