BRIEFING NOTES ON THE CIRCE URBAN CASE STUDIES: BEIRUT

Summary

- *Beirut is a densely populated city which experiences acute water deficits leading to intermittent supply in many areas.*
- *Urban areas are particularly vulnerable to climate change due to an anticipated increase in water demand for domestic and industrial consumption. Sensitivity to climate change is heightened by poverty, poor access to clean water and sanitation, and a lack of environmental regulation.*
- *Microbial contamination of drinking water is frequent during periods of water shortage when consumers abstract water from private wells or purchase water from unregulated water vendors.*
- *The potential adverse health impacts of climate change are associated with deteriorating water quality and salt-water intrusion (from sea-level rise and groundwater abstraction).*

1. Physical and socio-economic characteristics

Water resources in Lebanon are vulnerable to increasing temperatures and changes in precipitation patterns. While the country has better water resources per capita relative to other countries in the region, it will still be unable to meet its local demand by 2025 (MoE, 2001). In urban areas in particular, domestic water demand is expected to increase due to higher temperatures and climate change is likely to further exacerbate existing water shortages (Bou-Zeid and El-Fadel, 2002). The latter might have serious socio-economic consequences associated primarily with the health impacts of deteriorating water quality and salt-water intrusion arising from increased groundwater pumping and/or sea-level rise. In this context, the Greater Beirut area (Figure 1) has been selected to evaluate the potential water-related health impacts associated with climate change. Greater Beirut 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 (Yamout and El-Fadel, 2005). In addition to pressures of high population growth, water demand has been rising in response to tourism and industrial development. Consequently, Beirut experiences an acute water deficit leading to intermittent supply in most areas (10 hrs of supply every other day

in the summer), coupled with a lack of piped water supply to a large number of poor areas. Climate change is likely to further exacerbate this situation.

In response to the shortage or absence of a public piped-water supply, consumers resort to pumping water from private wells, which increases salt-water intrusion, and/or purchasing water from small-scale private water providers, more commonly known as water vendors who operate without proper regulation particularly in poorer areas. In both cases, water supplies are often contaminated resulting in serious adverse health impacts. Recent statistics reported by the Central Laboratory (Beirut) revealed a microbiological contamination of 24 percent of 403 samples collected from water vending companies, and 40 percent of 863 samples collected from potable water networks in various regions across Lebanon[1]. Moreover, of 450 samples collected from groundwater and springs, 37 percent were reported to be microbiologically contaminated (Table 1).

2. Justification

The Greater Beirut area accommodates nearly half the population of

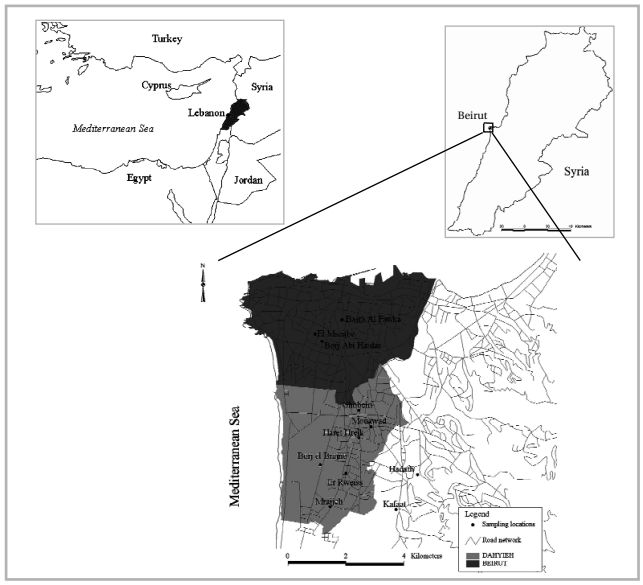

Figure 1: Beirut study area location

[1] *Note that these samples were collected from houses and not from the network itself, indicating that the source of pollution could have occurred anywhere between the point of delivery from the network to the point of collection.*

the country of Lebanon and is undoubtedly more vulnerable to potential climate change due to its coastal location, pre-existing poor quality of drinking water, and present and future water shortages. In addition, as the capital of the country it has more data available than other locations and it is more likely that decision makers and influential stakeholders will be accessible.
Several initiatives have been conducted to evaluate water quantity needs including the potential increase in demand linked to rising temperatures (El-Fadel and Bou Zeid, 2002; Yamout and El-Fadel, 2005). Similarly, water quality monitoring and characterization is an on-going effort. Mortality and morbidity data are relatively limited for health impact assessments of water quality, but are available at a national and annual level and can be extrapolated to the study region.

3. Key research issues

The potential health implications associated with water shortages and deterioration in water quality constitute the key research issues. The potential pressures of climate change are set within the context of other serious social and environmental pressures such as high population growth rates coupled with poverty, a general lack of environmental awareness, limited access to clean

	Water source			Total
	Bottled water	Network water	Ground water	
Samples exhibiting microbiological pollution	97 (24%)	345 (24%)	450 (37%)	892 (36%)
Total number of samples analyzed	403	863	1,215	2,481

Table 1: Results of water analysis by the Central Laboratory (Al-Safir, 2002)

Water tanks within shops

water and sanitation, and a drive towards industrialization with no environmental controls.

4. Key areas of integration

This case study will focus primarily on the assessment of the socio-economic implications of higher water demand and deteriorating water quality associated with climate change, and the development of adaptation and conservation strategies which take into account country-specific characteristics. It is expected that these strategies will include water allocation for competing sectors and water quality regulatory standards for water vending. Other sectors potentially influenced by climate change include air quality, tourism, coastal inundation, erosion and flooding, but these will not be the focus of this case study.

Water tanks provided by political organisations

Mobile water trucks

5. Regional stakeholders, policy makers, institutions

Public entities:

- Council for Development and Reconstruction
- Ministry of Energy and Water
- Ministry of Public Health
- Ministry of Environment

Municipalities:

- Non-governmental organizations
- National Council for Scientific Research
- Academic institutions and universities
- Private consultants
- General public of Greater Beirut

7. Data availability

The main data required for the case study is related to drinking water quality indicators partic-

References

- Al-Safir 2002, Official examinations confirm water pollution, In *Al-Safir Newspaper*, February 14, 2002 (in Arabic)
- Bou-Zeid E. and El-Fadel M. 2002, Climate change and water resources in the Middle East: A vulnerability and adaptation assessment, *ASCE, Journal of Water Resources Planning and Management,* 128, 5, 343-355. Available online from: http://infoscience.epfl.ch/getfile.py?docid=11604&name=Bou-Zeid%20and%20El-Fadel%20-%202002%20-%20JWRPM%20-%20improved%20graphics&format=pdf&version=1
- El-Fadel M., Maroun R., Semerjian L. and Harajli H. 2003. A health-based socio-economic assessment of drinking water quality: the case of Lebanon. *Management of Environmental Quality,* 14(3): 353-368. Available from: http://www.emeraldinsight.com/Insight/ViewContentServlet?Filename=Published/EmeraldFullTextArticle/Pdf/0830140304.pdf.
- MoE (Ministry of Environment) 2001, *Lebanon: State of the environment Report,* Ecodit, Beirut, Lebanon, 240 pp. http://www.moe.gov.lb/ledo/soer2001.html
- Yamout G. and El-Fadel M. 2005, An optimization approach for multi-sectoral water supply management in the Greater Beirut Area. *Water Resources Management,* 19, 6, 791-812. doi: 10.1007/s11269-005-3280-6

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ularly vectors of waterborne diseases, economic indicators related to income distribution, health costs, population structure and age distribution. While some data (limited in nature compared to records in EU countries) can be collected from various ministries, academic institutions, and international organizations with a reasonable degree of scientific certainty, other data are expected to be less reliable particularly those related to heath.
The latter is likely to present a limitation to the case study due to under-reporting of actual health impacts. The other more significant limitation will be the difficulty in separating impacts associated with climate change from those related to sanitation and hygiene practices. In addition, the availability of data are likely to be sporadic because monitoring systems are virtually absent in Lebanon. While comprehensive field surveys are beyond the scope and resources of this case study, future needs will be outlined.

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