Transforming Heat Islands into Neat Islands

Jonas Lamberg, Filip Śnieg
Master Students
Institute of Environmental Planning
Leibniz Universität Hannover
https://doi.org/10.15488/5567

Introduction

The resilience of cities has become an important topic to be considered by authorities in planning (Myrivili 2017, oral). Nowadays, many cities need to face various problems caused by environment, such as earthquakes, heat islands or floods (ibid.). The case study takes place in the centre of the city of Athens, to which the main emphasis has been paid during the research. This place also has to fight the shock of heat waves that occur during summer seasons on a daily basis (ibid.). It is not only a challenge for planning authorities, but most importantly it affects people who live in such areas.

Therefore, the heat waves have a significant impact on Athens' neighbourhoods, as its occurrence makes those areas barely liveable for people (Papaioannou 2017, oral). It is mainly burdensome for the inhabitants of such districts, where the surrounding areas have not been improved in ages, have not followed the newest and more socially friendly standards, which could reduce heat islands and therefore provide inhabitants with more liveable places to live in, like the researched one (ibid.). The proposal of transforming the heat islands to neat islands in the central district of Athens focuses on the creation of new green and clean places, where people could gather together, but at the same time, these areas would be efficiently reducing the phenomenon of heat islands.

Analysis

To establish a concept and further possible actions, there is a necessity to conduct a detailed analysis of the designated area. The designated area to be analysed is located in the central part of the city of Athens (see Figure 1). Centrally located districts, such as the researched one, are more exposed to occur as a heat island, because of very densely built, crowded and highly populated areas (Papaioannou 2017, oral).

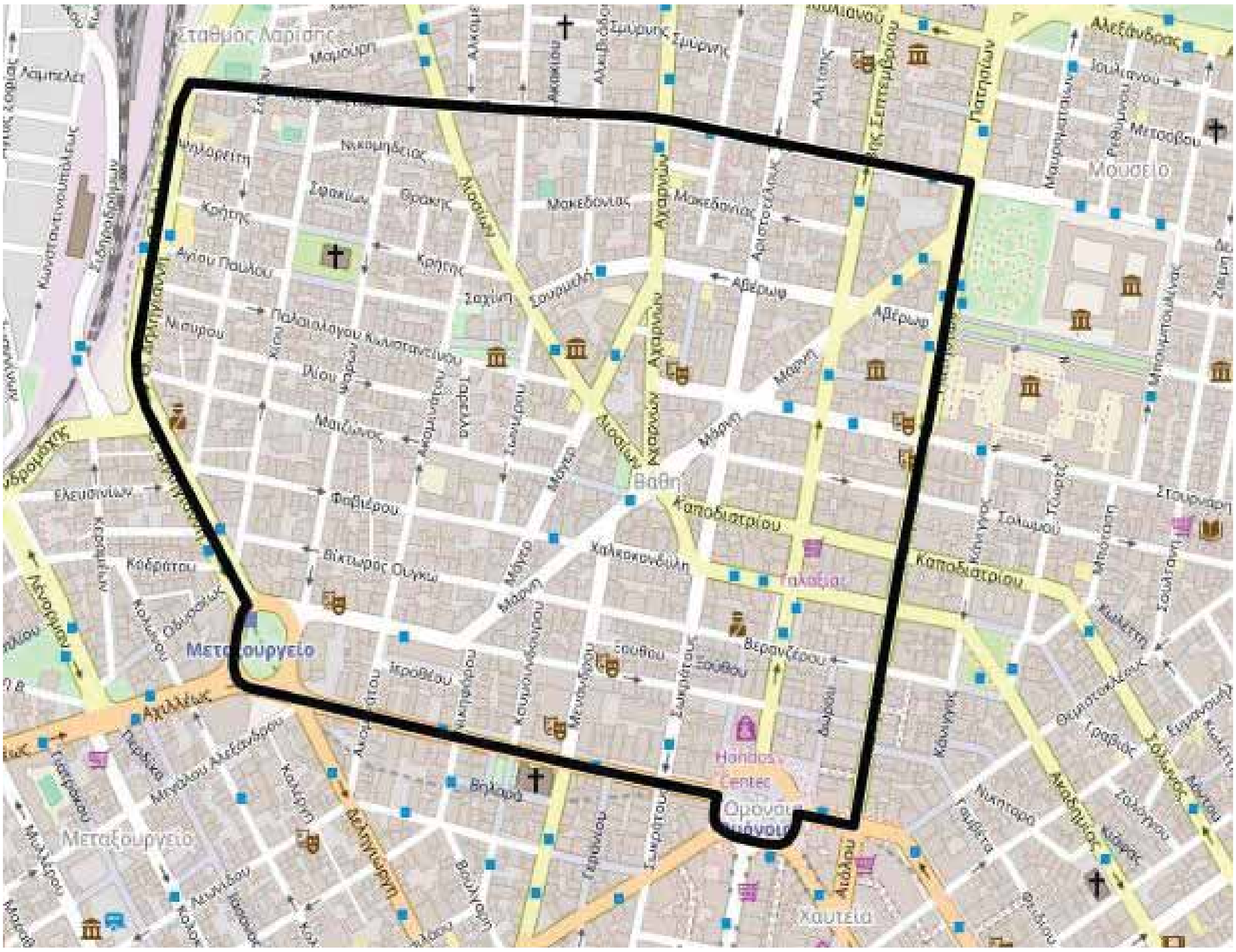

Figure 1: Borders of the Athens area (Source: Own Depiction based on Open Street Map 2017)

It is bordered to the south by the city center of Athens, where the Omonia Square is located (see Figure 1). It is a historically important place for Athens, because it was a crucial part and the final point of the famous visionary plan of Schaubert, that formed the new parts of the city of Athens in 19th century (Andriopoulos 2015, www). During the site visit, the Omonia Square appeared to be a vibrant and crowded place, where people of different social background could be seen, such as immigrants, business people as well as tourists and locals. Therefore, the place seemed to be the so called central part of the analysed area.

The Omonia Square, as being the main point, where five important thoroughfares meet, is always busy and full of car traffic (see Figure 2). Without a doubt, it has a significant impact on the occurrence of heat islands in this place.

Figure 2: The crowded streets of Omonia Square in May 2017 (Source: Own Photography)

To begin with the analysis, the necessity of designation of places with different characteristics appeared as the main step to move forward, while working on the resiliency against heat islands. During the site visit, the authors decided to divide the district into three "heat zones" - hot places, warm places and moderate places (see Figure 3)(see Table 1). The division and affiliation to the before-mentioned zones were based mainly on the existing crowd, car traffic, the occurrence of green areas and others.

Hot areas	**Warm areas**	**Moderate areas**
• High pressure on the area • A significant need for action! • Mainly primary roads are affected	• Medium pressure on the area • The existing squares, gardens and open spaces are affected	• Low pressure on the area • No need for a comprehensive change • Mainly secondary roads

Table 1: Determined division of the Districs and its characteristics (Source: Own Depiction)

Figure 3: The distribution of hot (red), warm (orange) and moderate areas (green) in the analysed district (Source: Own Depiction based on Open Street Map 2017)

The so called hot areas include the above mentioned central place of the district – Omonia Square, but this is not the only area to be considered as vibrant and crowded. The streets Agoiu Konstantinou (southern border of the area), 28s Oktovriou (eastern border of the area), as well as Marni, Acharnon and Liosion streets (main streets in central part of the area) (see Figure 3). If it comes to the main topic of the work, vulnerable places, as the above mentioned, are at the highest risk to be affected by heat waves. Not only the fact of being crowded and busy is taken into consideration, but also a low amount of trees and any other kinds of greenery, as well as its high and densely built streets. Therefore, crowded pavements, constant car traffic, lots of exhaust fumes, no greenery and low air circulation caused by the existing architecture favors the emergence of heat islands.

Moreover, many parts of the researched areas have been introduced as warm places, to which such areas like highly important side streets of the main thoroughfares in the eastern, northern and central parts of the districts are included (see Figure 3). Less busy streets and more green areas are the characteristics that create places friendlier for the inhabitants and at the same time reduce the vulnerability to heat waves (see Figure 4). Nevertheless, it does not negate the possibility of formation of heat islands. The warm areas are less vulnerable than hot areas. However, the authorities have to pay as much attention to them, so that the situation there does not get worse and eventually prevents from a higher risk and vulnerability to heat.

Figure 4: The so called warm place located in the norhtern part of the district (Source: Own Photography)

The least exposed areas are the so-called moderate places, which include all side streets in the western parts of the researched district (see Figure 3). They are characterised as places with low car traffic and a high number of trees that creates shadow, which is considered as necessary to limit the heat (see Figure 5). These streets do not need as many comprehensive changes as, in contrary, hot zones and some of the warm zones, because the pressure on them is much lower. Many abandoned and degraded buildings in the western part of the analysed area seem to have a crucial impact on the traffic situation, which notably contributes to the issue of heat islands.

Another important and final part of the analysis was determining the key characteristics of the district. As city resilience, and more specifically resilience to heat islands, is a complex term, therefore the key characteristics include various aspects, such as the current situation of the district's urban structure, social milieu and green infrastructure (see Table 2).

Figure 5: A side street in the western part of the analysed district: a moderate area (Source: Own Photography)

Key Characteristics

Urban structure	**Social milieu**	**Green infrastruc-ture**
• Dense urban structure • Multi-story buil-dings • Primary and secondary roads (main roads in one way streets) • Low quality of public space.	• High number of immigrants • Shaped by working class • Inhabited mainly by elderly people (a little number of child-ren)	• Partly green infra-structure • Conflict between green elements and public transport infrastructure • No connection bet-ween green spaces

Table 2: The key characteristics of the district based on conducted analysis (Own Depiction)

The key characteristics of the district have been divided into the three above mentioned aspects that should be taken into consideration to create the further concept of a resilient city. The urban structure on the analysed area varies a lot from each other. Nevertheless, the whole district is densely struc-tured, especially along the main thoroughfares and Omonia Square. Most of the area is built by multi-storey buildings, except of some parts in the western of the district, where many buildings are degraded and of lower quality.

Another covered aspect is a social milieu, which has a significant impact also the case of city resilience to heat islands. It is the society, who might need to change their habits to obtain predicted results. During the site visit, the authors established an average profile of the inhabitants, which is an immigrant from a working class. The central and western areas were mainly inhabited by elderly people, which might need more effort from authorities to change their habits during the process of introducing proposed actions.

The third aspect to be considered is the existing greenery. The district is quite well equipped with green areas. However, there is no link appearing between the existing ones. Nevertheless, there is a big potential for authorities to create a network of green spaces, which would have a positive impact on the perception of the area, as well as it could powerfully delimit the occurrence of heat islands. Currently no green infrastructure, such as green roofs or green walls, exists in the district, but the multi-storey building at the main roads could be a good base to start such investments.

The completed site visit has led to a meticulous analysis, which helped with understanding the covered area and eventually to achieve better results during the further work on concept and action plan. The researched area has a lot of potentials that are deeply hidden by now, but some actions might actually completely change the reality in central Athens.

Concept

A change of urban structures to reduce heat islands can have multiple effects. While the main goal is to reduce the air temperature, the quality of living can be generally improved. For instance, the implementation of green infrastructure primarily has a positive effect on the temperature. Furthermore, it has a very positive influence on the quality of public space in general. Improved microclimatic conditions result in better air quality. Trees and other plants create a more liveable environment. Therefore, it is more likely for inhabitants to spend time outside their buildings. As a result, the new urban environment is not only cooler than the old one, but also more attractive to use – a heat island is transformed into a neat island.

Planning with a scenario is a successful way to prepare urban neighbourhoods for the future (Schoemaker 1995). As increasingly urban heat islands are predicted in the case of neighbourhoods in Athens, the authors of this chapter defined three main goals to achieve improved living conditions in the case study area. These goals cover the three dimensions of economy, society and environment to achieve a comprehensive and inclusive concept.

The first goal is to reduce heat islands. According to the International Panel on Climate Change surface air warming will reach figures between 1.1 and 6.4 °C on a global stage until the end of the 21st century (IPCC 2007). Athens, in particular, is suffering from increased urban heat. As the optimal outdoor temperature to prevent temperature related deaths is defined as 17 °C (Hoyois et al. 2007), a change of the urban environment is required. Several actions are targeted. Opening the built environment towards existing green spaces can improve the flow of fresh air into the neighbourhood. Creation of 'green infrastructure' like green walls and roofs can have a positive influence on the local climatic conditions. Cities like Paris and Rotterdam are already successfully implementing large-scale green infrastructure in certain neighbourhoods (Mairie de Paris 2017, www; City of Rotterdam 2017, www). Several studies executed in cities with different climatic conditions such as Tel Aviv, Gothenburg, Bucharest and in several Japanese cities provide valid data concerning the effects of green infrastructure.

In a range of 100 up to 1000 meters, green infrastructure can force a cooling effect of 1-4.7 °C (Schmidt 2006). Especially trees are very effective (Rosenzweig et al. 2006). Data shows that a single tree is able to replace more than 10 air-conditioning units, which is equivalent to 20-30 kW power saving (Kravcic et al. 2007). Within research areas in different cities, green infrastructure was able to cool down the local air temperature up to 5.9 °C (Upmanis et al. 1998). Cooling effects resulted in energy savings up to 40% (Yukihiro et al. 2006). Additionally, the implementation of water springs and fountains is an effective tool to cool down urban heat islands. Due to the absorbing function of water, it functions as a heat buffer. "Water has an average cooling effect of 1-3 °C to an extent of about 30-35m. Water applications, in general, are more effective when they have a large surface, or when the water is flowing or dispersed, like from a fountain" (Kleerekoper, Van Esch, Salcedo 2012).

The second goal is an increasing resilience of the study area and in the long run of the whole city of Athens. From a governance point of view, the promotion of political willingness towards an active participation is necessary. Green measurements need to be supported. Funds must be given. The creation of a green economy must be supported proactively. Last but not least, the public, as well as nongovernmental organisations should be involved.

The third goal is defined as an 'environmentally friendly development'. It includes green education as well as different forms of incentives for environmentally friendly actors in the neighbourhood. As pointed out by Yukihiro et al. (2006), urban heat is related to a higher energy consumption. Therefore, solar panels and alternative modes of transport should be implemented. Several proposals for a new environmentally friendly public transport are proposed by the authors of this chapter. Main tools can be the introduction of electric cars, the development of the existing public transport network and the implementation of a comprehensive and connected bicycle network. Overall concepts are provided for example by Carlow and Yeon Wha (2016). A visual example is given in the following chapter.

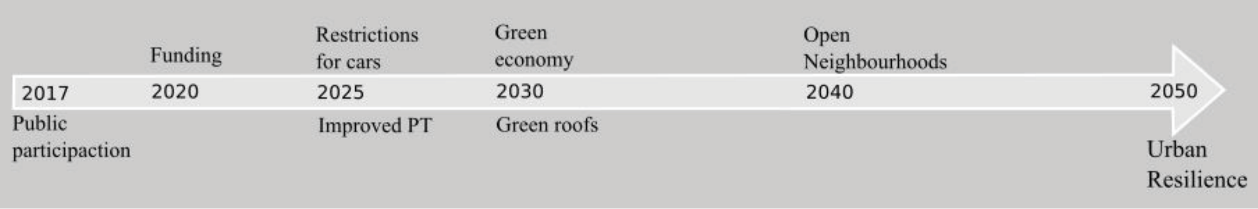

Figure 6: The timeline of predicted and planned actions (Source: Own Depiction)

Monitoring is an important tool to ensure the success of long term projects (see Figure 6). Schedules can help to ensure that certain steps are executed in time. In the case of the heat island strategy, public participation must be ensured from the beginning of the project. Funds must be created in the initial phase as well. Nevertheless, its implementation might be finished after three years. Transforming the built environment takes, even more, time and should be totally implemented after 25 years. The main goal for 2050 is a district that is totally resilient to urban heat islands. Impacts of climate change are lowered. Green spaces prevent high temperatures in public spaces. In the following subchapter, an example for the implementation is given.

As pointed out in the previous subchapter, economical, ecological and social framework conditions have to be mentioned when fighting urban heat islands. Nevertheless, the transformation of the built environment is the core action for changing heat islands to neat islands. The central area of the district, where warm and hot zones meet has been chosen for the introduction of the authors‘ action plan. It is an area, where busy car traffic throughout the day and one remotely is located and hardly reachable green space can be observed (see Figure 9). Moreover, within such a small area, three big sized parking places can be observed, whereas two of them are located on brownfield sites, which could be easily redeveloped (see Figure 9). Therefore, the authors decided to include the redevelopment of above-mentioned parking lots into a network of green areas in their plans (see Figure 8). Within the actions, the already existing green space should be upgraded by using local flora and is connected with the newly established ones.

A best-practice example is the Baana Foot- and Bikepath in Helsinki, Finland. Formerly used as a railway line, it is nowadays accessible for pedestrians and cyclists (see Figure 7). Opened in 2012, it provides a link between two major parks in the city centre of the finish capital (City of Helsinki 2017, www). The new urban space is equipped with local flora and fauna. Due to its different altitude, it is separated from car traffic. Compared to the road level, heat, noise and air pollution are effectively lowered.

Figure 7: The Baana Foot- and Bikelink in Helsinki, Finland (Source: Own Photography)

As seen in Helsinki, transformation of brownfield sites into urban green spaces can unlock a lot of potential. Small retail units like kiosks can compensate the loss of income formerly generated by brownfield sites functions. An additional incentive can be proposed by local authorities: costs for the brownfield owner can be demolished if the authority is in charge of the green space maintenance.

A creation of green infrastructure like corridors of trees between green spaces leads to a green network that covers the whole neighbourhood (see Figure 8). Last but not least, the installation of springs is an effective way to prevent heat islands and to lower its effects by decreasing temperature.

The proposed concept includes the upgrade of existing green spaces, the transformation of brownfield sites, as well as the connection of all relevant spots with green infrastructure. All these actions are based on and supported by governance actions that were explained in the subchapter before. They can lead to a decreasing urban vulnerability to heat and eventually reduce the risk of an occurrence of heat islands in the area proposed for the action plan.

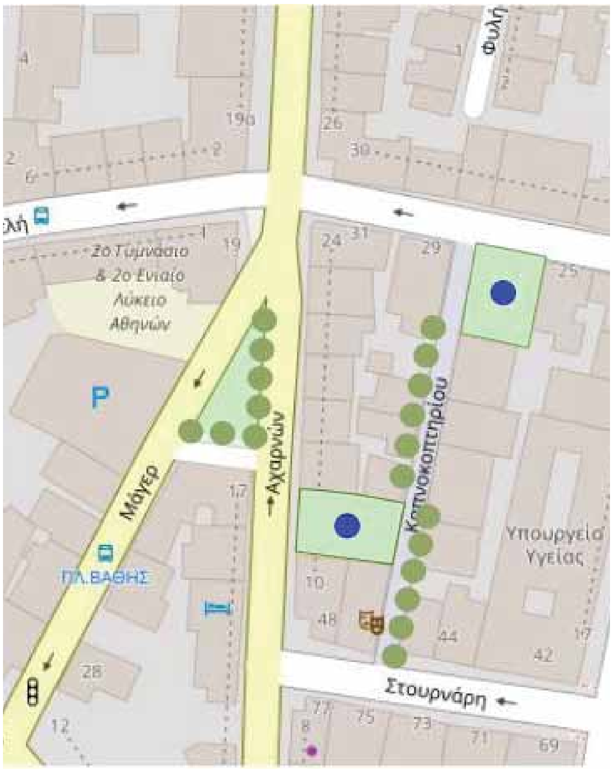

Figure 8: The vision of the central part of the analysed district (Source: Own Depiction based on Open Street Map 2017: www)

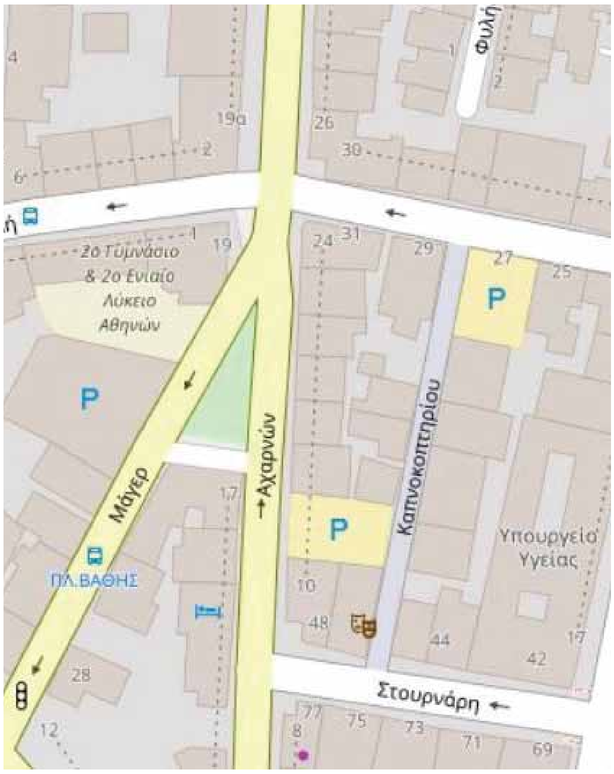

Figure 9: The current situation in the central part of the analysed district (Source: Open Street Map 2017: www)

Conclusion

The analysed district of the city of Athens is a vibrant and busy place that has many imperfections on different spheres. All, the economic, environmental and social situations, lack some stabilization, which would eventually lead to the full resilience of the whole area. To achieve it, there is a rapid necessity for actions from the authorities side. Nevertheless, it has to be followed by a detailed concept, participation and approval of local inhabitants.

The researched area has big potentials for changes, especially for those that can decrease the vulnerability for heat. Many degraded plots could be easily redeveloped into some more liveable places, but the ownership might be a tough issue to be solved during planning processes. However, as mentioned before, offering incentives for owners could potentially terminate problems that arose. As seen (see Figure 3), currently approximately half of the area is strongly exposed to the heat. Therefore, without any undertaken actions, the situation in the district regarding the heat islands will most likely deepen. The solutions proposed by the authors, if brought into reality, could diametrically change the perception of the areas and the heat that appears every summer in the Greek capital city. To achieve this, some drastic changes, high capital expenditure, and the determination of the authorities and citizens are needed.

Bibliography

ANDRIOPOULOS, T., 2015: Omonia Square as a limit and narrator. URL: http://www.athenssocialatlas.gr/en/article/omonia-square/ (last access: 28.07.2017)

CARLOW, VANESSA MIRIAM AND HONG, YEON WHA: Generic Design Tools to Produce Site Specific Solutions: Three Projects. In Wang, Fang and Prominski, Martin (2016): Urbanization and Locality. Berlin, Heidelberg

CITY OF HELSINKI, 2017: Baanat, Helsingin kaupunki. URL: https://www.hel.fi/helsinki/fi/kartat-ja-liikenne/pyoraily-ja-kavely/pyorareitit/baanat (last access 25.09.2017)

CITY OF ROTTERDAM, 2017: Waterplan2. URL: https://www.rotterdam.nl/wonen-leven/waterplan-2/ (last access 31.07.2017)

HOYOIS P, BELOW, R, SCHEUREN J-M, GUHA SAPIR D., 2007: Annual Disaster Statisctical Review: Number and Trends 2006 (Centre for Research on the Epidemiology of Disasters (CRED), School of Public Health, Catholic University of Louvain Brussels, Belgium, Brussels.

IPCC, 2007: An Assesssment of the Intergovernmental Panel on Climate Change, Summary for Policy Makers.

Kleerekoper, L.; van Esch, M.; Salcedo, T. B., 2012: How to make a city climate-proof, addressing the urban heat island effect. Published in Resources, Conservation and Recycling. 64. pp. 30-38.

Kravcíc M. Pokorny, Kohutiar J, Kovác M, Tóth E., 2007: Water for the recovery of the Climate – A New Water Paradigm Publication from partner cooperation between the People and Water NGO, the Association of Towns and Municipalities of Slovakia, ENKI and the Foundation for the Support of Civic Activities.

Mairie De Paris, 2017: Végétalisation des toitures-terrases. URL: https://www.paris.fr/duvert presdechezmoi (last access 31.07.2017)

Myrivili, E. (100 Resilient Cities - Athens): Oral statement. 23.05.2017

Open Street Map, 2017: Athens, Greece. URL: https://www.openstreetmap.org/#map=16/37.9872/23.7226 (last access 25.05.2017)

Papaioannou, M., (National Technical University of Athens - PhD Candidate): Oral statement. 22.05.2017

Rosenzweig, C., Solecki, W., Slosberg, R., 2006: Mitigation New York City's Heat Island with Urban Forestry, Living Roofs and Light Surfaces. New York State Energy Research and Development Authority.

Schmidt, M., 2006: The contribution of rainwater harvesting against global warming. London, UK: Technische Universität Berlin, IWA Publishing. In: Kleerekoper, L.; van Esch, M.; Salcedo, T. B. (2012): How to make a city climate-proof, addressing the urban heat island effect. In: Resources, Conservation and Recycling 64, p. 31.

Schoemaker, Paul J.H., 1995: Scenario Planning: A Tool for Strategic Thinking. Pennsylvania, p. 29 ff.

Sehested, K., 2009: Urban Planners as Network Managers and Metagovernors. In: Planning Theory & Practice, 10:2. pp. 245-263.

Upmanis H, Eliasson I, Lindqvist S., 1998: The influence of green areas on nocturnal temperatures in a high latitude city (Goteborg, Sweden). International Journal of Climatology, 18:681-700.

Yukihiro K, Yutaka G., Hiroaki, K., Keisuke H., 2006: Impact of city-block-scale countermeasures against urban-heat phenomena upon a building's energy-consumption for air-conditioning. Applied Energy 2006;83:649-668, Elsevier.