Air Pollution in Everyday Life: toward Design of Persuasive Urban Air Quality Services

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Abstract. To study the effects of air pollution on everyday life, a qualitative study was conducted assessing urban Finnish families' experiences regarding air quality variation. This paper sums the findings of the study. Opportunities are identified for the design of persuasive mobile services aiming to tackle the negative psychological and physiological effects of urban air pollution.

Keywords: urban air quality services, persuasive technology, mobile health.

1 Introduction

In the coming decades, urban areas will be responsible for the overall population growth, while drawing in some of the rural population [1]. Growth of urban areas will not occur without challenges. Air pollution is a global phenomenon, affecting urban populations, in particular [2]. Pope et al. [3] showed that changes in life expectancy were associated with differential changes in particulate air pollution that occurred in the United States during the 1980´s and 1990´s. Reductions in air pollution accounted for as much as 15% of the overall increase in life expectancy in the cities studied. Poor air quality affects also psychological wellbeing. A study assessing healthy individuals living in a polluted and non-polluted region of Bavaria pointed out area-related effects of sulfur dioxide on mood, stress and ability to concentrate [4].

This paper explores the potential of designing air quality services from a persuasive [5] perspective. We highlight two enablers for such approach. First, advances in wireless sensor networks will enable the generation of near real-time view of the geographic spread of air pollution. E.g., project OpenSense [6] aims to obtain a micro level understanding of the spatio-temporal variation of air pollutants, based on data collected with sensors placed on top of trams and buses. Second, as mobile phones are carried around ubiquitously, air quality information can be adapted to the routines of the users, inferred through continuously sensed mobile data [7]. Using these two enablers, an air quality service could highlight locations and routes encountered frequently by a given individual, along which air quality levels are particularly poor. Such information could convince the user of the importance of avoiding certain areas of the city.

Kim & Paulos [8] showed that when users were given mobile tools to measure indoor air quality variation in their homes, and to access the measured levels through a mobile phone interface, they were in certain cases able to identify the cause of the deteriorated air quality. This, in turn, led to behavioral changes. While [8] highlights the *potential* of air quality services, more research is needed to understand the *actual* needs. This type of approach can inspire the design of persuasive air quality services.

The present study adopted a user centric design approach to study urban air quality variation. The next section describes the method of the qualitative study and summarizes the findings. Section 3 lists opportunities around design of persuasive air quality services, identified based on the outcomes of the user research.

2 Effects of air quality variation on everyday life

Family as a social unit is interesting from the point of view of air quality services. Parents of families are likely to be concerned not only for their own wellbeing but also for that of their children. Six Helsinki based families were selected for the study. The following screening criteria were used: health (presence vs. absence of allergies and asthma among family members), location of home (centre vs. peripheral), and commute methods used (car vs. public transport). Variation along these three dimensions was sought when selecting the sample. The participants were given a diary, which was intended to be used to record air quality related observations using text and photographs, over the period of approximately ten days. The participants were subsequently asked to ideate an air quality service based on the observations made. The final interviews focused on the material created by the families.

2.1 Summary of findings

Families living in the capital region, even healthy ones, were affected by low air quality. Pollution had an adverse effect on wellbeing: polluted commute journeys as well as always ongoing construction work were mentioned by all participants. Also seasonal factors, such as road dust in the spring and heat spells during the summer, contributed negatively to the perception of Helsinki as a clean city. The families located in the most polluted areas found visual cues of pollution from their homes, such as dirt on the window panes. The two families living in the worst affected parts of Helsinki considered moving to a cleaner area. All of the families expressed a preference to spend their freetime in clean, rural environments.

Low air quality in Helsinki region was seen as unfortunate yet unavoidable. Especially when it comes to commuting to work or school, there was little freedom as to which route to select. All of the participants acknowledged the negative health effects of air pollution. Despite this, there were several gaps in knowledge pertaining to air pollution. Most interviewees were unable to name the pollutants. They were not able to specify the exact health impacts of the specific pollutants, and furthermore, they were unaware of how to protect themselves during a period of low air quality.

The participants were at ease ideating services tackling air pollution. Several expressed a preference for combined presentation of weather and air quality

information. This may be influenced by the fact that online weather services showing realtime information are relatively mainstream in Finland. Ideas were expressed pertaining to mobile services highlighting polluted (or clean) personal routes or locations. For instance, the service could provide a list of the cleanest parks in one's city. Preferences were also expressed for effortless access to air quality information while on the go.

3 Design opportunities and conclusions

The findings led to identification of 3 opportunities for design of persuasive mobile communication features conveying air quality information. The opportunities could facilitate perceptual and behavioral changes, resulting in increased wellbeing. The opportunities are: (1) positive focus, (2) personalization; (3) active role of users.

Positive focus. Participants acknowledged the adverse health effects of air pollution. Preferences were expressed to receive air quality alerts. However, emphasizing the negative aspects of air pollution may not necessarily result in a positive overall effect. Threshold for behavior change can in fact be lower when in a positive mood [9]. Hence, an opportunity emerges, namely one related to the service emphasizing the fresh and clean contexts, as opposed to the polluted ones. The ideas of some of the participants fall in line with this opportunity. It was suggested that recommendations for clean parks and jogging routes could be generated, essentially shifting the emphasis on the positive aspects of the city.

Personalization. The participants stated that air quality information is conveyed in a coarse grained manner to the citizens. Relatively few monitoring stations measure air quality variation for any given city and the pollution levels communicated in conjunction with weather reports were perceived to be general. The novel measurement techniques [6] can yield a high granularity representation of air quality variation, however, making it possible to offer personalized data relating, e.g., to air quality associated with the usual routes of any given individual. Preference for this type of information was expressed by the participants, both from a real-time, as well as from historical points of view. Yet another form of personalization would be to summarize the mobility patterns of the individual and suggest changes to them, with the aim of reducing that particular person´s exposure to contexts of low air quality.

Active role of users. Previous research indicates that air pollution can become a neglected background characteristic of urban environments [10]. In line with this, participants of this study thought that not much can be done to effect one's exposure to air pollution, mostly because the everyday routines are spatially and chronologically fixed. To overcome such helpless mindset, the air quality service could underline the possibility of the user taking on an active role in reducing one's exposure to air pollution. Given the constraints imposed by the everyday life, this effect could be achieved by suggesting minor changes in the geo-routines of the individual, while allowing the overall pattern to remain the same. For instance, changing the bus stop used during a commute journey to one associated with a smaller level of pollution could result in a decrease in exposure to poor air quality. Users could also be reminded that they can personally contribute to reductions in

urban pollution by taking certain actions. One participant suggested that the measurement results associated with the sensor boxes could be conveyed directly to people nearby. Displays placed on top of buses could feedback the present air quality level. The displays would serve as a "collective conscious" reminding nearby drivers that the emissions from their vehicles are contributing to the air quality level.

To sum, health effects of air pollution were readily acknowledged. Despite this, the notion of air pollution remained at an abstract level. Most participants were not able to name the common pollutants and there was low awareness of how protect oneself during a period of bad air quality. The participants also felt that not much can be done to avoid exposure to pollution during the time constrained everyday life. It could hence be concluded that mobile air quality services have several challenges to address. Carefully designed persuasive service features could make air quality information more approachable and usable for urban dwellers and result in an increased wellbeing. The opportunities discussed in the present paper are a useful start. In the future, the topic should be studied across a wider range of use segments, as well as geographic regions.

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