Urban Climate 14 (2015) 370–382

Contents lists available at ScienceDirect

Urban Climate

journal homepage: www.elsevier.com/locate/uclim

Mobile technologies and services for environmental monitoring: The Citi-Sense-MOB approach

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ARTICLE INFO

Article history:
Received 17 February 2014
Revised 30 July 2014
Accepted 2 August 2014

Keywords:
Citizens' Observatory
Participatory sensing
Urban environment
Air quality
Low-cost sensors
Mobile platforms

ABSTRACT

The impact of mobile technologies on the Citizens' Observatory in the areas of air quality, environmental health and climate change, has the potential to significantly improve data coverage by the provision of near-real-time high-resolution data over urban areas. The Citi-Sense-MOB Citizens' Observatory will be part of an environmental health monitoring system and environmental health knowledge base, created from information provided by GNSS (Global Navigation Satellite Systems) signals such as GPS (Global Positioning System) and Citizens' Observatory data. The main objective of Citi-Sense-MOB is to support green growth and sustainable development in Oslo, Norway, by providing citizens and authorities with information on transport, CO_2 emissions and air quality. This paper presents the approach used to develop the information value chain necessary to the success of Citi-Sense-MOB, from the sensor platform and architecture to the products and services

Abbreviations: GNSS, Global Navigation Satellite Systems; GPS, Global Positioning System; GPRS, General Packet Radio Service; WFS, Web Feature Service Interface Standard; RDF, Resource Description Framework; GIS, Geographic Information System; ICT, Information and Communication Technology; GEOSS, Global Earth Observation System of Systems; VGI, Volunteered Geographic Information.

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http://dx.doi.org/10.1016/j.uclim.2014.08.002

supporting participatory governance through the Citizens' Observatory concept.

1. Introduction

The quality of the environment within urban areas is of vital importance. Urban and peri-urban growth is increasing, and Europe is now one of the most urbanized continents in the world. Today, more than two thirds of the European population lives in urban areas and this proportion continues to grow (EC, 2011).

Air pollution is one of the factors negatively affecting quality of life within cities. The European Union (EU) has made some progress over the past decades in reducing atmospheric pollutants, but a recent report published by the European Environment Agency (EEA, 2013) shows that many areas of Europe have persistent problems with outdoor concentrations of particulate matter (PM), nitrogen dioxide (NO_2) and ground level ozone (O_3). In 2011, 33% of the urban population in Europe was exposed to concentrations of PM_{10} (PM with size up to 10 microns) in excess of the EU daily limit value, and 15% were exposed to $PM_{2.5}$ (PM with size up to 2.5 microns) concentrations above the EU target value set for the protection of human health (EEA, 2013). For NO_2, about 5% of the EU population was exposed to levels exceeding the annual mean limit value. The method commonly employed to calculate human exposure to pollutants considers the entire urban population as potentially being exposed to the city average concentration, which is measured at urban background monitoring stations. However, because in some European cities many people live in close proximity to traffic, the percentage of city residents exposed to PM and NO_2 levels above the limit values is likely to be higher than the estimated values published in the report (EEA, 2013).

In cities, road traffic is the dominant local source of pollution, along with domestic combustion, which has been growing over the last few years (EEA, 2013). At the same time, private vehicle use in Europe is growing, and a further doubling of traffic is predicted by 2025 (EC, 2014). Air pollution and exhaust emissions from traffic have been classified as carcinogenic (WHO, 2013). Studies show that traffic-related air pollution may cause major adverse health effects in the population living at or near air polluted roadways (Padmanabhan and Glenn, 2009). According to a recent International Agency for Research on Cancer (IARC) review, exposure to air pollution increases the risk for lung and bladder cancer (IARC, 2013). Based on a synthesis of the best available evidence, the HEI (Health Effects Institute) identified that an exposure zone, within a range of up to 300–500 metres from a major road, is the area most highly affected by traffic emissions (HEI, 2010). Studies are thus needed to characterize personal exposure to traffic-related air pollution, and to better understand the link between traffic-related air pollution and public health effects (Liu et al., 2013).

Additionally, traffic emissions also play a key role in carbon dioxide (CO_2) emissions. Energy consumption in urban areas – mostly in transport and housing – is responsible for a large percentage of CO_2 emissions. Because of their larger consumption of fossil fuels, cities emit 76% of the world's energy-related CO_2 (EC, 2011). Consequently, cities are key players in efforts to reduce CO_2 emissions and mitigate the effects of climate change (EC, 2011). Monitoring road traffic and associated efforts to devise and evaluate strategies to reduce exhaust emissions from road traffic will benefit both air quality and climate change.

This article presents the novel approach followed in the Citi-Sense-MOB project, based on the use of lower-cost sensors for monitoring air quality at street level. The sensors will be mounted on mobile platforms, such as buses and bicycles. The project will enable citizens to participate in monitoring their environment by using sensor equipped bicycles and data collected from buses. All data collected will be available to the citizens in a user-friendly and visually informative layout, using both web services and mobile phone apps.