BRIEFING NOTES ON THE CIRCE URBAN CASE STUDIES: OVERVIEW

These notes provide an overview of the three urban case studies chosen to assess the integrated impacts of climate change in the Mediterranean area. Separate briefing notes are available for each case study: Athens (Greece), Beirut (Lebanon), and Alexandria (Egypt).

1. Justification

The Mediterranean Sea connects the coastlines of countries in Europe, the Middle East and North Africa, making the region environmentally and culturally unique and diverse. It is along this coastline that many of the cities of the ancient world were founded. These cities, especially those in the east and the south of the region, currently face multiple challenges. Heatwaves and flash floods, health effects of air pollution, saltwater intrusion, and an inadequacy of energy and water resources, are among some of the problems expected to intensify under climate change. The urban case studies provide an excellent opportunity for using an integrated and multi-scale (temporal and spatial) approach. In the spatial dimension, work will extend from the inner city boundaries to the surrounding mountains, coastal or forested areas. In the temporal dimension, research will extend from the observed time period (using available meteorological and sector data) to future time periods using model output from several climate change projections. In addition, a multi-sector approach to climate change impacts will be adopted. The impacts covered will range from direct climate impacts on natural ecosystems to indirect impacts resulting from cascading climate-social-economic linkages. Potential adaptation measures will be examined across impact sectors for each case study.

2. Key hazards and vulnerabilities

Climate projections for the Mediterranean suggest that the region will become warmer and drier with more frequent and extreme weather events. This presents a threat to urban areas in the form of increased risks of flash floods and heatwaves. These climate hazards will inevitably aggravate other environmental issues, such as water resource availability, saltwater intrusion, air pollution and peri-urban forest fire risk. Socio-economic sectors will also be impacted. Human health will be a major issue of

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concern under climate change together with the challenges of rising energy demand for cooling and shifts in the seasonal pattern of tourism. While flash floods are mainly a hazard for the northern Mediterranean cities and saltwater intrusion a threat for low-lying and deltaic areas, the other climate, environmental and socio-economic hazards and threats are common to all urban areas in the Mediterranean.

Vulnerability to climate change is greater for urban areas in the south and east of the region with their limited economic resources, rapid population growth and poor planning and regulation. Therefore it is from this area of the Mediterranean that the urban case studies have been selected: Athens in Greece, Beirut in Lebanon and Alexandria in Egypt (Figure 1).

3. The case studies

Athens, Greece is a large metropolitan city with around 4 million inhabitants and a densely populated urban area with few green open spaces. The topography of the city, surrounded by mountains, favours the formation of air pollution episodes during periods of anticyclonic circulation. The city is prone to heatwaves in the summer and floods during heavy precipitation events. Impacts of climate change extremes and air pollution on human health, tourism, energy demand and peri-urban forest fire risk will be examined in this case study.

Beirut, Lebanon is the largest metropolitan area in Lebanon with around 2 million inhabitants, nearly half of the country's population. It is a densely populated urban area renowned for problems of water shortage. In addition to the pressures of high population growth, water demand has been rising in response to the growth in

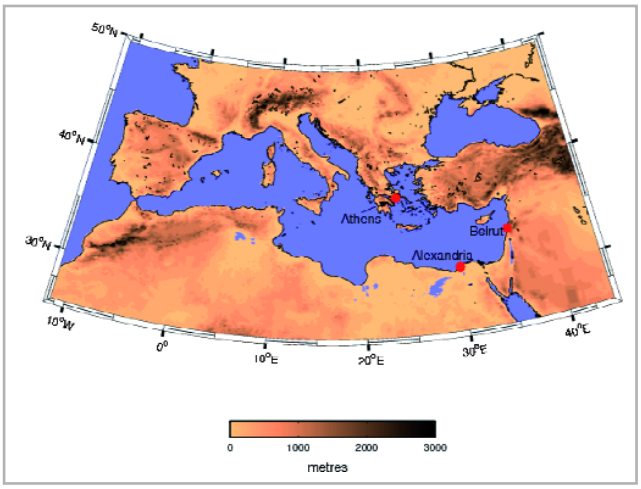
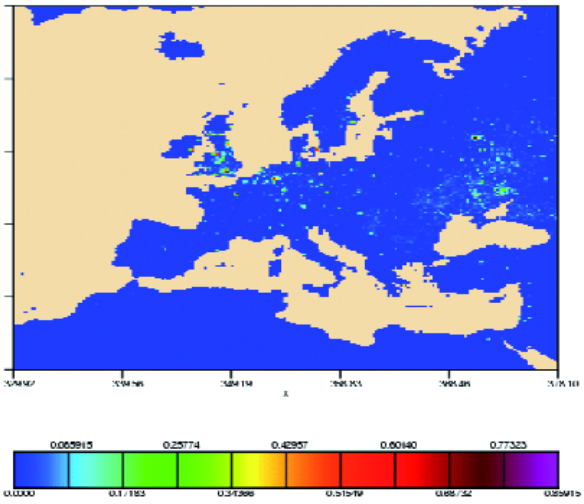


Figure 1: Location map of the three urban case studies: Athens, Beirut and Alexandria

Box 1

Urban heat island modelling at the Hadley Centre

Climate model resolution tends to be much lower than the scales required to explicitly capture urban heat islands, and higher resolution models cannot practically be run for extended periods of time. The Hadley Centre regional climate model (HadRM3) runs at a much higher resolution (25km) than global climate models for a limited area, in this case Europe and the Mediterranean. The influence of global climatic change is introduced at the boundaries and by prescribing sea surface temperatures. Even at this resolution the urban areas are poorly represented, as shown below. To address this, the Hadley Centre uses a 'tiled' surface scheme. Each grid box is represented as a mix of nine different surface types, one of which is urban. The heat and moisture exchange between the surface and atmosphere is then determined for each surface type. In this way sub-grid scale urban areas and their feedback on the local and regional climate are directly accounted for. The same urban scheme is used within the Met Office numerical weather prediction suite, and has been shown to improve urban temperature forecasts. The combination of the regional climate model and the 'tiled' surface scheme provide an important link between large-scale features of climate change, and their potential impacts on localised environments such as found within cities.



The fraction of each 25km grid box of the Hadley Centre Regional climate Model (HadRM3) over the European domain that is classified as being of urban surface type

tourism and industrial development.
Consequently, Beirut experiences an acute water deficit leading to intermittent supply in most areas, coupled with a lack of piped water supply to a large number of poor areas. This case study will assess the socio-economic implications of rising water demand and deteriorating water quality associated with climate change, and the development of adaptation and conservation strategies.
Alexandria, Egypt is the largest city in the West Nile Delta with a population of over 3.5 million. The Greater Alexandria area is an important resource for agriculture, tourism and industry, but suffers from severe environmental pollution and a lack of environmental monitoring and regulation. Its deltaic location makes the city vulnerable to sea level rise due to climate change and saltwater intrusion. An exploration of possible adaptation options and an evaluation of the socio-economic problems impeding sustainable development in the region will be undertaken.

4. Main climate threats

Increased frequency of heatwaves and persistence of high temperatures and dry weather are the key aspects of climate change common to all urban areas.
Urbanization itself greatly affects surface characteristics and their interaction with the wider atmosphere. This leads to distinct urban climates that differ substantially from rural environments. The most apparent consequence of this is the urban heat island. The capacity for the built environment to store heat during the day and release it at night, along with the direct release of heat through human activity (for example heating or cooling of buildings, traffic, and human metabolism) can contribute to higher temperatures within cities compared to their rural surroundings. The urban heat island is also sensitive to the ambient weather and climate.
Non-linear associations between the urban heat island and climate result in a requirement for the inclusion of cities within climate models (Box 1).

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