

EGU22-7164

<https://doi.org/10.5194/egusphere-egu22-7164>

EGU General Assembly 2022

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Seismic and air monitoring observatory for greater Beirut : a citizen observatory of the "urban health" of Beirut

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Already sensitive because of its geology (seismic-tsunami risk) and its interface between arid and temperate ecosystems, the Mediterranean Basin is being transformed by climate change and major urban pressure on resources and spaces. Lebanon concentrates on a small territory the environmental, climatic, health, social and political crises of the Middle East: shortages and degradation of surface and groundwater quality, air pollution, landscape fragmentation, destruction of ecosystems, erosion of biodiversity, telluric risks and very few mechanisms of information, prevention and protection against these vulnerabilities. Further, Lebanon is sorely lacking in environmental data at sufficient temporal and spatial scales to cover the range of key phenomena and to allow the integration of environmental issues for the country's development. This absence was sadly illustrated during the August 4th, 2020, explosion at the port of Beirut, which hindered the effective management of induced threats to protect the inhabitants. In this degraded context combined with a systemic crisis situation in Lebanon, frugal innovation is more than an option, it is a necessity. Initiated in 2021 within the framework of the O-LIFE Lebanese-French research consortium (www.o-life.org), the « Seismic and air monitoring observatory for greater Beirut » (SMOAG) project aims at setting up a citizen observatory of the *urban health* of Beirut by deploying innovative, connected, low-cost, energy-efficient and robust environmental and seismological instruments. Through co-constructed web services and mobile applications with various stakeholders (citizens, NGOs, decision makers and scientists), the SMOAG citizen observatory will contribute to the information and mobilization of Lebanese citizens and

managers by sharing the monitoring of key indicators associated with air quality, heat islands and building stability, essential issues for a sustainable Beirut.

The first phase of the project was dedicated to the development of a low-cost environmental sensor enabling pollution and urban weather measurements (particle matters, SO₂, CO, O₃, N₂, solar radiation, wind speed, temperature, humidity, rainfall) and to the development of all the software infrastructure, from data acquisition to the synoptic indicators accessible via web and mobile application, while following the standards of the Sensor Web Enablement and Sensor Observation System of the OGC and to the FAIR principles (Easy to find, Accessible, Interoperable, Reusable). A website and Android/IOS applications for the restitution of data and indicators and a dashboard allowing real time access to data have been developed. Environmental and low-cost seismological stations (Raspberry Shake) have been already deployed in Beirut, most of them hosted by Lebanese citizens. These instrumental and open data access efforts were completed by participatory workshops with various stakeholders to improve the ergonomics of the web and application interfaces and to define roadmap for the implantation of future stations, consistently with most vulnerable populations identified by NGOs and the current knowledge on the air pollution and heat islands in Beirut.

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