Chapter 47
Implementing Participatory Sensing in Environmental Mobile Applications

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ABSTRACT
Advances in mobile technologies have led to a novel form of collaborative innovation (CI), namely participatory sensing, a process in which individuals and communities use increasingly more powerful mobile devices, such as cellular and smart phones, to collect and analyze systematic data. In this chapter, the authors describe experiences with the implementation of innovative collaborative environmental mobile applications involving participatory sensing. Specifically they focus on two mobile applications: an invasive species tracking system, and a mapping-based collaborative tourism system.

INTRODUCTION
During the last two decades there has been a considerable proliferation of web-based information and communication technology (ICT) tools such as mapping, wikis, blogs, social networks and on-line communities that support connection and communication among disparate groups and individuals. This progress has caused both geographic and virtual communities to re-examine their strategies based on new evolving networks and forms of collaborative innovation (CI) (WEF, 2009).
Collaborative innovation involves assembling a team of people to explore and act upon change in an idea or situation (Chesbrough, Vanhaverbeke, & West, 2006). The span of collaboration is a virtual community of practice or interest, or a geographic community (Wenger, 1998; Kretzmann & McKnight, 1993; Shirky, 2009). The individuals that compose the team can represent themselves, different departments in a single organization or different organizations. A team often works in a mediated environment where responsibility for actions can be devolved to specific team members. CI teams have a collective vision and wish to work together by sharing ideas, information and work, as in the case of environmental data collection and analysis groups.

Given the participation of mobile phone users in sensorial data collection both from individuals and from the surrounding environment, a novel form of potentially pervasive paradigm called participatory sensing has been proposed. Participatory sensing refers to the process in which individuals and communities use increasingly more powerful mobile devices, such as cellular and smart phones, to collect and analyze systematic data (Burke et al., 2006). Participatory sensing applications support the creation of new communities of data interest, management and coordination within these communities, and user access to significantly insightful information that can have exceptional granularity and coverage (Reddy et al., 2009). Such applications engage individuals carrying mobile devices to explore phenomena of interest using in situ data collection, in which the data may depend on aspects such as location and time. These novel applications have the potential to impact many aspects of our lives by supporting, for example, improvements in health and environmental protection.

The focus of this paper is to describe our experiences with the implementation of innovative collaborative environmental mobile applications involving participatory sensing. Specifically we focus on two mobile applications: an Invasive species Tracking System (ITS) and a mapping-based collaborative tourism system (NewsAtlas). These systems were implemented using the Web Informatics Development Environment (WIDE), which is a set of technologies, processes and meta-tools designed and developed by the Computer Systems Group at the University of Waterloo (UWCSG - http://csg.uwaterloo.ca/) to support the creation of frameworks that can be easily completed by members of the participatory sensing groups.

Over 50 web-based information infrastructures supporting CI in many forms have been developed by the Centre for Community Mapping (COMAP - http://comap.ca/) and UWCSG based on the WIDE technologies. Although the focus of this paper is on environmental applications, examples of web-based systems for CI in fields other than the environment have been developed in areas such as cultural heritage, tourism, socio-economic development and planning (Cowan et al., 2010).

MOBILE DEVICES AS SENSORS

Mobility adds a new dimension to collaboration as now collaboration can happen while participants are on the move. For example, when locating an invasive species, an individual can locate it on a paper map which can then be transcribed to a Web-based map when he/she returns to their desktop or laptop computer. Instead a smart phone with its Global-Positioning System (GPS) can be used to record the location on a map where the map might also be shown on the phone. Thus mobility has the potential to provide more accuracy and immediacy as the data can be captured and reported upon in real-time.

Participatory sensing applications support laypersons in using their mobile devices as sensors when they locate specific assets (e.g., items or places). By using a smart phone it becomes possible for someone to photograph or take a video, activate the GPS to record the exact location and collect the relevant data. In this case, obviously
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