

## Chapter 5

# Blue–Green Infrastructure for Heat Exposure Mitigation: Alexandria, Egypt

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### **ABSTRACT**

*Global and regional warming phenomena drive the effect of climate change on cities. Research on urban heat adaptation strategies has been growing, with many studies concentrating on blue and green infrastructure (BGI) as an alternative to grey infrastructure and to minimise the adverse effects of urban heat islands. Building upon investigating the case of Germany, this chapter presents mitigation strategies for Alexandria, Egypt that can reduce the temperature at the urban design level and identify urban heat island effects through BGI and their performance, as well as their importance in achieving sustainable urban development and low-temperature cities. The lessons learned show that BGI is a new approach to city planning that can minimise the impact of human development on functioning natural systems, the quality of life, and the economic consequences. A set of BGI guidelines for Alexandria on how to keep cities cool and improve the city's environment were agreed upon.*

### **INTRODUCTION**

Rapid changes in global temperature trends and climate have resulted due to the increase of greenhouse gases in the Earth's atmosphere. These changes are predicted to have significant safety, security and health effects, in addition to disrupting daily lives and causing environmental losses in urban areas. Another recent phenomenon

DOI: 10.4018/978-1-6684-2462-9.ch005

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that has exacerbated this issue is the Urban Heat Island (UHI) effect, where a metropolitan area can be on average 1.0-6.0°C warmer than nearby non-urban areas (Dimoudi, Kantzioura, Zoras, Pallas and Kosmopoulos, 2013).

According to research, cities currently account for 60-80% of the world's overall energy usage (Chaoui, 2009). It was also mentioned that UHI is a crucial factor that affects heating and cooling loads in buildings, and thus urbanization has a significant impact on energy consumption. Since it has been estimated that the ratio of the world's urban population to the total population is expected to rise from 54% in 2016 to 60% in 2030 (United Nations, 2016). Therefore, UHI is expected to become a severe problem in the future of urban life.

The natural land cover is converted to built surfaces that trap the incoming solar radiation during the day and then re-radiate it at night. As a result, urbanization demand created a decline in vegetated areas and increased the built-up surfaces. Consequently, there has been a severe loss of green spaces to an artificial environment. For this reason, there have been an increase in study on urban heat (UH) adaptation measures, with many pieces of research focusing on blue and green infrastructure (BGI) as an alternative method to grey infrastructure (GI) and a tool to reduce the negative impacts of urban heat island (UHI).

At the local level, blue-green infrastructure has been highlighted as a “best practice” for generating greater resilience and sustainability. It is increasingly recognized and valued as a solution for addressing the urban water and green challenges posed by current climate variability and urbanization and reinforcing the cities to future change. In addition, the implementation of BGI is driven by the need to minimize urban heat and improve thermal comfort in towns. Environmental concerns in urban planning are not a new concept, and they have played a leading role in the evolution of planning theory and practice. Still, the idea of blue-green infrastructure is relatively new.

Humans cause not only environmental problems in Alexandria city, Egypt, but climate change poses significant threats, mainly heat stress in urban areas and an increase in urban heat islands, both of which have a considerable influence on the city's inhabitants. This is due to the city's high-density buildings and streets accommodating a large population. Urban expansion threatens land supply, causes traffic volume growth, increases pressure on the environment, and makes the city unsustainable. Thus, like many other cities, Alexandria faces the problem of climate change, the force of scarcity of resources, high pollution and severe environmental degradation, which cause dangers to human health. Consequently, the lack of reaction to these issues will have disastrous problems.

These problems were observed along the Mahmoudiya Canal (west of Alexandria city), a central concern in all Alexandria's Governorate plans for the past 40 years. There has never been a plan or strategy that consider microclimate conditions that

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