# Chapter 1
# Smartphone Solutions for Citizen-Centered Risk Monitoring in Environmental Disaster Situations

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## ABSTRACT

*Through an analysis of three case studies, this chapter proposes a new kind of democratic risk communication that can be realized through environmental sensing by citizens with smartphones, and considers the challenges involved. The three case studies, which the authors have implemented in the society, are as follows: (1) The Pocket Geiger (Pokéga) is a radiation sensor for citizens developed immediately after the Fukushima nuclear accident. More than 100,000 Pokéga units have been produced under an open source license. (2) The Unreal iSOTOPE is a mobile simulator developed for training Japanese law enforcement agencies during radiation disasters. (3) The Pocket PM2.5 Sensor visualizes the distribution of invisible air pollutants indoors and outdoors. It is particularly useful for fieldwork in developing countries where environmental assessments are inadequate.*

## INTRODUCTION

Global citizens today carry a sophisticated tool for environmental monitoring in their pockets: a smartphone. Smartphones did not exist at the time of the Minamata disaster, the Deepwater Horizon oil spill, the Three Mile Island accident, or the Chernobyl accident, but it is the conviction of the authors that they hold immense potential for public health. In fact, they could play an essential role in minimizing the

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damage caused by such disasters in the future by enabling the public themselves to access live information and determine risk at an early stage through mutual communication with experts.

This chapter discusses three mobile participatory environmental monitoring solutions developed by the authors based on this belief: Pocket Geiger (Pokéga) and Unreal iSOTOPE (USOTOPE) for radiation detection, and the Pocket PM2.5 Sensor for monitoring air pollution caused by PM2.5 (atmospheric particulate matter that has a diameter of less than 2.5 micrometers). Integrating physical and social technologies, these systems use smartphones and social media to empower ordinary citizens to monitor their environment, make sense of the results, and take responsibility for their own health.

The chapter begins with an introduction to Pokéga, a low-cost mobile radiation detector. The discussion concentrates on the socially inflected process by which Pokéga was developed and tested, measurement data was shared, and how effective risk communication was facilitated through social media among citizens, sensor engineers, and radiation experts. With over 100,000 sales to date, it is hoped that the case of Pokéga may provide a helpful model for the social implementation of chemical sensing in the environmental field.

The second solution introduced is USOTOPE, a virtual radiation measurement application for smartphones that uses Bluetooth and Wi-Fi beacons to measure electric field strength and simulate the display of a radiation-measuring instrument. As the discussion shows, USOTOPE provides an innovative solution to the difficulties associated with first-responder training for chemical, biological, radiological, nuclear, and explosive (CBRNE) terrorist attacks. Describing a series of drills carried out using USOTOPE, this section explores other possible uses for the application in disaster drills, including zoning by law enforcement, screening of the sick and injured by medical personnel, and cooperation with the private sector and citizens—all of which have hitherto been difficult to achieve.

The third solution addressed is the Pocket PM2.5 Sensor, a device that can be connected to smartphones to monitor air pollution. As the discussion shows, the device has particular potential in developing countries, where air pollution is responsible for millions of premature deaths annually. This section presents a field study being conducted in Rwanda and explores the potential for gamification to raise the awareness of air pollution in households with children.

## BACKGROUND

Environmental disasters that cause severe damage to public health and the natural environment are a constant global threat. In traditional risk assessments, such as those described by the United States Environmental Protection Agency (1992), risk management is determined by expert discussion and top-down decision-making. In contrast, the authors believe that citizen-centered participatory monitoring holds the key to effective disaster prediction, prevention, and response.

Burke et al. (2006) originally presented the concept of participatory sensing and predicted that the data collected from mobile sensors held by citizens could be used for public health, urban planning, natural resource management, and documentary filming. With the spread of smartphones, this concept has become a reality. For example, road congestion, consumption behavior, location information, and travel history are widely collected and utilized through Global Positioning System (GPS) sensors and payment modules pre-built into smartphones. The authors take this concept one step further with the addition to smartphones of environmental sensors for crisis communications.