Preface and Acknowledgments

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Multiple pollutants and substances are churning through the air of modern environments. Toxic gases and intensifying carbon, carcinogenic particles and novel viruses circulate and accumulate into atmospheres that have effects spanning the bodily and the planetary. This book is a study of how people attempt to sense and respond to air pollution. More specifically, it documents and analyzes research from the Citizen Sense project, which worked with communities in the United States and the United Kingdom to monitor air pollution and propose transformations to environments. The Citizen Sense research project, initially funded through the European Research Council, began in 2013 as a study into how sensor technologies organize, promise, and activate citizenly engagements. This research looks at how people are taking up citizen-sensing devices to monitor air, collect data, inform policy, and act on environmental pollution.

Even more than observing citizen-sensing technologies and practices, however, this research has collaborated with communities to document and map pollution, build sensing devices, work through data sets, propose action points, and circulate data stories to influence policy makers and industry. By working with communities to install and test sensors, while monitoring and analyzing data outputs, we investigated how these devices operate and the potential citizenships they would activate. We also studied the varying effects of citizen data as it is collected, circulated, acted upon, rejected, or ignored.

When the Citizen Sense project began, there were few social-research projects that specifically researched and analyzed how community, citizen, or participatory sensing takes shape through these emerging digital technologies. Many of the early studies in this area had been undertaken within the realm of human–computer interaction, where a focus on developing digital devices and systems has been more central; or in creative practice, where speculative arrangements

of technology, environments, and social practice spurred different encounters with environments. I detailed some of these projects in my earlier book, *Program Earth*. Yet the research described here seeks to move beyond a central focus on sensor technology to understand in more depth the concrete social, political, and environmental engagements that are made possible or restricted through citizen-sensing practices over time.

The primary way in which this work pursues this area of inquiry is by investigating how citizenships are operationalized along with sensing technologies in the attempt to act on environmental problems. The focus on the citizen is in part a response to one of the most frequent set of questions that surfaced during this research, namely: Who or what is the "citizen" in citizen sensing, what form of political agency is this, and what forms of membership are mobilized here? This is where the notion of "citizens of worlds" comes into play, as the mutual constitution of political subjects and environments. As a concept, "citizens of worlds" signals how diverse political subjects, collectives, and technologies form with and through multiple milieus, and how they undertake practices that express diverse and diverging environmental experiences. This approach expands into an analysis of citizens as more multi-agential, pluralistic, and collective than a seemingly singular unit of abstract citizenship. But it also points to collisions of worlds, where power to make worlds matter is unevenly distributed and wielded. These are conditions that are central to struggles to make more breathable worlds.

Environments are increasingly sites of pollution, extraction, disaster, and development. Technologies and practices for documenting environmental pollution and destruction are not just capturing evidence of these events; they are also devices, operations, and milieus through which citizens and communities materialize and make sense of environmental problems. By documenting practice-based investigations of sensing technologies used to monitor and evidence concrete environmental problems, this study considers the collaborations, conflicts, aspirations, troubleshooting, disappointments, and political change that are forged in specific sensing projects. In doing so, it seeks to identify practices for engaging with environments and working with digital technologies that generate more expansive possibilities for citizens and worlds. How people work with, respond to, care for, shape, fight for, and transform environments informs the political subjects and collectives that materialize. This is also a way of reworking political subjects through their environmental affiliations and attachments—toward citizens of worlds. Different formations of subjects and worlds are constitutive of distinct possibilities for being in and becoming with worlds. Citizens form

through worlds, and their coming into being and political capacities register not just in relation to other political subjects but also through the conditions of those worlds.

While this work is practice-based, it is not a project of making sensors for making's sake. Moreover, the research does not stand back and observe participants using sensors, but instead works through a collaborative set of engagements to understand environmental problems and diverse responses to them. This work includes learning about existing monitoring projects while proposing how to develop potential further sensing practices. It involves ongoing attempts to make sense of data and searching for ways to operationalize observations for more breathable worlds. In this process, some contributors to this research have asked to be identified as project contributors and authors of data, while others have asked to remain anonymous, in which case more generalized descriptions of participants are used. Overall, this approach to research involves mutual investigation, shared learning, and respect for the multiple contributions that can be brought to a research project as a democratic and collective endeavor.

My work on sensors has followed a very long trajectory, and it is difficult to identify a starting point for work that has been ongoing for nearly two decades. I began the core part of the research described in this text while at Goldsmiths, University of London in 2013, and completed it while at the University of Cambridge from 2018 on. Thank you to both institutions, including the departments of sociology where I have been based, for providing lively environments in which to undertake this research over a span of more than nine years.

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Dustboxes, a particulate-matter sensor for monitoring air quality developed by Citizen Sense. Photograph by Citizen Sense.