



## Research article

# Citizen-sensor-networks to confront government decision-makers: Two lessons from the Netherlands

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## ABSTRACT

This paper presents one emerging social-technical innovation: The evolution of citizen-sensor-networks where citizens organize themselves from the 'bottom up', for the sake of confronting governance officials with measured information about environmental qualities. We have observed how citizen-sensor-networks have been initiated in the Netherlands in cases where official government monitoring and business organizations leave gaps. The formed citizen-sensor-networks collect information about issues that affect the local community in their quality-of-living. In particular, two community initiatives are described where the sensed environmental information, on noise pollution and gas-extraction induced earthquakes respectively, is published through networked geographic information methods. Both community initiatives pioneered in developing an approach that comprises the combined setting-up of sensor data flows, real-time map portals and community organization. Two particular cases are analyzed to trace the emergence and network operation of such 'networked geo-information tools' in practice: (1) The Groningen earthquake monitor, and (2) The Airplane Monitor Schiphol. In both cases, environmental 'externalities' of spatial-economic activities play an important role, having economic dimensions of national importance (e.g. gas extraction and national airport development) while simultaneously affecting the regional community with environmental consequences.

The monitoring systems analyzed in this paper are established bottom-up, by citizens for citizens, to serve as 'information power' in dialogue with government institutions. The goal of this paper is to gain insight in how these citizen-sensor-networks come about: how the idea for establishing a sensor network originated, how their value gets recognized and adopted in the overall 'system of governance'; to what extent they bring countervailing power against vested interests and established discourses to the table and influence power-laden conflicts over environmental pressures; and whether or not they achieve (some form of) institutionalization and, ultimately, policy change.

We find that the studied-citizen-sensor networks gain strength by uniting efforts and activities in crowdsourcing data, providing factual, 'objectivized data' or 'evidence' of the situation 'on the ground' on a matter of local community-wide concern. By filling an information need of the local community, a process of 'collective sense-making' combined with citizen empowerment could grow, which influenced societal discourse and challenged prevailing truth-claims of public institutions. In both cases similar, 'competing' web-portals were developed in response, both by the gas-extraction company and the airport. But with the citizen-sensor-networks alongside, we conclude there is a shift in power balance involved between government and affected communities, as the government no longer has information monopoly on environmental measurements.

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## 1. Introduction

Using new digital technologies and media for self-organization, more and more citizen networks organize themselves voluntarily, especially around sustainability themes like renewable energy, sustainable resource use and preservation of neighborhood quality.

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In doing so, citizens create information networks for the purpose of sharing knowledge and monitoring environmental phenomena like air pollution, noise, or other non-visible but yet human-experienced social-environmental pressures, which are usually not accounted for in current institutionalized governance system, being considered mostly as ‘environmental externalities’. It is this last form of bottom-up social network creation that we address in this paper: The use of geo-information about sustainability issues and the publication of ‘live’ or near-real-time map-based apps through open web-portals and social media networks. Through world wide web and social media, citizen groups increasingly have access to advanced technical know-how and low-cost sensing devices and software applications, allowing them to undertake complex activities previously undertaken only with highly expensive instruments and large information systems. The latter systems are typically built by governments, large public research institutes, or private industry.

Nowadays, low-cost sensors in the hands of many participants form similar (networked) approaches that can monitor and potentially manage environmental problems. Our objective with this study was to understand the origination and impact of two very early examples of ‘networked geo-information tools’ and the actor-network or human organization surrounding it. The main question addressed in this paper, is: How do the social-technical innovations that we call **citizen-sensor-networks** come about, and can these networks become a powerful agent in environmental planning and governance? The main question is studied by tracing two case studies in particular, and from those case studies reflecting, in the concluding section, upon the following research questions: How do citizen-sensor-networks come about and what effects do they have? How does the process of knowledge construction and collective sense-making work within citizen-sensor-networks? How can we understand this innovation of citizen-sensor-networks in terms of transformative potential in planning? Can citizen-sensor-networks become a powerful agent in environmental planning and governance, confronting government decision-makers more often?

A first version of this paper has been presented to the Association of European Planning Schools (AESOP) conference in Utrecht (Carton and Ache, 2014).

### 1.1. Article structure

After an overview of recent examples of citizen-sensor-networks and brief discussion of theoretical background stemming from Participatory GIS literature, this paper presents two cases from the Netherlands. Lending from ethnography, a narrative approach was followed, reconstructing the storyline in each case of how the particular *citizen-sensor-network* came about in its social environment, structured along the main interview topics that were central in our interview questionnaire. After the two case descriptions, we interpret our findings on the research questions, reflecting on aspects of social and technical networking like the interconnectedness of people, places, things and information, processes of empowerment, alterations of boundaries and knowledge politics. We conclude with a diagnosis to what extent the presented examples of ‘networked GIS use’ by local communities and their social-technical organizations that we call citizen-sensor-networks, are expected to become influential agents in bringing about policy change in environmental planning.

### 1.2. Voluntary environmental monitoring

Recently, Stepenuck and Green (2015) have studied when and how instances of *volunteer environmental monitoring* leads to

impacts on individual and community level. Their article gives a state of the art overview of research on this topic, with an extensive literature analysis and evaluation of advancements in this field. They note a lack of research dedicated to understanding to what extent, and how, attitudes and behavioral changes occur as a result of the participatory set-up of the analyzed environmental monitoring programs. They conclude that most research articles seem to focus on the *technical* rather than the *participatory* aspect of monitoring. For instance, Adams and Kanaroglou (2016) have studied how one can process and analyze real-time measurements in monitoring air pollution, but they do not study social or behavioral aspects among participants, or implications for planning or governance. An exception from this tendency to look at the technical side is the work of Lawrence (2006). She calls for research on questions around the experience and changing values of participants in voluntary (biological) monitoring and the conditions required for empowerment in relation to participatory environmental governance. In our research, coming from a background in participatory planning and GIS, we have not studied the literature on environmental monitoring in-depth as Stepenuck and Green (2015) have, but rather, we have looked at cases in planning practice where we have seen citizens taking initiatives to gather information. We have analyzed to what extent, and how, those citizen-initiated practices have influenced decision-making processes on the level of governance and collective action.

### 1.3. Empowerment of citizens accelerated by web 2.0 and social media developments

The empowering impact of the web infrastructure and social networking practices have been noticed in government discourses for some time. For example, the E-Government survey of the United Nations in 2010 formulates how the increasing use of ‘Web 2.0’ by citizens is bringing change to government decision-makers. They signal that Web 2.0 and social networking tools have empowered citizens to become more active in expressing their views on many issues, especially on issues concerning environment and health (and other areas of government policy). In words of the UN E-Government survey 2010 (Section 5.1.1. p.84, italics added):

“Citizens use Web 2.0 and social networking tools to galvanize other like-minded citizens to share ideas and to develop collaborative approaches in tackling the issues that are important to them. Politicians and other decision-makers need to tap into this wealth of information and knowledge in order to be more responsive to their constituents.”

The UN E-Government survey in 2016 mentions the use of GIS data explicitly as one of the *potential transformers* in today’s development (Executive Summary, p. 5–6, italics added):

“Technological progress continues to drive innovative development interventions. The use of *Geographic Information System data* and Internet of Things (IoT) hold the potential to transform the way public policy is formulated, implemented and monitored.”

### 1.4. Recent examples of citizen-sensor-networks in practice

We do not pretend to study all actual projects currently being undertaken in this direction, but we do see a number of projects that may fit in the category termed by the UN E-Government survey (2016) as holding transformative potential: We provide an

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