USING CLASSIC METHODS IN A NETWORKED MANNER: SEEING VOLUNTEERED SPATIAL INFORMATION IN A BOTTOM-UP FASHION

Linda Carton[1], Peter Ache[2]

[1]Radboud University Nijmegen (Geography, Planning and Environment department, Institute for Management Research), l.carton@fm.ru.nl
[2]Radboud University (Geography, Planning and Environment department, Institute for Management Research), p.ache@fm.ru.nl

Keywords: citizen sensor networks, Internet based environmental monitoring, citizen-validated evidence-based planning

Abstract

Using new social media and ICT infrastructures for self-organization, more and more citizen networks and business sectors organize themselves voluntarily around sustainability themes. The paper traces and evaluates one emerging innovation in such bottom-up, networked form of sustainable governance: The use of sensor data by citizen communities. In such 'bottom-up community initiatives', the sensed data is published on Internet presenting real-time, web-based GIS maps about issues like noise, air quality or earthquakes. In the study, two particular cases are analyzed to trace the emergence and network operation of such a 'networked' geo-information tool in practice: (1) The Airplane Monitor Schiphol and (2) The Groningen earthquake monitor.
The paper discusses how in these cases, citizen sensor networks are combining classical methodological approaches with enabling infrastructures and data sources. We find the makers creatively blend classic methods with newly available open data & information technologies. The tools are working as "social boundary objects," as information hubs, which co-evolve with and reinforce the power of the citizen initiative as a network. The paper concludes with a discussion of two propositions: (1) Computer and Internet technology co-evolve with method advancement in planning, and (2) Citizen sensor networks work as embodied method for hypothesis falsification.

1. Introduction

Since the communicative turn, 'classical' planning methods such as Cost-Benefit Analysis (CBA), Multi-Criteria Assessment (MCA) and Geographic Information Systems (GIS) have been discredited by planning professionals of having a technocratic nature, serving as state-instruments for legitimizing 'pre-cooked decisions', and privileging that 'what can be counted' over other values. Despite of this critique, the rationale and analytic workings of these methods are still being employed. One direction of further evolution of these methods can be identified in a 'bottom up' use and blend with modern social media capabilities, as part of a wider sustainability movement in society. Using new digital technologies and media for self-organization, more and more citizen networks and business sectors organize themselves voluntarily around sustainability themes like renewable energy, sustainable resource use and revitalization of livelihoods.

The paper analyzes one innovation in such bottom-up (networked), voluntary methods use: The use of volunteered geo-information and publication of "Participatory GIS maps" by citizen networks about territorial sustainability issues. In two case studies, the emergence and network operation of a geo-information tool is analyzed in its social context: (1) The Airplane Monitor Schiphol and (2) The

Groningen earthquake monitor. These cases were not selected at random, but picked for their innovative use of Internet and GIS maps and combination with sensor-data and community initiative.

The case studies are evaluated on the emergence and institutionalization of the tool in its social context. The following research questions are being addressed in the case evaluations:

1. How did the instrument come about?
2. What was the role of the instrument in the community and wider actor network?
3. How was the tool presented to the public, how was it received, and what effects did it have later on?
4. How do the tool developers look back at their initiative in hindsight?

With these research questions, we have looked at the social context of the instruments. With the exploratory knowledge from these two ‘advanced’ case studies where geo-information is applied in a networked context, we aim to draw conclusions about if and how these applications, combined with Internet technologies and social media capabilities, are driving change and contemporary innovation in planning.

2. Theoretical framework

2.1. The advances in planning methods during the era when the ‘rational paradigm’ was dominant, and its criticism.

The ‘rational paradigm’ flourished during the years ’70 and ’80 of the last century, when advancements in (classical) policy analysis methods and computer-based techniques focused on supporting spatial planning in general. Computer technologies enabled the possibility to store and process large volumes of data, and this brought new advances in planning analyses within reach. Within the time-span of political decision-making processes, the speed and low-cost in terms of man-power made the execution of complex rational analyses feasible. Large datasets were structured in layers (or cells, vector objects or other spatial topologies) in GIS, or processed in mathematical models for future scenarios and impact assessments. As these tools bring together data on various aspects, the question of how to represent priority preferences in policy goal-setting becomes manifest if one is to compare impacts on the various aspects and “weigh” which impacts, or which criteria should be considered “weighing more” than others; in these heydays of the rational paradigm, this very political question was translated into generic planning methods, such as Multi-Criteria-Evaluation. The apparent discredit of especially quantitative methods by practicing planners may be due to their premise versus their delivery; the chain of the process is as weak as its weakest link, and the accumulation of uncertain inputs leads to very uncertain, and thereby very unreliable, outcomes. Weights of criteria are, by the very nature of values, inherently subjective and personal. Add to these the strategic behaviors of the people whose interests are benefitted by particular set-ups of the endeavor (for instance; which alternatives to select for inclusion in a legally required Environmental Impact Assessment) and the execution of such an assessment can be regarded as a ritual dance.

2.2. Current developments in planning theory

In planning theory, the rational paradigm has been succeeded with multiple alternative paradigms, identified and summarized under ‘macro’ labels like *postmodernism* and *social constructivism*. Actual impact of analytic planning methods in practice often turned out to be different than anticipated, and planning studies focused on the complex of government institutions, societal dynamics and discursive framing practices to explain the social behavior and interactions among multiple, interdependent governing actors observed in practice (Fischer and Forrester, 1993; Hajer, 1995;. Arts, Leroy and Tatenhove, 2006),

In intellectual debates about the formative power and constraining function of discourses in policymaking, social scientists theorize about actor's motivations for social behavior and decision-making, dismissing the idea that actors' agency is based on rational choice. Philosophers like Foucault (1966) and Luhman (1995) argue that agency is predominantly predestined by social structures, hegemonic discourses and practical cultures, and decision-making is highly influenced by habits and language-constrained, habitual thinking, instead of a conscious, strategic and rational-analytic evaluation of options, an underlying assumption in many economic models and impact assessment methods. Influenced by Habermas' communication theory (1998) and the complexity of society (Castells, 1996), new theories about multi-actor governance and inclusive, participatory planning approaches have taken an important place in planning literature today (Healey, 2005 and Randolph, 2012, amongst many others).

Complex adaptive system theory and bottom-up patterns of change

Theory on complex-adaptive systems, stemming from beta-sciences (physics, mathematics, biology) is trying to bridge the distance between the natural sciences and its rational-analytic founding assumptions on one hand, and social sciences on the other hand, where postmodernism and social-constructivist paradigms form the dominant discourse (Portugali, 2006). In a complex-adaptive system, a diverse variety of intelligent agents (in social systems usually living people) act and organize themselves in sub-parts, interrelated through tight internal networks. The system as a 'whole' is connected to an outer environment, with the border or 'fence' between outer and interior being permeable. In the system, complex patterns emerge bottom-up, initiated by small, individual parts. The parts communicate with outer and inner counterparts and react on outer as well as internal driving forces, forming short-term and long-term relations.

Bottom-up patterns of change and newly growing relations can cause instability in the overall 'system state'. When certain tipping points are passed, at so-called bifurcation points (in Dutch: zadelpunten), the system state enters into a crossroad regarding its future course of development (Scheffer, 2009). The system as a whole can suddenly go through a transition and turn into another state or even collapse, with new equilibrium values around which agents push and pull for change or stability. The overall level of quality of certain complex system characteristics, such as sustainability indicators, number of agents in the system or economic (re-) production rates, may have changed dramatically in this new system state. A well-known example of such system states in practice can be found in Western-style political systems, where conservative parties (usually aiming for stability) and progressive parties (usually aiming for change) are in continuous competition with each other. After political elections, the dominant state of a parliament may be radically altered, with the dominance of conservative or progressive values weakened or strengthened by the amount of selected citizen representatives in the new parliament formation, effectuating structural change in the 'political system state'.

In summary, the complexity science emphasizes the non-linear pattern of behavior and the emergent nature of adaptation and (radical) change in complex social-technical 'systems'. According to the 'butterfly metaphor', one small initiative at one place in the system may cause a swirling effect in the system as a whole. In contemporary literature on planning and governance, the social-adaptive systems theory is embraced as a new 'lens' to study network relationships, to make sense of non-linear courses of action, and to explain the rise and fall of complex patterns of behavior of communities of practice and governing regimes (for example, Termeer, Teisman, Nooteboom, and Deelstra, 2013).

According to this complexity perspective, lenses only focusing on top-down, hierarchical (state) government institutions and formal policy formulation processes, miss out on important mechanisms that drive change from the invisible, informal "marginal places within the system" (for example, Scott, 1998).

2.3. Innovation in methods for planning: citizen sensor networks for participatory GIS

Simultaneously with the 'participatory turn' in planning, literature on Geographic Information Systems (GIS) shows a shift in approaches to less expert-based, more citizen oriented and participatory practices. The edited volume of Craig, Harris and Weiner (2002) serves as milestone for the foundation of (Public) Participation GIS as a significant sub-stream in geo-information science. Combining citizen empowerment with GIS is identified as a powerful combination in establishing change in planning and policy (Corbett, 2006; Carton, 2007).

Participatory sensing or 'grassroots' sensing (Burke et all., 2006) is considered a next step in this development, oriented at the democratization of knowledge processes in planning. According to Burke et all., participation means more than just data collection; it can also impact professional research and planning. Corburn (2004): "Democratizing practice in both fields [urban planning and health] demands that professional knowledge not be compartmentalized from practical experience, that lay knowledge be considered alongside expert judgments, and that the incomplete models of the technically literate not be mistaken for the sum total of reality."

Geographically referenced sensors, also called *geo-sensor networks* (Kooistra, Thessler and Bregt, 2009), can offer a shared, bottom-up or grassroots-based image of environmental quality, that can be compared with the experience of local inhabitants by their very bodily experiences. Professional planners can improve their diagnoses and evaluation practices with such input. Moreover, we think that planners professionals could think of approaches that embrace the idea of citizen-sensor networks as integral element in the process of problem diagnosis, framing of solution-spaces and policy objectives, scenario analysis, impact assessment and ex-post policy evaluation. As the knowledge process in planning might be opened-up for –sensed and bodily experienced– information, this could make citizens feel as being taken more seriously by governing officials, because of their intimate involvement in the knowledge process. This way, democratization of the knowledge process in planning may be the next step for (improving legitimacy in) participatory governance.

The role of the tool and the networked information flow that stems from citizen-sensor networks can be considered as "*boundary objects*" or *boundary-information-flows*, funnelling and framing complexity into meaningful images of 'realities out there'. Star and Griesemer (1989) have coined the term 'boundary objects' to refer to the process of *methods standardization in cooperative work*, in the development of an institute (the Berkeley Museum of Vertebrate Zoology). They use the term to make explicit the subtle mechanisms in participatory work processes that maintain coherence across intersecting social worlds. Classifications and concepts are used by multiple people, attaching partially shared meaning to them, while attaching different –professional and lay– understandings of the same object (these may be abstract concepts or concrete artifacts). Star and Griesemer: "Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. […] They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation."

Similar to the way Portugali (2006) sketches the conception of place and space in geography as two faces of the same coin, as two forms of information compression, we believe that bottom-up citizen networks and top-down governance regimes could be two faces of the same planning process. Sensor networks may embody the type of boundary objects that fit in different social worlds: lay versus expert; qualitatively experience-focused versus quantitatively model-focused; focused on local-scale needs versus focused on national interests; focused on human-environment interactions versus focused on human-human interactions; etc. As such, citizen sensor networks may provide the language that unify actions and strategies of allied actors in communities and citizen movements. In this sense, they may have the potential to change or bring forward the policy-making social-institutional infrastructure on top of, or rather as a result, of the construction of the technical sensor network itself; as a product of co-evolution. In the next section, we will describe and evaluate the emergence, effect and institutionalization process of an early instance of such *citizen sensor networks*, the airplane monitor Schiphol.

However, a word of caution and modesty is in place. Good practice and good governance do not 'automatically' arise from technological tools and information processing projects. Good practice in good governance implies *legitimising respect for specificity and localness*, and not enforcing blanket solutions (McCall and Dunn, 2012). This depends on respect for local knowledge and its sources. McCall and Dunn: "Whatever technology is being introduced, the kind of social dynamics in which it operates will determine whether it will empower or further marginalize poor communities; like the double-sided coin of accessibility and exclusion. It may never be feasible that geo-information tools reflect the full complexities of local spatial knowledge, human interaction with environment, or power relations. There must be significant technological advances as well as a fundamental mind-shift before external expert spatial information and local geographical knowledge could be regarded as truly complementary or integrated."

3. Case Airplane Monitor Schiphol

The idea for a tool that would monitor airplane noise originated in 2003, in the city of Leiden. In this year, airport Schiphol, the main airport of the Netherlands near Amsterdam, opened the so-called "fifth runway," the 'Polderbaan'. In the run-up to this extra runway, many reports had been published to analyze and deliberate the pros and cons of the planned airport expansion. The new runway would cause airplanes to make turns, take-off or land over densely populated areas, flying low over many towns and villages scattered across the landscape, as far as 35 km from the airport itself. Government representatives and environmental groups had populated various committees. In this process, 'the public had been professionally been fouled' (interview respondent 8). For instance, for the large village of Castricum, the central airplane route would fly low (1 km) over and turn exactly above the village. However, the official impact assessment foresaw "zero complaints for the municipality of Castricum". The official hypothesis of the State government was, that the airport would increase economic activity and simultaneously reduce environmental and noise impacts.
Since the fifth runway of Schiphol was in use, it rained complaints in the region. Also in the city of Leiden where Post lived, people were unpleasantly surprised that the noise level of Schiphol was so intrusive in the private spheres of inhabitants. Many people experienced sleep disturbance during night times because of loud landings and take-offs during the night. The people felt betrayed by the government and Schiphol about the positive predictions of the noise impact of the fifth runway in official policy reports. There was a common feeling of *injustice*, and frustration about the untransparency of public information about noise burden ('overlast' or 'hinder') for citizens.

3.1. How the tool came about

The tool was an idea of Rene Post, an ICT/Internet pioneer and civil undertaker. During his education he became inspired by "The Digital City" project in the 90's, which brought together all kinds of artists and ICT pioneers in Amsterdam. Post took part in this "freenet activity" and learned about the possibilities of Internet access. In 2003, Post had an own ICT firm that serves information on Internet speed. One day he saw the Dutch minister ms. Netelenbos on television, who was responsible for Schiphol and the extension of the airport with the fifth runway. The minister said: "Noise is unmeasurable, so we have to calculate the noise." Post thought: "This must be complete nonsense. Noise can be measured. But the State and Schiphol do not *want* to measure." He acquired information with some noise experts. They gave him the answer that this statement was, from a technical or science perspective, nonsense. According to them, noise can be measured, although it is a very complex phenomenon, influenced by things like wind direction, and disturbances from the environment.

This was enough knowledge for Post. His considered it a challenge to proof that the minister talked nonsense, and that airplane noise can be measured. The public should not be fouled about experiential possibilities to get an open, insightful picture of the substantive noise load in the affected towns and villages. Somebody should debunk the *mystified* and on some points *false information* that was being spread around, in this controversial planning process. A 'independent' picture of noise, measured on the ground, should shed some light on the real noise loads experienced by large amount of people in North and South Holland. Rene Post had the opportunity and saw the possibility. Post was a creative thinker. He envisaged the desired result: a simple website, with a map and locations of microphones. Relatively low-cost microphones should be found somewhere, which could record and measure the noise, and local personal computers would communicate this data over the Internet to a central server. There, the overall data could be visualized on graphics related to each microphone spot on the map. Every step would be transparent. The instrument would be Open, on the Internet, and the noise would be measured. The tool would be made on the basis of want-to-know the measured level of airplane noise, but without an opinion about it. Just plain outcomes of measurements would be shown. The main objective for the tool was to provide independent, factual, measured noise loads, on various locations in populated areas.

Post knew to arrange for a small subsidy and, after a search for the right microphones, he bought 25 microphones in Germany for less than 200 Euro a piece. In his company, he had people who could build the ICT infrastructure. Now, he asked citizens to join his pilot project and allow for a microphone on their rooftop, connected to their own personal computer. This was a cost-effective part of the idea; the pilot project would make use of the *existing ICT infrastructure and Internet connection memberships* of the participants at their home. It was not difficult to find 25 volunteers who wanted to join the pilot project and place the microphones on their rooftops, cable-connected to their computer (see Figure 1). Since societal outrage about Schiphol and the airplane noise was at its peak, many people wanted to assist.

Figure 1. Installing a measurement point of the sensor network. Source: Alderstafel Schiphol (2012).

3.2. Architecture of monitoring system

One of the arguments why airplane noise could not be measured, stated by experts of Schiphol airport, was that other sources of noise could pollute the data. This argument, however, was circumvented by placing multiple sensors in triangles in the field. This way, triangulation calculations could be performed to calculate the speed of the incoming sound. This idea is very much like the old 'classical idea of triangulating in geodesy', e.g. calculating coordinates from field observations using a network of triangles. If the calculated speed of sound would be high, say over 200 km/hour, then it would be clear that this would not be a moped or person shouting. Loud noise that travels at speeds higher than say 200 km/hour, usually is coming from an airplane. Later, this hypothesis turned out to work well and provided for validly represented airplane passages (see Figure 2).

By the network of microphones, the noise profile during the passage of an aircraft was measured, and the duration of noise per passage [in seconds]. The passage's peak noise level [LAmax dB(A)], as well as the total amount of noise energy [SEL dB(A)] per passage, was derived from these measured noise profiles (see Table 1, further in the text). Also, for each monitoring point the number of –measured– airplane passages in 24 hours were counted, time-stamped and archived (see Figure 3). During the construction of the microphones, it turned out to be difficult, but possible, to observe noise. The low-cost microphones gave problems during rain, and at times a microphone's calibration was not stable, causing measurements 'to walk away'. But although noise turned out to be a complex phenomenon, and there were issues with accuracy of measurement, the overall pattern on the map that was visualized by the tool, was remarkable. The many airplanes and the high level of accompanying noise loads at the 25 observation points was now visible, and was being recorded continuously. The objective of open, independent, observed-and-measured, factual noise measurement information about airplane noise was achieved.

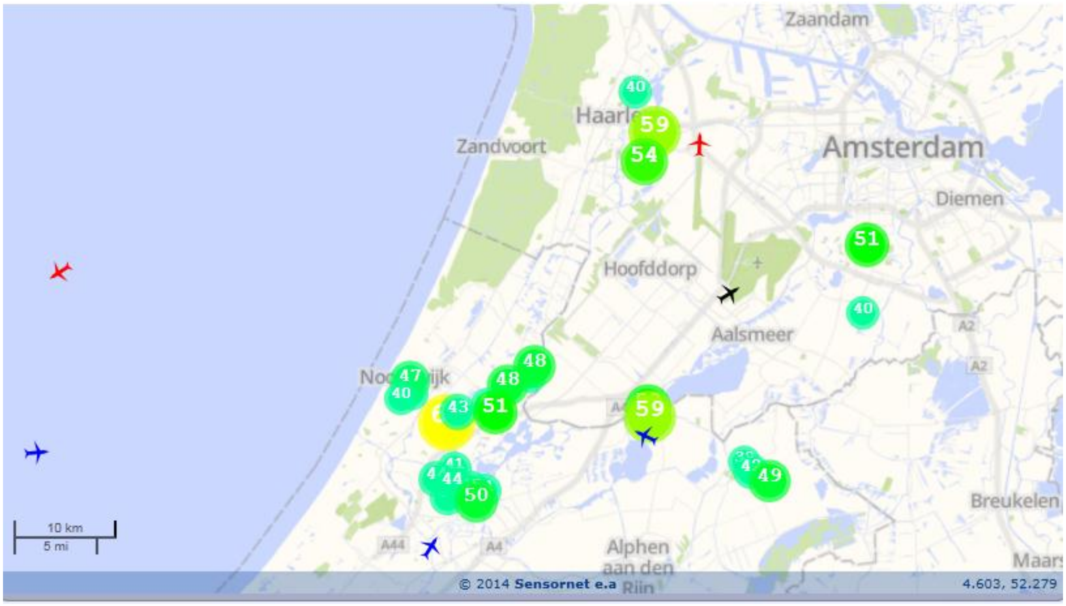

Figure 2. Noise measurements presented "live" through Internet. (source: Sensornet, 2014). www.sensornet.nl (Note: a picture of the original version of 2004 was not available)

3.3. Effect when the tool was launched

The first pilot only took half a year (2003 – 2004). The pilot was rounded off with a conference at the Waag Society in Amsterdam, which also had been the organizer of the platform "the Digital City". The outcome, a simple map on the Internet with the sensors and their measurements represented on the map with colored spheres, from green till orange and red, was presented.

For this conference, 'everybody' was invited; the national government, citizen groups, the airport committee Eversdijk, etc. In the back of the room, one national delegate, a member of the committee Eversdijk was loudly shouting words of criticism and spread doubts about the pilot study. He discredited the project members as "not being noise experts." Behaviorally speaking, this delegate served as 'merchant of doubt'. After the conference had finished, it appeared an advantage –not a disadvantage– that the national's official committee member had been so critical so loudly. A local environmental group now said to Rene Post: *"If he is so angry with you, then we believe in you."*

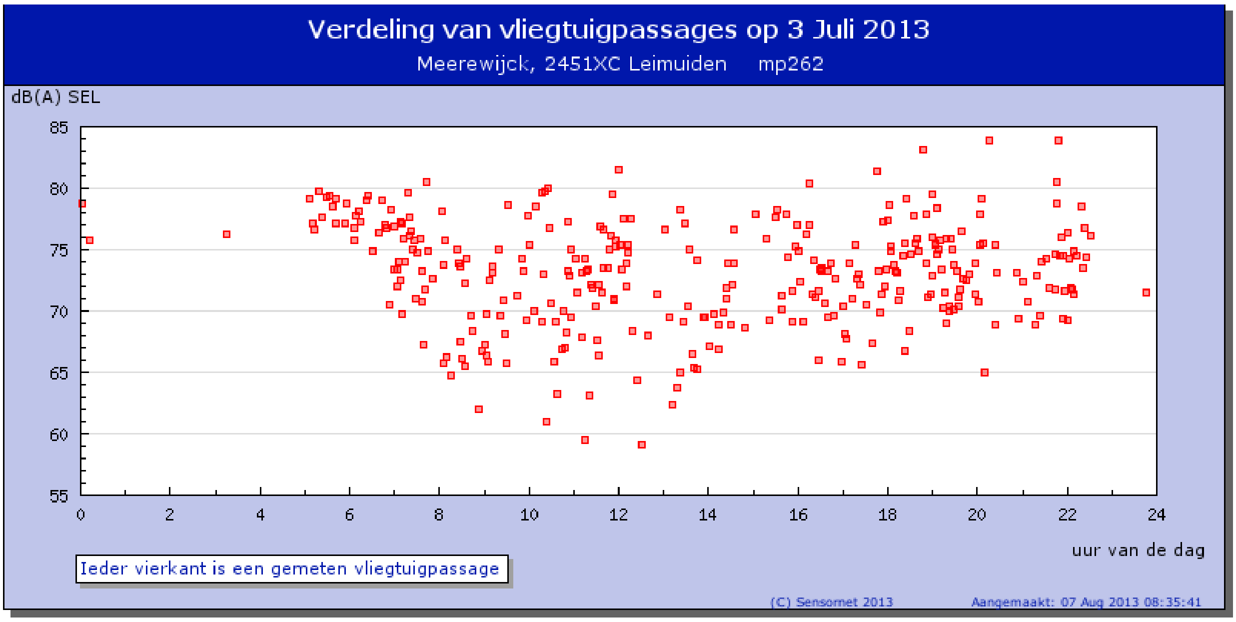

Figure 3. Graphics of Geluidsnet Schiphol for the place of Leimuiden on one day (24 hours). Every point is a measured airplane passage over de village, with the locally measured total noise energy in dB(A) SEL levels (left). Source: Werkgroep "Geluidshinder Kaag en Braassem Noord" (2013)

The environmental group wanted the project to continue. Other members stepped in that also wanted to ‘keep this instrument in the air,’ in what now had evolved into a polarized conflict between local groups and municipalities on one side, and the State government and Schiphol at the other side. Ten municipalities said: we want to sponsor a number of measurement points; and we want you to place noise measurement sensors in our municipalities. The municipalities wanted to have an own information base about measured noise in their deliberation with the national level of government, in order to stand stronger. These municipalities didn’t believe the minister anymore, and too felt fouled by the succeeding committees, which had been putting them asleep with reassuring scenarios and reports.

Thus, in 2004-2005, agreements were signed and the pilot-study succeeded under the name of “Geluidsnet”, a foundation funded by municipalities, citizen platforms and also actors like the professional ‘Milieudienst West-Holland’, an inspection institute. In a session of the national Parliament (Second Chamber), no politician believed anymore that “airport noise cannot be measured”. This was verbally expressed. For the pioneer Rene Post, the original objective was reached: it was now clearly stated in Parliament that the airport noise can in fact be measured; parliament members no longer believed the minister on the statement that noise “has to be modeled and calculated because it is impossible to measure”.

3.4. Process of institutionalization of the instrument

In 2005, Geluidsnet professionalized and registered as foundation, signed contracts with paying actors (especially the municipalities were an important paying client), and the noise measurement infrastructure had to be improved and professionalized. Through the foundation, media attention and personal contacts, deliberations with multiple local platforms were held. The platforms represented people in various cities and villages who protested about the airplane noise in the wider region around Schiphol. To deliver the agreements in the signed contracts with 10 municipalities, the technical setup and architecture of the pilot project had to be improved and rolled out.

A second partner joined Geluidsnet, Jasper Koolhaas. Next to managing the various technical elements of the foundations monitoring network, Koolhaas added information about airplanes and flight numbers on the map. He used the transponder information sent by the airplanes themselves. Now, also the plane itself was visualized on the map. This meant that all people who live near an airplane route, could watch and check the noise impact “live” by looking at the map, and looking out of the window to see a specific airplane come over (“Oh, its the KLM837 from Singapore”; fictive example). In 2006, the launch was widely received in the media, and covered by the national news on Television on prime time (in Dutch: het 8 uur journal). Since this launch, citizens can find the actual data on the Internet. The participating municipalities get the monthly reports.

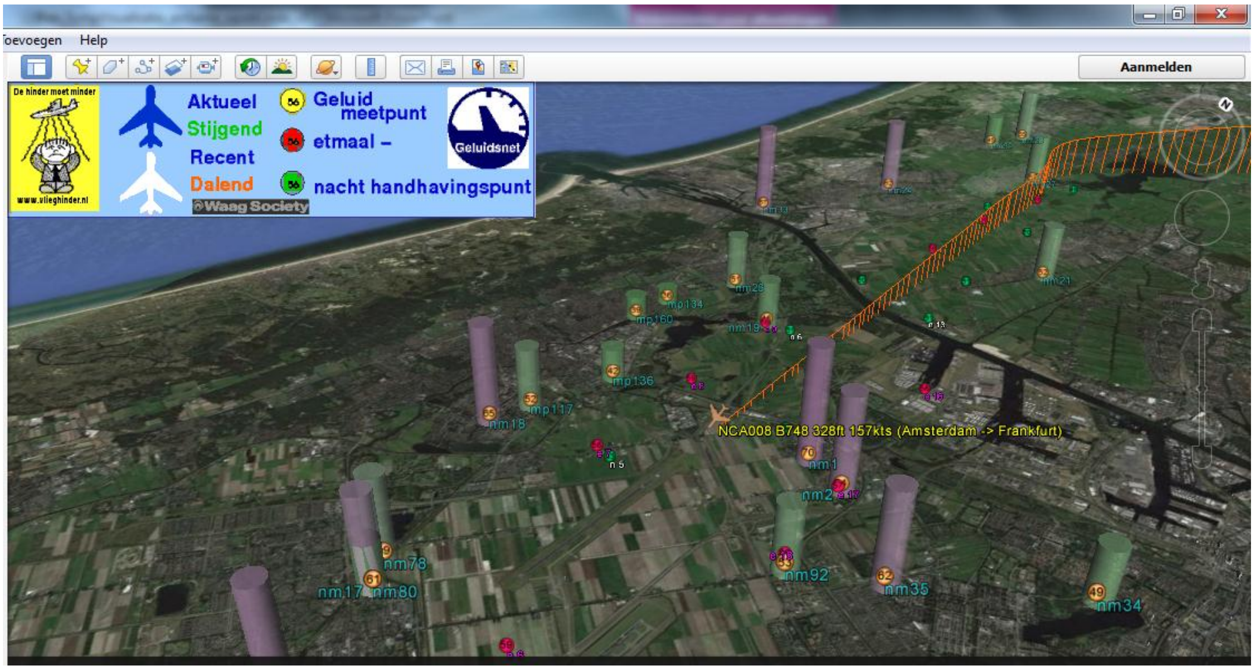

Figure 4. Combination of real-time noise measurements of Geluidsnet with real-time aircraft tracing in 3D in Google Earth. The vertically visualized sensor values are growing and shrinking according to measured noise level. Source: Platform Vlieghinder Regio Castricum (PVRC) and Geluidsnet (nowadays called Sensornet).

Networked developments with citizen initiative PVRC

In the meantime, the Platform Vlieghinder Regio Castricum (PVRC) had a similar idea. One of its members had made an app (kml layer) that showed flight number information on a map, in Google Earth. But they did not have noise measurements. Geluidsnet and PVRC made an agreement of the use of noise measurements from the Geluidsnet network and providing this continuous data flow (RSS-feed) to the platforms website application. Now the air flight information and the sensored noise measurements were **both visible in real-time** in Google Earth, in a “live” 3D airplane monitor (see Figure 4 and 5).

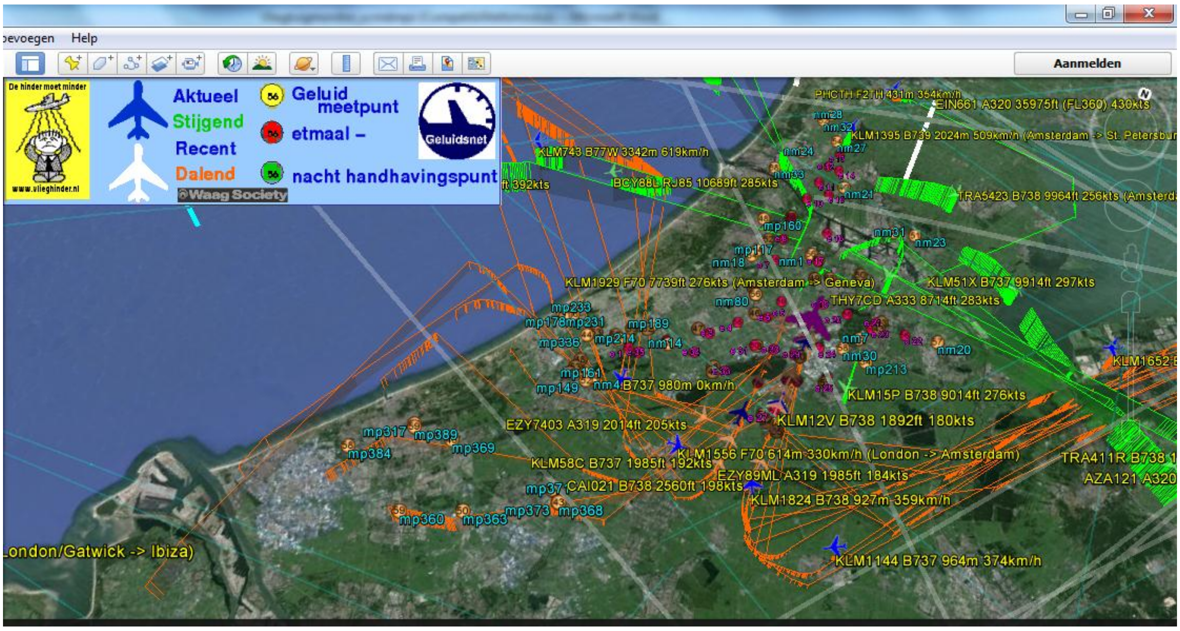

Figure 5. Real-time airplane monitor, including flight information and sensors representing ground noise.

On social media and in digital communities, the particular kml-layer in Google Earth was well-shared and liked. Here, we see that the tool became an *information hub*, a "*social boundary object*" in a web of actors that adopted it. Stakeholders adopted the tool because the actors recognized their own perspective and noise perception visualized on the Internet through this monitoring instrument. And now for the first time, they had a factual tool in their hands that gave these subjective, personal noise experiences an objectified counterpart. The tool served different purposes, from checking and counting airplane passages to confronting national government with monthly reports of the manifested, recorded, noise patterns of airplanes.

Offspring activities: Social network dynamics by users

Geluidsnet itself became an 'established' airplane noise monitoring system. The microphone network was extended to 200 measurement points. Koolhaas developed the organization further, and went to measure noise in other projects. For investments in new projects, a commercial business was established, called Sensornet, while the foundation Geluidsnet was continued for the Schiphol case. Later, Sensornet became part of engineering firm DGMR. One of the other projects of Sensornet was to measure the effects of AWACS airplanes near the village Schinveld, in Limburg (Netherlands), where AWACS, take-off and land from airport Keilenkirchen (Deutschland) to execute the defense of the European Air Space for the NATO. Here, noise levels up to 100 dB(A) are being measured. More and more citizen initiatives start using the monitors, the Geluidsnet information and the Google Earth airplane noise monitor. (For instance, platform "Oegstgeest ziet ze vliegen" and working group "Geluidshinder Kaag en Braassem Noord"). Especially in the wider area, citizen movements emerge. The airport considers these places "exterior" relative to the legal 'noise contour.' This noise contour is a modeled boundary around airplane routes based on information about aircraft types, and calculated estimates of where the noise would, in theory. reach a certain level. In 2007, this mode of working and modeling noise seems outdated, it stems from science in the 1960's. But the institutionalized legally binding policy regime on airplane noise is still based on these old methods. As former Alderman Matt Poelman formulates: "*Schiphol sais: Meten, dat kun je wel vergeten. Wij zeggen, berekenen is*

vertekenen.” (in Eglish: “Schiphol sais; Measuring noise, one can forget about that. We say: Calculating is manipulating and distorting the picture”.)
Meanwhile, Schiphol Schiphol copied the idea of the noise monitor and started its own competing noise measurement system with online data in 2005, NOMOS Online. The setup and graphic outlook is remarkably similar to the monitor of PVRC.

Figure 6. Schiphol starts its own noise measurement network, NOMOS Online (source picture: Schiphol Nederland BV., 2011).

Summarizing the story, an individual with ICT know-how initiated a pilot project with 25 microphones connected through the Internet with the objective to visualize the sensed noise levels of airplanes on a map. From this initiative, a network formed of people hosting a sensor location, and an audience interested in the outcomes of the measurements. After its launch, municipalities appeared interested to turn the project into a long-term endeavour through buying-in local measurement points and the institutionalizing the undertaking into an official foundation.

This network formed itself by a common interest to wanting to have measured numbers on noise levels, in order to check what one sensed, heard, at home, with some form of objectivized “thermometering”. The absence of trust in the State government reinforced the pattern that citizens came to the initiative of Geluidsnet for information. In this way, the tool became a *countervailing power* ‘against the state.’ The tool gives *information power*. With this asset, the local interest groups gain respect with official institutions. For instance, the village Leimuiden has shown with the Geluidsnet overviews how much noise its citizens have to bear at night after 2009, when an airplane route was shifted in their direction. (see Table 1).

Table 1: Example of the reporting on the Internet by Geluidsnet about Schiphol aircraft noise

Tijdstip [time] 2013-07-01	**Duur sec.**	**SEL dB(A)**	**LAmax dB(A)**	**[height] in m**	**Toestel [aircraft]**
00:35:23	79	74.1	65.3	1112	Boeing 737-82R (B738) Pegasus Airlines
01:09:44	124	83.6	74.4	716	Boeing 747-4EVF (B744) Southern Air
01:48:07	127	76.4	64.4	1242	Boeing 737-8K2 (B738) Transavia Airlines C.V.

Tijdstip [time] 2013-07-01	**Duur sec.**	**SEL dB(A)**	**LAmax dB(A)**	**[height] in m**	**Toestel [aircraft]**
01:54:37	82	71.1	61.5	1127	Airbus A319-111 (A319)
02:34:02	111	79.8	68.6	949	Boeing 747-406F (B744) Martinair Holland N.V.
03:18:57	98	78.5	67.0	1318	Tie-up extracted from Country Sequence
03:28:40	96	75.6	65.1	1165	Boeing 737-8S3 (B738) Corendon Airlines
04:21:14	127	77.8	69.1	1193	Boeing 737-8K2 (B738) Transavia Airlines C.V.
04:25:19	93	72.1	59.5	2363	Boeing 767-38EER (B763) JetAirFly
04:29:05	111	75.8	64.5	1043	Boeing 737-8KN (B738) Corendon Dutch Airlines B.V.
05:07:25	99	77.0	65.9	1383	Boeing 737-8K2 (B738) Transavia Airlines C.V.
05:09:19	110	78.8	69.1	1264	Boeing 737-46J (B734) AirExplore
05:11:18	96	77.5	67.5	1191	Boeing 737-86N (B738) TUI Airlines Nederland B.V.
05:12:48	78	78.7	67.2	1351	Boeing 737-8K2 (B738) Transavia Airlines C.V.
05:14:07	83	77.1	66.4	1150	Boeing 737-8K5 (B738) TUI Airlines Nederland B.V.
05:15:40	91	78.7	68.2	1283	Boeing 737-8K2 (B738) Transavia Airlines C.V.
05:17:32	111	77.2	67.8	1257	Boeing 737-8EH (B738) Transavia Airlines C.V.
05:19:44	101	77.9	68.0	1198	Boeing 737-8EH (B738) Transavia Airlines C.V.
05:24:32	81	74.5	63.2	1275	Boeing 737-7K2 (B737) Transavia Airlines C.V.
05:27:47	109	77.0	65.4	1232	Boeing 737-8K2 (B738) Transavia Airlines C.V.
05:31:03	117	76.4	67.1	1259	Boeing 737-8K2 (B738) KLM Royal Dutch Airlines
05:34:02	123	78.1	67.3	1112	Boeing 737-8K5 (B738) TUI Airlines Nederland B.V.
05:43:00	71	78.7	69.2	1158	Boeing 737-86N (B738) TUI Airlines Nederland B.V.
05:50:14	106	76.3	64.7	1135	Boeing 737-85P (B738) Corendon Airlines

Table 1: Example of a list with a selection of flight details during the night, measured by Geluidsnet in Leimuiden between 0:00 and 6:00 AM on July 1st, 2013. (Source: This list is part of the overview of the "Year graphic of Measurement point mp262". Open data available at: http://project.geluidsnet.nl/kaag/grafiek/?mp=mp262&date=2013-07-01&yg=jaarevents)

Since December 2006, there is a new State committee on the Schiphol affairs. This Alders Tafel gave advice about the balance between the development of Schiphol and the region, first on short term, then on middle-long term (2020). Nowadays, the Alders Tafel is re-institutionalizing the communications and organization of the representatives and reducing the amount of deliberation structures. One thing that is new, is that the "omwonenden" are now considered a separate category. The formalized platforms of citizens who represent the people who complain about the noise levels and effects on sleep disturbance, will no longer been regarded as "one with the municipality as local actor", but is regarded as a relevant constituency in its own right.

3.5. Evaluation in hindsight

There was an 'emotional' trigger and success factor of the project; there was a lot of anger and frustration among citizens about the national government, and a commonly shared feeling of injustice or unfairness of information. Because many people in the region felt lied to and misled, there was huge support for such a "protest activity/project" of a creative individual that courageously said "let's go measure the noise ourselves". People stood behind the goal to start measure the noise themselves, from their roofs. In their opinion, the real information about this noise was not on the table. Meanwhile, the national government and Schiphol refused to think about measuring the noise, because they aught this “not possible” in 2003-2004. After this project showed successful, Schiphol started a similar project themselves –but they lost the *information monopoly* on aircraft noise information. The professional noise experts of Schiphol and the inspection service formed a “small world where people know each other well”. They used to have a world of their own, where their statements were authoritative. Now, they were confronted by ‘novices’ who approached the complex phenomenon of noise in a ‘lay-person with common sense’ manner and simplistic way. Innovative was, that Geluidsnet approached the phenomenon of noise from a (technical and organizational) network perspective, using Internet as a powerful infrastructure and publication medium.

The tool could spread fast with help of media attention, because it was well-timed. The pilot happened in a time when the municipalities felt they had to do something to represent the feelings being manifest among its citizens, who were forming citizen protest groups that had lost trust in their national (and local) government. Multiple statements were made, in newspapers, on websites and in municipalities’ communications, that the ‘national parties’ had bluntly lied to its citizens, had been delaying decision-making by parking and critical thought in ‘committees’, and by subtle sabotage of the existing way of calculating the noise, drawing up ‘a curtain of smoke’. The existing noise observation infrastructure that had been put in place, was owned by Schiphol; *as a butcher who test its own meat.* It had put expensive measurement points in a few places, often in ‘empty grassland’ instead of in villages, to validate or check the modeled noise patterns. But these noise sensors were in maintenance each year for a long period during the summer holidays when the airport had its top days. In general, it was received as a flawed system by citizens.

The tool did provide the “objectivized measurements” that people missed. People who had thought, “Am I crazy perhaps, that I hear so much noise, this loud?” now had an impartial piece of technology, that would “thermometer” noise levels and classify it as high or not. As a reaction, Schiphol started to copy the project and placed extra measurement instruments in the field themselves. The values became less and less debated. The debate shifted towards how to solve the high noise levels and divide the noise burden evenly (waterbed effect; increasing quality of life in one village by adapting airplane routes, often worsens the situation elsewhere). Rene Post: “*You are transferring the discussion, coming out of the ‘trenches’. That was beneficial.”*

Typical characteristics of the tool: A conviction of Post and Koolhaas was, the monitor had to represent in real-time what people could check in the field themselves; there should be face validity. Thus, the instrument should be “live.“ Another conviction was that the Instrument should be openly accessible through Internet, and the processing of data should be as transparent as possible. (Post: *“In the Internet, Openness is in its genes.”)* In about five mouse-clicks, it should be possible to trace graphics and monthly report data back to its original measurement by individual sensors, in language that lay-people can understand. This last principle was important, and distinguished this tool from the lengthy reports of the national government, where information in annexes usually was lengthy and not-understandable for others than professional noise experts.

End conclusion airplane monitor Schiphol:

According to interview respondents, it was to be expected that Schiphol would take all the noise-space it would get, and that it would argue and lobby for freedom and borderlessness of its noise-space, as it limits their economic aspirations. But a minister and an environment inspection institute should have a wider professional distance from Schiphol than seemed current practice in the case. The excuse argument of the State government and Schiphol, “it is a fact, we cannot measure noise” has been demasked as a façade for behind-the-scenes mechanisms of power, where the ruling regime was unwilling to allow for steps in this direction.

4. The Groningen Earthquake monitor

In 2009, the citizen initiative “Groninger Bodem Beweging” was founded. A reason for its foundation was the total breakdown of trust in the national government (personal quote, interview1): “Trust is simply not there any longer. Until now, that is also justified.” Earthquakes were causing more and more cracks and other damage to houses in the region around Loppersum, a village east of the city Groningen. A part of the local community was worried about the earthquakes in relation to their homes, house values, quality and safety of living, and in relation to the ongoing gas exploitation of the ‘Slochteren gasbel’ by the Dutch State and Shell. (The Dutch State and the international oil company Shell are the shareholders of the gas extraction firm NAM in Groningen.)

4.1. How the tool came about

For a long time, NAM doubted openly whether the earthquakes had any relation with the gas exploitation. When the interdependency between gas extraction, soil subsidence and earthquakes became inevitably clear, the occurrence of earthquakes and especially its impact (meaning damage to houses and other constructions like churches, pipes, dikes), was said to be little, minor to other causes or marginal. If damage to houses was detected, citizens could file a complaint to the NAM and a professional would come and locally inspect if any financial compensation should be warranted. Often the conclusion of NAM-experts was that the NAM was not proven to be responsible, and thus did not need to take any compensating action (as the butcher who judges its own meat). Local people felt as if they were not taken seriously by the NAM or by any governmental body, regarding this issue. Some people in the area were of the opinion that all the fuzz about ‘earth vibrations’ was exaggerated, others did not want to speak about it loudly, or wanted to prevent others to do so because it could cause housing values to decrease if the severity of the phenomenon of recurring earthquakes would become widely known.

Because the earthquakes (or ‘earth vibrations’) became more frequent and more severe, damage to houses became more serious. In 2009, the Groninger Soil Movement (in Dutch: Groninger Bodem Beweging, GBB) was founded as citizen initiative (Source: Werkgroep PR, Groninger Bodem Beweging, Factsheet Gaswinning). Part of its community activities was to make a clear and transparent overview of the earthquake activities. The maker of the Groninger Earthquake monitor is mister Wim Blanken. He is geo-information advisor of profession, and works for governance bodies like the province and Rijkswaterstaat, the primary executing agency of public works and water management in the Netherlands. In those days in 2009, there was no oversight of the situation, and when the press asked for data, the new citizen initiative could not provide in this. Blanken envisaged that the citizen union would become much stronger if the GBB could provide oversight information and imagined a real-time web-based GIS map that showed all earthquakes and (reported or verified) damage. Blanken: “You would have an instant overview over the situation.”

4.2. Building the tool

As geo-information professional and hobbyist in programming with open source software Quantum GIS, he built the tool (in Dutch called “Bevingskaart”) in about two to three weeks. Because Blanken could do most work himselve, in his available ‘free time’, the tool was inexpensive. The hosting of the site costs about 20 Euro a month, and the maintenance of the tool takes one or two days a month, in total. While the cracks and damage to houses are being recorded and photographed by the inhabitants themselves, the earthquakes are not seismologically traced by citizens. For this data, Blanken used the seismologic information of the KNMI, the Royal Netherlands Meteorological Institute of the Dutch

Ministry of Infrastructure and the Environment. KNMI is a national reference and research institute focused on weather, climate, and seismology. The KNMI has an extensive network of seismometers to measure seismic activity in and around the Netherlands. Its network consists of geophones in boreholes (to 300m depth), accelerometers and 'broadband' seismometers. (source: KNMI). Blanken noted that the KNMI did not provide a complete overview of all earthquakes and vibrations in the territory on its website, but just showed the last 30 earthquakes. It did have a report with older earthquakes, but this was a report in PDF, not in any suitable GIS-format. In order to build a complete dataset with all recorded earthquakes, Blanken wrote a semi-automated script to import the earthquake data from the annexes in the old PDF report into his own database, and published them on a web map, the "Bevingskaart". Furthermore, he programmed the automatic insertion of new earthquakes on the Bevingskaart by importing a real-time geo-RSS feed from the KNMI website into his database (updated every 15 minutes).

4.3. Effect when the tool was launched and network formation practices

In hindsight, Blanken had not expected that the launch of the Bevingskaart would have the huge impact that it did. After he Twittered that the Bevingskaart was online on the Internet in 2013, the number of new citizens applying for membership of the GBB exploded. The province and the Safety region (Veiligheidsregio) came to visit GBB. Emergency services requested if the real-time data could be served as Open Data in kml or geo-RSS feed through PDOK, a Public Service on the Internet with webservices (digital maps). The union GBB, now run by volunteers, is growing and professionalizing further. On February 28th of 2013, a new board was installed. Blanken's partner has taken the responsibility as secretary of the GBB, making news updates for the website and managing the membership list. The municipality of Loppersum has made an empty building available, offering office space to the GBB. There has been a meeting with the KNMI about getting the right seismologic data. Most of this data is now provided for to GBB. However, this comprises all the processed data of the KNMI, not the "raw data" that the seismologic sensors trace in the field directly. Ultimately, this is the sensordata GBB wants (because some of the data of the KNMI has been filtered ex-post, according to Interview 2).

During 2013, the Bevingskaart has got a network function in the region. Currently, the GBB has produced successor of the "Bevingskaart" in the more extensive, Open Data based "Gasbevingen portal" (gas vibration portal, available at http://opengis.eu/gasbevingen/, see Figure 7).
Recently, the KNMI has also disclosed the earthquake information in a kml-file (which all people can access and see in Google Earth), so the Bevingskaart is not unique anymore. Also the NAM is now making its own earthquake map on its website. The Bevingskaart thus now has two similar 'sister' websites, one of the government seismologic research institute and one of the gas exploitation firm.

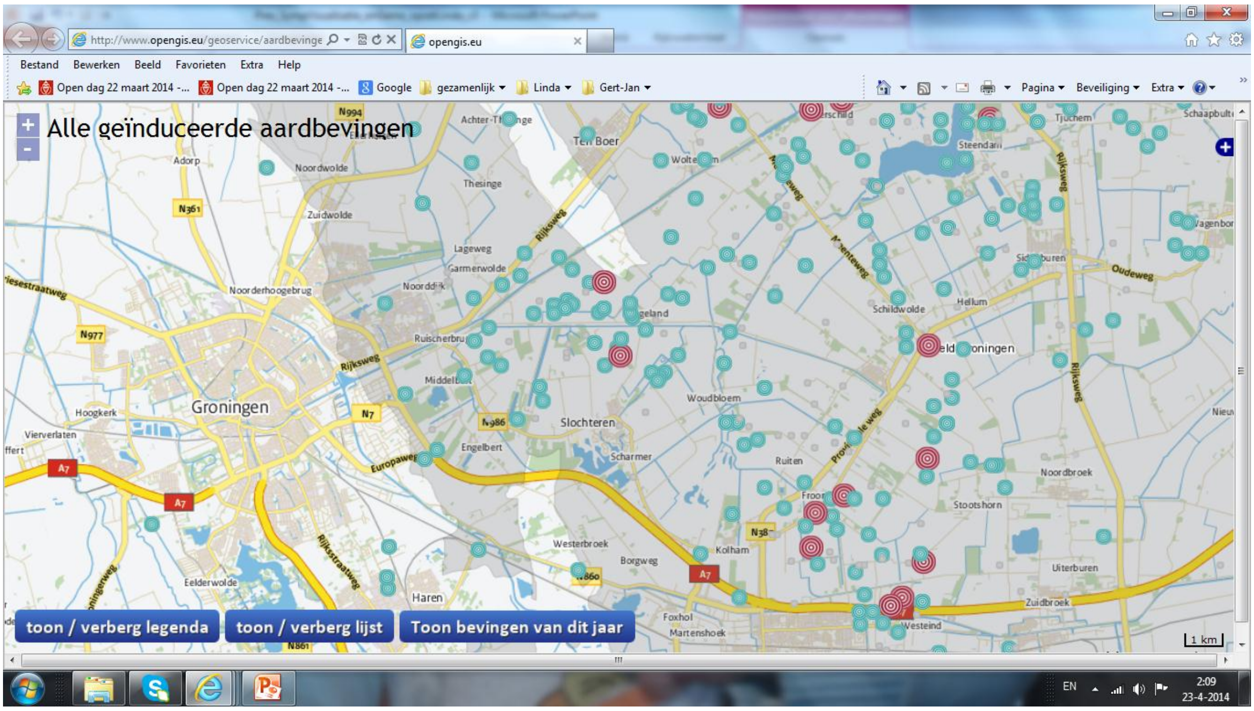

Figure 7. Gasbevingen portal, successor of the "Bevingskaart" with data of the Groninger Bodem Beweging and the KNMI. Source: Vereniging Groninger Bodem Beweging (GBB).

4.4. New developments after January 2014

In 2013, the conflict between North-East Groningen citizen movements and the Dutch State raised its peak so far. Interviewed citizens recall to journalists that they had never thought the national government would allow for earthquakes as high as 3.6 on the Richter Scale. In recent studies, earhquakes of 4.1 and 4.3 on the Richter Scale have been projected for the future. According to GBB, the gas extraction should be scaled back to half the current rate. GBB: "The current policy is "pappen en nathouden" (a Dutch expression for "muddling through". There is hardly any reduction in gas extraction, only some minor changes in drilling locations. This has to stop. We citizens are all in the same shit. And we cannot leave, because no one is going to buy our houses. So we are here to stay." Meanwhile, the national government has done research in autumn of 2013, and has decided in January 2014 to change the gas extraction scheme and extract less gas in extraction sites in Loppersum, but to increase gas extraction rates in other places. According to Minister of Economic Affairs, international agreements and related national interests are of such an economic importance for the State, that slowing down gas extraction rates any further is not in the interest of the Netherlands as a whole (although admittedly this would be beneficial for the region of North-East Groningen). Research in the effects of gas extraction will be intensified, and the process of damage reclamation will be further object of study and decision-making. For the region, the national government wants the damage caused by gas extraction limited as much as possible and reimbursement of remaining damage. The reimbursement process should be improved. Aside from that, the NAM needs to help building owners to strengthen houses against earthquake damage, for example by placing additional support beams.

In March 2014, TNO, a government institution for technical building research, has been commissioned by the NAM to place 200 sensors in buildings in North-East Groningen. The sensors will measure and record each earthquake and the effect it has on the building. Municipality governments in Groningen show much interest. During the writing of this research, in May 2014, the mayors of 15 Groningen municipalities have requested to place a sensor in their Town Hall. In addition, over 300 inhabitants of Northeast Groningen have signed up for a building sensor. The building sensors are part of a new *measuring and monitoring network*, which will be expanded in 2014. The objective of the NAM with the measurement results is to learn more about the strength of houses and buildings, and how (and what) buildings above the Groningen gas field could be made earthquake-proof.

To conclude, we see a blend here of citizen information and use of government sensor data. We find it remarkable that lists of earthquakes had been produced previously (by the KNMI), but this information had not been mapped. When draft findings of this analysis were presented on a "visualization seminar" on April 24th, 2014, the secretary-general of Rijkswaterstaat responded: "This is a nice item. We have to do something about this, the public government has to map the situation and have the information, otherwise citizens are going to do it themselves. Pictures are powerful messages, if you do not refute image information, than the picture becomes the truth."
Now, a new research-sensor network is going to monitor and report about building constructions and their robustness against earthquakes in the region. But no sensor-network is being rolled-out on monitoring gas extraction and its impacts on soil stability. In our view, this is at odds with each other. (And from a long-term sustainability point of view: why is gas more valuable if it is used (and spoilt) today in not-so-efficient processes like the warming of old, non-isolated housing stocks in the Netherlands, than when the gas is stored in the ground as asset for future harvesting and selling?)

5. Findings, discussion and conclusion

5.1. Results from the two cases, comparative analysis

Comparing the two case studies, the social dynamics around the Schiphol airplane monitor and the Groninger Bevingskaart, we find a number of overlapping characteristics:

1. In both cases, there is a stunning lack of trust in the information provision by the national government, and public outrage about the attack on people's local quality of living.
2. There is a clear need, a manifest information question about phenomena that affect the 'quality of living' of (large) groups of inhabitants in the region. "How bad is it?" is the core question that local *people ask among themselves and their neighbors.*
3. Local people feel they are criticized as not everyone experiences the same burden from the developments that become intrusive and affect the private livelihood. They ask themselves: Am I crazy, or is this not normal? And (when) has a threshold been passed beyond which the situation has become "unsound", that is, unhealthy or unsafe? Where does the 'tipping point' lie? Local people want an 'objectivized' type of monitoring.
4. In both cases, an ICT professional takes the initiative individually and builds the idea and tool in own time. Both professionals have experience with Internet technologies in their work. In both cases, the pioneers have a "can do" mentality. They self-developed the tool on the Internet, against relatively low costs.
5. Both tools are founded on principles of Openness of data, on accumulating measurements and data over time, and on providing all information with others through a publically accessible website.
6. Because the tool is "live", (almost) real-time, measuring and visualizing these phenomena, people can 'validate' by looking "out of their window"; what they experience 'on the ground', is now being represented in a tool, which provides the information in an objectivized way [in decibels or 'vibrations on the Richter scale']. This step is important, because it reduces the discussion about whether or not the particular noise or earthquake has really taken place and if it was 'a significant one'.

7. In both cases, the designers have put effort in an understandable format to present the information. Both designers criticize the national government for not providing understandable information in an easily accessible fashion, nor servicing the source data.
8. Both instruments had a big media effect: the airplane monitor came on the 20:00 hour news (prime-time in the Netherlands), the Bevingskaart came in the newspaper and was retweeted on Twitter, leading to new membership applications for GBB.
9. Both instruments led to a form of institutionalization.
10. In both cases, the 'social boundary object function' of the tool contributed considerably to its success: Many people could pick their own pieces of interest from the vast amount of information, the instrument became a kind of information hub in a network. As the hub function grows, the importance of this node in the actor network also grows.

With these points of a limited two-case-study comparison, we will now turn back to our research questions of this paper, and draw our main conclusions.

5.2. Discussion and concluding remarks

Proposition 1: Computer and Internet technology co-evolve with method advancement in planning

One of our conclusions, which we cannot yet proof with quantitative numbers but which appears to us as a form of co-evolution, is that Computer technology drove innovation in planning practices and methods circa 40 years ago, and that Internet and Digital media technology is driving change in planning practices today. We see a parallel or co-evolution between ICT 'revolutions' (breakthroughs) on one hand and transformation of planning practices on the other hand, with technology enabling method-advancement. However, while in the previous heydays of planning methods the State was receptive and can be seen as an early adopter, nowadays the embracing actor and pioneer is often found in other spheres than the central government, denoted here as the citizen network.

Explanation:
In the heydays of the 'rational paradigm', in the 70's and 80's of the last century, the fast advances and many publications on planning methods coincided with the enabling of "accumulation" and "stapled, iterative processing" of large volumes of data by computerized methods. Computer technology was the main driver, contemporary decision-making cultures were receptive to embrace modernity. General rational structuration approaches formed a 'logic route' to make generally accepted –and thus legitimized– claims on possible outcomes and consequences based on data input. Labor-intensive administrative work (calculating, map drawing, re-arranging files in paper archives) was speeded up enormously, using methodologies like GIS, scorecards, cost-benefit schemes, system dynamics (differential equation) models, etc. Computers bore the promise of a better future; investing in planning support would pay itself back. Later, critics pointed at the reproductive mechanism in this alignment of political decision-making social spheres and 'computerized support expert' spheres, which tended to re-enforce existing social structures and thus, to some extent, served as *legitimation machine* for the ruling class.

Nowadays, Internet and Digital media technology has enabled new ways of information processing, with technologically standardized (rational) schemes for directing and transforming continuous data flows, from diverse –networked- sources and towards diverse target groups and mass media. The interconnectedness of people, things and places by sensors, smartphones, social media and a working, decentralized and networked information and communication infrastructure binds pieces of information and connects individuals with mass media platforms. This enables individuals to reach their audience, and empowers them to voluntarily gather and upload *for them relevant* pieces of information. The innovation is now not only coming ‘from above’, from universities (f.i. on health science, climate science, environmental science) and global Internet companies like Google and Facebook, but also ‘bottom-up’ from individuals being receptive of the enabling power these technologies provide, and taking initiatives like building regionally monitoring and ‘live feedback provision’ information structures and (consciously or un-planned) connecting communities around these.

In the two case studies of this paper, the centralized State government was an inhibitory factor that eventually, by an economically oriented policy with little acknowledgement of the regionally raised concerns, and by its passive attitude on the quality of living for many local citizens, empowered its own countervailing power in the form of a networked community raising objections to truth-claims made by the State. It is a hopeful sign that these working information models (‘vliegtuigmonitor Schiphol’ and the ‘Bevingskaart’), here called social boundary objects, are being embraced by municipalities and other local government bodies. They find in the tool a powerful *information instrument that legitimates their position* and point of view in dialogue with the national government and Schiphol, strengthening their negotiation power. The networked structure of getting data from many (geographically dispersed) places and the open way of communicating this data in understandable and transparent, factual format back to the affected citizens, provides the tool its legitimacy. This legitimacy is acknowledged by the various government bodies (municipality, minister, parliament). *Legitimacy as the notion of the ‘right to govern’ (Bodansky, 1999) always rests on the shared acceptance of rules and rule by affected communities* (Van Vossole, 2012).

Proposition 2: Citizen sensor networks work as embodied method for hypothesis falsification

While acknowledging the deep influence and meaning of language in our thinking and decision-making, and our embodied way of understanding our surroundings (Lakoff and Johnson, 1980, 1999; Lakoff and Núñez, 2000), we also emphasize that the ‘natural world’ has its own embodiment. ‘The worlds out there,’ communicate or interact their signals in forms like rythms (day, night), smells, temperatures, light and darkness, and in “wholes” like landscapes, ecosystems and emotions. We make sense of these signals not only in terms of language, but also by directly sensing smells, tastes, feelings, sounds. Sensors can bring a certain level of *inter-subjectively agreed standardization* in measuring (selective) parts of these phenomena [in decibels, vibration on the Richter Scale, air pollutants in parts per million concentrations, etc]. Combining sensors with citizens brings this measured, standardized information back to the community and its decision-makers.
The interpretation of measured values can be debated and negotiated, but technically validated outcomes of measurements in terms of agreed, formalized classification systems are not only persuasive, there comes a point when they become convincing and clear, even for skeptics. Even when this means that hypotheses under ruling policy regimes are being falsified, such as in our case studies, convincing measurements will be adopted in some form of evidence-based planning. In the cases evaluated in this paper, fundamental assumptions underlying the dominant, State-controlled policy regime were proven false: Hypothesis falsified in case 1: “sound cannot be measured.” Hypothesis falsified in case 2:“there is no causal link between gas exploitation and soil subsidence.” If hypotheses under policy regimes are proved outdated, responsible decision-makers take action and change the policy regime accordingly towards more legitimate planning strategies, in order to remain accountable. (In both case studies of this paper, the responsible state minister took action.) *Therefor citizen sensor networks, in the hands of many, form a powerful tool for informed planning.*

Closing remarks

We will end this paper with a plea for a combination of creative ‘out of the box thinking’ and experimenting in planning with new options Internet and Digital media are offering, joined with a call for commitment of planners to safeguard quality of living on local scales and *think with*, not for, locally affected communities. Part of this safeguarding is communicating transparently about planning interventions, while *using representations of our natural world that affected communities can understand.*

Acknowledgements: The authors are grateful to the interview respondents for their time and efforts spent in providing information and data for this paper.

References

- Alderstafel Schiphol (2012) Technische beschrijving vliegtuig geluidmeetsystemen: Luistervink, Nomos, Sensornet.
- Arts, B.J.M., P. Leroy, and J.P.M. van Tatenhove, 2006, Political Modernisation and Policy Arrangements: A Framework for Understanding Environmental Policy Change. Public Organization Review 6(2), pp. 93-106.
- Bodansky, D., 1999, The legitimacy of international governance: A coming challenge for international law? American Journal of International Law, 93(3), pp. 596 – 624.
- Burke, J.A., D. Estrin, M. Hansen et all, 2006. Participatory Sensing. Paper presented at the World Sensor Web Workshop, ACM Sensys 2006, Boulder, Colorado. (available through the Center for Embedded Network Sensing, University of California).
- Carton, L.J. 2007, Map making and map use in a multi-actor context. Spatial visualizations and frame conflicts in regional policymaking in the Netherlands. PhD thesis, TU Delft. (open access, available at the TU Delft library PhD thesis repository)
- Castells, M., 1996, The rise of the network society. Oxford: Blackwell.
- Corbett, J. et all., 2006, Mapping for Change – the emergence of a new practice. Participatory learning and action 54:13-20.
- Corburn, J., 2004, Confronting the Challenges in Reconnecting Urban Planning and Public Health, American Journal of Public Health 94(4), pp. 541-546.
- Craig, W.J., T.M. Harris and D. Weiner (2002) Community Participation and Geographic Information Systems. London: Taylor and Francis.
- Fischer, F. and J. Forrester, 1993; The argumentative turn in policy and planning. Duke University Press and UCL Press Limited, London.
- Habermas, J., 1998, On the pragmatics of communication. Cambridge, Massachusetts: The MIT Press.
- Hajer, 1995;.The politics of environmental discourse; ecological modernization and the policy process. Clarendon, Oxford.
- Healey, P., 2005, Collaborative Planning: Shaping Places in Fragmented Societies, 2nd Edition, Palgrave Macmillan.
- Kooistra, L., S. Thessler, and A.K. Bregt, 2009, User requirements and future expectations for geosensor networks – an assessment. in: Trigoni, Markham, and Nawaz (eds): GSN 2009, LNCS 5659, pp. 149-157.
- Lakoff, G. and R.E. Núñez, 2000, Where Mathematics Comes From: how the embodied mind brings mathematics into being. Basic Books.
- Lakoff, G., and M. Johnson, 1980, Metaphors we live by. University of Chicago press.
- Lakoff, G., and M. Johnson, 1999, Philosophy In The Flesh: the Embodied Mind and its Challenge to Western Thought. Basic Books.
- Luhman, N., 1995, Social Systems, Stanford: Stanford University Press.
- McCall, M.K. and C.E. Dunn, 2012, Geo-information tools for participatory spatial planning: Fulfilling the criteria for ‘good’ governance? Geoforum 43, pp. 81-94.

- Portugali, J., 2006, Complexity theory as a link between space and place. Environment and Planning A, vol 38, pp. 647 - 664.
- Randolph, J. (2012) Environmental Land Use Planning and Management (2nd ed.) Island Press, Washington DC.
- Scheffer, M. (2009) Critical Transitions in Nature and Society. Princeton Studies in Complexity
- Schiphol Nederland BV. (2011) Audit Noise Monitoring Systeem (NOMOS III), Ardea acoustics and consult, Leiden.
- Scott, J.C. (1998) Seeing Like a State. How certain schemes to improve the human condition have failed. New Haven: Yale University Press.
- Star, S. and J. Griesemer, 1989, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39". Social Studies of Science 19(3), pp. 387–420.
- Termeer, C., G. Teisman, S. Nooteboom, Y. Deelstra (2013) Climate adaptation leadership between small adjustments and transformative change. The case of the Dutch Delta Program. Paper presented at the ECPR General Conference, Bordeaux.
- Van Vossole, Jonas, 2012, Local legitimation crisis and legitimation strategies. Working paper, presented at the PhD course “Para uma Leitura Transcalar da Democracia: Os Espaços do Local e a Irrupção dan Dinâmicas Participativas”, Centre of Social Studies, Coimbra University.
- Werkgroep "Geluidshinder Kaag en Braassem Noord" (2013) Analyse Geluidshinder Problematiek Leimuiden. T.b.v. Microklimaat Project Leimuiden. Advies voor de Alderstafel.
- Werkgroep PR, Groninger Bodem Beweging, 2014, Factsheet Gaswinning: Casus Gaswinning Groningen (received in April 2014.)