Making Sense

Advances and experiments
in participatory sensing

REPORT ON THE MAKING SENSE FRAMEWORK AND ASSESSMENT OF PARTICIPATORY STRATEGIES

D5.2 + D4.3

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REPORT ON THE MAKING SENSE FRAMEWORK AND ASSESSMENT OF PARTICIPATORY STRATEGIES

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INTRODUCTION

Making Sense is a 2 year European Commission funded project that presents an opportunity to bring participatory sensing to citizens and communities who wish to monitor environmental issues of concern.

The project was designed to create collective and individual environmental awareness by harnessing the power of networks of people, knowledge and sensors. Its specific contribution has been to emphasise and support the move from collective awareness to collective action, by leading to better informed decision making practices and citizen empowerment through participation and interaction. This, in turn will lead towards change and transformation at community and individual levels.

The project focuses on the core principles of openness, co-creation, empowerment and change making. These principles have informed the design and participatory processes of the pilot studies from the beginning all the way through to the end. Through the use of accessible open sensing technology, and open data and data awareness, the project has aimed to support collaboration and strategies for diverse dimensions of change.

The pilots conducted as part of Making Sense have addressed a combination of environmental issues and focused on participatory sensing of environments. They have been conducted in three European cities: Amsterdam, Barcelona and Prishtina in Kosovo. The sensing technologies used are open source, such as the Smart Citizen Kit that exemplify our principle of openness. Making Sense has worked together with communities to create, interpret and make sense of sensor data to encourage awareness of local environments and empowerment towards change making.

Enabling the active participation of communities and their collective practices is an intricate endeavour. Sensing technologies for citizens to monitor their surroundings themselves or together with others are indeed more accessible, cheaper and easy-to-use. But Making Sense started from the idea that the availability of technologies doesn't by itself induce actual community building and empowerment, which instead requires putting in place sound participatory tools and strategies

Our goal was to move towards more co-created and collaborative interventions in participatory sensing, where citizens are at the core of the whole process. Throughout the project, we embraced the notion that citizens are co-creators with the ability to co-design the problem definition, data collection, analysis, dissemination and public discussion. Dismissing any one-size-fits-all approach, our participatory strategies also took into account the unique features of each local context in the pilots. These included the specific needs and goals of the communities, the chosen technical solutions, partnerships with external stakeholders and organizations, or the type of workshops, interventions and public events.

The consortium is multidisciplinary, including IAAC in Barcelona (Architecture and city planning), the University of Dundee, UK (Duncan of Jordanstone College of Art and Design/ DJCAD & Centre of Environmental Change and Human Resilience/CECHR), Waag Society in Amsterdam (Institute for Arts, Science and Social Innovation), JRC in Brussels (Foresight and Behavioural Insights Unit), the Peer Educators Network (Kosovo) and the European Fab Lab Network. Next to these, we have a large network of supporting partners, from academia to governments and arts organisations, including health, pollution and technology experts.

Two key members of the European Fab Lab network, Fab Lab Barcelona (part of IAAC) and Fab Lab Amsterdam (part of Waag Society) were involved in the Making Sense project. The incorporation of their facilities, networks, agents and expertise helped tap into and grow an existing open innovation ecosystem, where communities of practice and communities of interest collaborate in the design, development and deployment of adaptations to the Making Sense platform to deliver custom solutions to local challenges.

This document is a combined effort of Dundee University and the Joint Research Center, based on the integration of D5.2 (Report and evaluation of the pilot approaches to 'making sense campaigns') and D4.3 (Report on assessment of participatory methods in the pilots and final recommendations). The Making Sense open communication strategies and integrated approaches between consortium partners allowed us to join our evaluation and assessment outputs into one single reporting document for present and future reference. This option offers a single entry point to those potentially interested in a final overview of Making Sense, either considering how its pilots were individually developed, or how the project as a whole managed to build a new collective approach for participatory sensing campaigns.

Section 1 articulates the Making Sense approach to pilots and covers our campaign rationale, stakeholders and summarises the Making Sense pilots.

Section 2 describes the design and iteration of the Making Sense Framework.

Section 3 shows how the Making Sense Framework has been exemplified through the pilots and describes and illustrates each phase of the Framework with an example from a pilot.

Section 4 focuses on ten key topics where we observed how citizen engagement and community building were addressed inside Making Sense and how the project participatory strategies developed from there on.

Section 5 puts forward a new augmented version of previously devised recommendations for participatory or community driven sensing projects, with lessons learned from and for Making Sense

DEFINITION OF TERMS

Calibration Setting or correcting of a measuring device or base level, usually by adjusting it to match or conform to a dependably known and unvarying measure

Co-production Communities and researchers producing findings and outputs together

Collaborative Inquiry Communities and researchers working together as co-researchers to identify issues, challenges and understand previous work

Iteration The process of doing something over and over to improve it

Participatory design All stakeholders actively involved in design and decision-making of technology and organisational development

Protocol An established procedure within the pilots for accomplishing a purpose

Smart Citizen Kit & Platform The platform consists of integrated Arduino-compatible sensing devices, a database for storing the sensor data, a publicly available website, a data visualization API, and a mobile app

Triangulation of data Using multiple sources of data to ensure findings are valid and to enhance understanding

1. THE MAKING SENSE APPROACH TO PILOTS

The definition of the Making Sense campaign is a coordinated period of activity leveraging open hardware, open data and open design focused on the monitoring of environmental issues such as soil, air, water, noise and light pollution. Campaigns are designed to achieve social innovation, support change and reflect upon impact.

1.1 Campaign Rationale

An intention for Making Sense is to collectively position periods of participatory sensing as 'campaigns'. The word campaign in this context is not new, initiatives use the term to describe an invitation, with engagement, awareness and empowerment of citizen-scientists to contribute to scientific research. There are however, alternative understandings and connotations to the word campaign in the same field, and these are linked to protest and activism. Here, local knowledge, issues and questions can be placed 'in opposition' with policy makers, which frequently places scientists in the role of 'facilitator' or 'mediator'.

To this end Making Sense moves from the common concept of campaigns as awareness raising, towards one of a campaign as coordinated steps towards collective awareness and action. The former is a communication and mobilisation action around contested or undisclosed knowledge, the latter is a citizen science and mobilisation action around knowledge production and change. The key factor here, is that the Making Sense moves beyond awareness as this fails to recognise the huge potential of greater participation in question definition, local and situation-specific knowledge, and more complex analyses as well as in decision making.

1.2 Stakeholders

The Making Sense approach consists of campaigns that first engage citizens and potentially also other stakeholders i.e. scientists, policy makers and other bodies, around burning issues to support better environmental decision making and action. Each pilot must identify relevant stakeholders and these will vary across cities and pilots and stages of the pilot process. For all of the pilot campaigns, the communities of practice and interest are the largest groups of stakeholders.

Communities of interest come together through shared concern or enthusiasm and would tend to have lower technological skills than the community of practice (Fischer, 2001). In the context of participatory sensing, communities of interest could be groups of people who jointly perceive an environmental challenge in their local environments. Communities of practice are bound together by their shared expertise who come together to learn collectively how they can improve their skills (Wenger, 2015; Wenger & Snyder, 2000). Examples of communities of practice would comprise hardware makers and tinkerers well versed in open source technologies and digital fabrication.

The Making Sense Framework identifies stakeholders within the first phase and this process of identifying and engaging with stakeholders is discussed further and exemplified in the scoping section below.

There are advantages and disadvantages to including many stakeholders within a pilot. Stakeholders can ensure a diverse and representative view of the community but also may lengthen the process due to differing views and agendas. Whilst data may be open, building communities means participation and trust are vital and openness does not equate to an 'open door' to anyone. Many aspects of community building means participation becomes bounded by the group's aims and motivations. A diverse range of stakeholders can promote knowledge exchange and generate resources for the communities of practice and interest. Consequently, attention should be paid to valuing differing types of expertise e.g. lay and professional as there can be power differentials between different stakeholders. Finally, key stakeholders can promote awareness across to other organisations and partners and create infrastructure for actions to reach widely (Making Sense D5.4, 2016).

1.3 Pilot Summaries

1.3.1 Amsterdam Urban Air Quality

The Dutch environmental defence organisation Milieudefensie found that the Valkenburgerstraat and the Weesperstraat in the heart of Amsterdam were the most polluted streets of the city. Making Sense wanted to know more about the situation in this part of the city and measured the air quality in collaboration with the residents.

A sensor was developed in close collaboration with Wageningen University and RIVM during previous work. This sensor was reproduced, adapted, and updated with better sensors (e.g. the NO2 sensor). The sensors were connected to the residents' Wi-Fi networks and measured: NO2, particulate matter, humidity, and temperature. The air quality data was analysed and interpreted in collaboration with experts in order to make it useful for the residents.

1.3.2 Amsterdam Smart Kids Lab

The Smart Kids Lab began as an installation at the Dutch Cinekid Festival. Children there were able to use the installation to conduct their own measurements on soil, liquid and air and then compare results. Accompanying the installation was an online platform that facilitated performing tests at home or at school, with downloadable materials. This led to the production of downloadable materials for creating self-made sensors in classrooms.

The Smart Kids Lab made it possible for children in Amsterdam to map their environment in a playful way, by using modern technology and instruments. With the aid of small scale tests and self-made sensors they hands-on monitored their direct surroundings at school.

1.3.3 Amsterdam Gamma Sense

Information about incidents concerning nuclear radiation usually takes around 3 days to reach citizens. With Gamma Sense, Making Sense is hoping to bring this down considerably. It is possible to measure gamma radiation with tools most people probably already have today: any smartphone, laptop or tablet camera will work. This pilot is scouting the possibilities to design and build new tools that can be used with and by civilians that want to monitor gamma radiation.

1.3.4 Barcelona Community Champions

In Barcelona, Making Sense worked with participants to teach them the methods for fabrication of technology, the data literacy to make sense of the information captured and the methods to develop future communities through co-creation and collaboration workshops. The idea was to create community champions who have a level of understanding and skills in these technologies that they can pass on to future prospective participants, who are perhaps more technologically sceptical.

The sensor used was the open source infrastructure of Smart Citizen. This is a civic technology that includes a sensor kit and a data platform, which allows users to collect and share open data about phenomena such as temperature, humidity, noise, and air quality. In the end, the citizens chose noise pollution as the issue to focus on.

1.3.5 Barcelona Fab Kids Lab

The Making Sense Barcelona team collaborated with a group of 15 Kuwaiti students aged 9-14 years old to explore the potential of bringing an international perspective to understanding the effects of climate change in their local environment. Working with the Smart Kids Lab activities originally developed by colleagues at Waag Society in Amsterdam, they investigated how going from analogue sensing to digital sensing could give a clearer picture of how pollution can affect local bird species.

The students made Acid-o-Meters from red cabbage to test the pH levels of water and soil samples, as well as creating DIY air pollution monitors from juice boxes and Vaseline. Afterwards, they went on a scavenger hunt to find Smart Citizen Kits (SCKs) that were hidden in the woods surrounding Barcelona's Green Fab Lab. They found them by using the data the SCKs were capturing to understand the environment they were in.

1.3.6 Barcelona Gracia Sound

The Plaça del Sol in Barcelona is a town square that has historically suffered from the noise of drinking into the early hours of the morning by crowds drawn from near and far. Working with the Making Sense team in Barcelona, the neighbourhood association of the Plaça del Sol has been researching and measuring how high in relation to the norm are noise levels around the plaça, and what can be done to improve the situation.

The Community Champions from an earlier pilot were involved in the planning, development and implementation of this pilot. Once a strategy was developed, they taught the neighbours of Plaça del Sol the necessary tech skills to put together and maintain an environmental sensor and to make sense of the collected data.

1.3.7 Kosovo Season 1

Kosovo is one of the most polluted regions in Europe. Making Sense investigated the air pollution in Kosovo by empowering young people and affected communities and jointly breaking the institutional silence around air pollution in Kosovo through evidence-based campaigns and actions. All three of the Kosovo pilots focused on air quality and all three pilots used a variety of sensors to capture the data. The first pilot focused on air quality measurement in hot-spots around Kosovo and Prishtina.

A participatory approach was taken where committee members aged 17 – 30 were recruited to plan, organise and run the pilot. The committee members collaboratively designed the measurement strategy, for example, where and when to measure air quality, as well as collaboratively designing actions or interventions to be taken.

1.3.8 Kosovo Season 2

The second Kosovo pilot had the same committee members as the first pilot, with the same focus on a participatory and democratic process of designing and conducting the pilot. Air quality measurements were focused on a primary school in the centre of Prishtina. Additional participants from the primary school took part in the process, including pupils from the school and their parents, carers and teachers.

1.3.9 Kosovo Season 3

The third Kosovo pilot also had the same committee members as the previous two as well as the same collaborative and participatory process. In this pilot, air quality sensing was focused on areas around power plants. Pilots 1 and 2 also covered summer, autumn and winter and pilot 3 covered spring and summer, therefore measurements of air quality occurred across all of the seasons over the three pilots. This pilot also included the measurement of bio-indicators, mapping lichen diversity as an indicator of environmental stress.

2. MAKING SENSE FRAMEWORK

This section presents the Making Sense Framework, a step-by-step process of designing participatory sensing activities and discusses the development and iteration of the Framework.

Best practice in collective awareness platforms is changing in response to new science-society-policy objectives and the technologies that can support them. On the one hand, there are substantial know-how and sustained grassroots movements, and on the other, there are large-scale funded, often time limited projects that are not sustained but whose experiences are vital. Sanz et al (2014) derive meaningful indicators to make sense of and share data as well as align with best practice in citizen science.

A distinctive dimension in Making Sense has been on this focus on the transition from collective awareness to collective action, and towards change in the world. Correspondingly, the novelty in the Making Sense approach to participatory sensing is to amplify the stages prior to and post what could be understood as conventional Citizen Science activity.

Furthermore, this exceeds in significant ways what can be termed 'contributory' citizen science. Bonney et al. (2009) describes the different roles for the citizen in science in three ways, contributory (observing and collecting data), collaborative (data collection and refining project design, analysing data, disseminating results); and co-created (public and scientist design together and share the majority of steps in a scientific project/process).

In order to support pilots across the project a Making Sense Framework is proposed to articulate a step-by-step approach in the design of participatory sensing and change-making activity. The framework and process draws on tried and tested as well as new research methods by scoping issues and positioning questions with stakeholders, employing Powerful Deliberate Practices (Dundee and CECHR) as well as Critical Science and Technology Studies coupled with Generative Design for Community Building (JRC). Pilot leads had also previously developed models such as the Amsterdam Smart Citizens

Lab (Henriquez, 2016), The Bristol Approach[1] and Science for Change[2] to support participatory sensing with citizens, however a full cycle of inquiry, leading to action and strategies for change making was not the primary aim of earlier work.

Dependent on the aims and objectives, citizen science and participatory sensing initiatives frequently report on successful outcomes. Occasionally change may occur in the world. However, in the main, change-making has tended to be opportunistic rather than systematically planned for. We argue for the articulation of a full end-to-end process that takes into account the complex longitudinal nature of observing and evidencing change. Without this, a critical evaluation of the steps undertaken to achieve change remains elusive, and the methods or strategies employed make a comparative evaluation of approaches and strategies difficult. Furthermore, subsequent initiatives cannot easily learn from the challenges and successes.

2.1 Framework Design

To ensure best practice, the Making Sense framework adhered to guidelines outlined by Citizen Science Do Tank (Sanz et al, 2014).

Figure 1: Citizen Science Do Tank Guidelines (2014)

The design of the Making Sense Framework occurred over three stages, the first and second consisted of a 7-step framework proposed at the start of the project and iterated after the first cycle of pilots at 12 months (WP5 Woods, Hemment). The final version in month 18 built on the previous frameworks following a further round of pilot activity, and was iterated in a

collaborative workshop session with project partners.

At the first stage, a process was defined that consisted of the following steps: **1) Define Campaign Issues and Indicators 2) Position a Campaign 3) Discover Data 4) Make Sense 5) Open Data through Sharing Stories 6) Distribution of Toolkits 7) Transformation**. The steps can support co-created citizen science, by enabling citizens, communities of practice and interest and other stakeholders, as appropriate, in all stages of the process.

The second stage refined an overarching 7-step strategy **1) Scoping 2) Sensing 3) Awareness, 4) Action 5) Evaluation 6) Sustainability 7) Impact**. The strategies were coupled with indicative methods that upheld the value of collaborative and participatory approaches, including Collaborative-Inquiry, Co-Creation, and Advocacy (see Figure 2).

CAMPAIGN STRATEGY	METHODS AND APPROACHES	7-STEP PROCESS
Scoping	Collaborative Inquiry	**Map campaign issues and indicators**
Sensing	Participatory Design	**Position campaign and monitor**
Awareness	Co-Production	**Discover and share data**
Action	Storytelling	**Open data and share stories**
Evaluation	Triangulation of Data (Qualitative and Quantitative)	**Make sense**
Sustainability	Education	**Distribute toolkits**
Impact	Advocate	**Change**

Figure 2: Second stage Making Sense Framework

The third and final Making Sense approach (Figure 3) proposes an action-based framework for participatory sensing towards change-making. The framework places collaboration, co-creation, change-making and empowerment at the heart of all of the activities, and it proposes these are designed in at the very start and throughout every step.

CROSS-CUTTING MAKING SENSE PRINCIPLES & GOALS
(OPENNESS, CO-CREATION, CHANGE-MAKING, EMPOWERMENT)

Phase	Process Definition
Scoping	Mapping, identifying and framing issues Identifying communities of interest & practice and stakeholders Defining internal organisational process Research and literature review (Academic, grey, prior organisational knowledge) Understanding context & motivations
Community building	Community recruitment Starting engagement process with communities of interest & practice Identifying skills available in community to address gaps Fostering community cohesion & communication Management and governance Instilling principles Documentation protocol
Planning	Fostering and enabling new skills Making or learning about sensors Data literacy Mapping indicators Sensing strategy and protocol Sensor calibration Goals Tools - Selecting, Acquiring, Building, Developing o Sensors (tech) o Methods (design)

Sensing	Measurement of environment Collecting individual observations Questionnaires with citizens Uploading and accessing data Feedback
Awareness	Sharing and (optionally) visualizing of data Interpreting & understanding of data Understanding environmental and health impact Identifying potential for change
Action	Impact (Policy, social/cultural, public discourse) Action by citizens/communities Interventions (artistic, protest etc)
Reflection	Sustainability of the pilot/community Iteration of process/method/protocols/technology Accountability and evaluation Critical reflection and lessons learned
Legacy	Change in the world External impacts for issue e.g. policy change Fostering external appropriation Sustainability of project tools Writing publications Uptake of toolkit/approach by others

Figure 3: Final Making Sense Framework

The first iteration of the Making Sense Framework underpinned the aims of the project and the final version reflects best practice for designing the pilot processes. In this document it will be used as a tool for evaluating and illustrating the different aspects of the campaigns. It is hoped that this will be a useful framework for other researchers, practitioners or communities when designing participatory sensing programmes. Each step of the framework is described and illustrated with examples from the Making Sense pilots in the section below.

3. THE MAKING SENSE FRAMEWORK EXEMPLIFIED

In this section we cover the phases of the Framework in more depth, and present examples for each phase of the Framework from a representative range of issues and Making Sense pilots.

3.1 Scoping

The first phase of the framework and recommended starting point for designing and implementing a participatory sensing approach is scoping. Scoping is the stage for identifying critical challenges through a process of co-operative inquiry (Coulson & Woods, 2016). This involves mapping out the issues of interest and can be done, for example, by a research team initially or in collaboration with a community that already has an issue identified that they want to address. Ideally a literature review would be conducted to understand the work that has already taken place in the field thus far and what citizen science or participatory sensing, if any, has been conducted around the issue either in the local area or internationally. An understanding of the local context in which the work is to be conducted is essential. The culture and motivations of the citizens and community will be vital to understand if successful change and impact is desired. In this phase it is also key to define the internal organisational process of the project leaders. At this stage of the process, mapping and identifying the communities of interest, practice and other stakeholders is critical.

Potential stakeholders: Communities of practice and interest, project team, local community leaders, external experts.

SCOPING

Barcelona Community Champions

This pilot illustrates a comprehensive scoping process, the first stage of the Making Sense Framework. Scoping enabled the Barcelona team to recruit appropriate communities, understand local issues and learn lessons from previous work with the Smart Citizen Kit. They also began the process of co-creation at this stage by identifying environmental concerns within the community and identifying what members of the community could contribute to the project at their launch event. They covered all aspects of scoping in regards to the Making Sense framework and their process can be followed by others who wish to conduct comprehensive scoping.

The Making Sense team in Barcelona took a mixed method approach to scoping that aimed to identify:

- The communities facing environmental issues (and willing to engage in citizen sensing).
- Community-raised matters of concern.
- The technological challenges that users face when interacting with the SCK and platform.

Identifying technological needs

User-research survey: An online survey to community members of the SCK in Barcelona was distributed using Google Forms, this identified the key challenges that SCK users faced. (April - June 2016)

Interviews: Interviews with FabLab Barcelona community members, took place over Google Hangouts, Skype, or telephone, and lasted between 10-20 minutes each. Participants were selected for this user research based on individual experience with deploying the SCK and/or having used the Smart Citizen online platform. The participant batch was heavily skewed male. This is a pre-existing gender bias in the technology community at large and is not a reflection of whom selected for the survey and interviews. (June 2016)

Combined analysis of both methods revealed some challenges evident in the responses, which included:

- **Context and purpose.**
- **Technology.**
- **Community.**
- **Sense Making.**

These challenges are summarised below with supporting evidence from the survey and interviews.

Context and purpose:
The main motivation for people joining the Smart Citizen community was due to an interest in citizen science, environmental monitoring, and civic engagement. However, respondents reported a decrease in motivation due to a lack of purpose in contributing to the platform.

Technology:
Although respondents had an interest in technology, many participants did not have experience with open hardware prior to receiving their SCK. A higher number reported issues with installing the SCK, which was also given as a primary reason for the decrease in participation. As one interview respondent mentioned:

> I work in IT but I found [setting up the kit] difficult for me. I spent the day installing it. I find it is a nice initiative because it is an easy way for people to interact with devices. I can see people being motivated to do it. As well, I see Smart Citizen as immature still. There is a lot of information to validate [P3].

This is also became evident from analysing the survey results, which demonstrated that technology issues, such as connecting to the WIFI and platform and maintaining the sensor kit were the top challenges in the project.

Community:

During the initial launch of the SCK only a few participants expressed a desire to be part of a sensing community, however a majority of the interviewees remarked on a need for more social interactions, events and workshops as part of joining the platform. This was apparent in several of the interviews, as the following quotes demonstrate:

> I wanted to know what other people were doing in the project. I was aware that the sensor would have errors. I was interested in what people were doing but not necessarily specific results.

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would have errors. I was interested in what people were doing but not necessarily specific results.

> Measuring things is easy, but the social point of view is very important. It can show you different things and you can use it for support to know you live in a better place or if it's getting worse. The social point for me is important. It gives you the opportunity to talk to other people, to see what you have in common and to know what other people are doing with the data.

Sense Making:

Respondents admitted a lack of ability to understand the data which was collected and broadcasted by the SCK, this was evident from the survey data. Some participants took the initiative to learn about environmental standards and compare it to their sensor readings. However, a majority requested assistance in understanding the information they were helping to produce.

> We have the data but we didn't know what those measurements were about. We could see when it was going up or down but not the real measurement. I didn't know which number was the real measurement. If there was documentation about that, that would be helpful. I couldn't find good information in the forums. I looked up the documentation about the sensors themselves.

Identifying communities and matters of concern

Desk-based research: A review of official reports, local newspapers, magazines and blogs, published in the last three years, with the objective of finding articles referring to local environmental issues, was conducted to inform the Making Sense team on the complexity of the environmental challenges. Insights gained demonstrated that environmental issues in Barcelona are discussed, primarily, in terms of noise pollution, humidity and damp, air quality, and preservation of green spaces (e.g. urban parks). (February - March 2016)

Community mapping: This approach aimed at identifying the existing grassroots organisations, ranging from neighbourhood associations to citizen movements, NGOs and cooperatives, amongst others, and mapped them on the territory in order to better understand how they connect to each other and to the local issues. This resulted in a database of 274 community groups which were categorised by primary activity according to the emergent themes: environmental, social, infrastructure and services, cultural, educational, economical, health, and politics. (April - June 2016)

Rapid ethnography: To identify which of the environmental concerns are most urgent to citizens in Barcelona, rapid ethnography was employed to examine areas of the city that have been repeatedly associated with environmental issues. Key indicators included hanging posters and flags from resident's windows which expressed matters of concern, specifically opinions against mass tourism and noise levels, both apparently tightly related. (June 2016)

Launch Event: Initially 85 people joined the pilot during a scoping workshop, which aimed at identifying a common target to track what they were willing to contribute to the project: from resources to time, skills, data, and connections to other communities of interest (such as neighbourhood associations and NGOs). They also mapped environmental issues that they knew of in different districts of Barcelona. A contribution chart also allowed for participants in the Launch Event to put themselves forward to take part in the pilot as community champions. (November 2016)

3.2 Community Building

The second phase of the framework focuses on engaging and building the communities identified in the first phase. Recruiting the communities of interest and practice for the project is the first step. Once the communities are on board, the engagement process can begin. Fostering community cohesion and communication is important in contributing to the sustainability of the community throughout the process. Setting up spaces and times for the community to meet together and with the project team is key to this process. As is instilling the principles of the project, for Making Sense these values are openness, co-creation, change-making and empowerment.

During the community building phase it is also important to plan the management and governance of the project team itself and how the communities will manage themselves. This was effectively carried out and is shown clearly in the example from Kosovo Season 1 below. Also, at this point in the process it can be useful to identify the skills available in the communities in order plan how to foster and enable new skills in the next phase to address any gaps. For the project team, planning a documentation protocol is useful for transparency and accountability.

Potential stakeholders: Communities of practice and interest, project team

COMMUNITY BUILDING

Kosovo Season 1

A participatory approach has been the core of the Kosovo Season 1 Pilot since its initial phases, and has been applied across all fields of work: from designing participatory events to measurements in the field and campaigns. The Kosovo pilot Season 1 detailed below demonstrates their process of community recruitment and building.

The strategy for community building in the first pilot passed through the following stages:

- Recruitment of new youth activists and consolidation of the movement (Environmental Festival "Change is in the air" - April 2016;
- Strengthening the internal governance based on radical direct democratic decision-making (May-June 2016);

Recruitment Strategy

Due to country's demographic profile, over 53% of Kosovo's population is under 25 years old, but yet they face immense challenges: from unemployment to lack of visa liberalisation, corruption, etc. Kosovo Season 1 focused its work with young people between ages of 17-30.

There was an existing community of participants (called Committee Members) from the initial stage of Science for Change (2014) to which we added a new group of participants through recruitment during the Environmental Festival "Change is in the air!" Furthermore, when Kosovo Season 1 started to work in the field and promote itself in different events such as Doku:Tech, the Pilot drew immense interest by young people who expressed their wish to join the movement via social media. Therefore, two other Calls for Committee Members were issued in media outlets and social media, where everyone could apply. The selection process of new Committee Members was done by an inter-Committee working group who evaluated the applications and approved them. Lastly, in order to add new energies to the existing community of Committee Members, the last call was made through the first Digital Bootcamp that took place in October 2016. The Call for Participants to attend the Digital Bootcamp received massive attention, over 80 youths applied during a 1-week open call. Participants who were selected for Bootcamp were given a place as Committee Members.

Recruitment of new youth activists and consolidation of the movement (April 2016)

The Environmental Festival which in itself included mini-events such as the Topical Barcamp,

hands-on workshops, talks, concerts, etc., is a great example of how we brought together a community of interest and practice, stakeholders, environmental experts and artists. We did not want to monopolize the space with the Kosovo Season 1 Pilot, instead providing a platform and infrastructure for all those interested to come together and discuss and take actions against air pollution.

In April 2016 the Kosovo Season 1 Pilot launched through the Environmental Festival "Change is in the air!" that took place between 22-23 April 2016, held in Prishtina. The Festival brought together a large audience, including environmental experts, policy-makers, representatives from central and local institutions, artists, activists and other representatives from international organizations. The event was linked with Earth Day, and consisted of numerous activities such as: barcamp talks, presentations, bootcamp workshops, music sessions, open discussions, presentation of sensing tools, and recruitment of new members.

The festival aimed to increase the narratives and awareness about the state of the environment in Kosovo while involving a broader audience, such as: young people, institutions, and other relevant stakeholders in the Making Sense project in Kosovo. Furthermore, young people were provided with the opportunity to enhance their practical skills on informal environmental education and the interactions between technology and environment through a variety of workshops; as well as joining the Making Sense committees.

Kosovo Pilot 1 also delivered a Topical Barcamp – an activity that brought together existing Committee members and newly recruited members, as well as other environmental and health-related issue experts to discuss the environmental situation in Kosovo, focusing on air quality and its impact on health. This event, amongst other activities, served as an information session regarding the project goals, activities, community growth, and future plans. Participants of the Topical Barcamp shared their contact information, which was used to contact all interested parties for the upcoming meetings. This event was attended by 153 participants.

Demographic profile of participants

The pilot recruited 43 Committee Members (24F / 19M). Committee members' age varied from 17 to 30. They came from different cities of Kosovo, but the majority of them live in Prishtina (either studying or working). Their backgrounds are also diverse: students of different profiles (i.e. BA, MA, environmental science, film-making, law, economy, mechatronics, high school, etc.); some of them hold also part-time or full-time jobs, such as: teachers, waiters in the bar, etc.

Internal governance & internal communication

Once the recruitment of new members occurred during the Environmental Festival, a series of meet-ups were organized with the newly-recruited and existing activists to get to know each other and understand the project. Additionally they were planned to strengthen the internal governance based on radical democracy decision-making. Consequently, all the activists were distributed into three semi-autonomous Committees: **1) Research and Monitoring Committee; 2) Education Committee; 3) Campaign and Mobilization Committee**. During the meet-ups it was agreed that monthly General Assemblies would take place.

Therefore on 1st June, 2016, the first General Assembly was held and it served as a coordination point with the project community, as well as a bridge for an open forum and reflection on the work of the project. These meetings were held once a month, and they enabled the committee members to share discussions, suggestions, outcomes, and challenges. The committee members also reflected on the work of the project and took joint decisions based on direct democratic principles regarding the approaches and methodology that they wanted to use in implementing project activities.

The idea behind distributing activists into Committees and giving them a role within the project, that is, a title and the right for equal decision, was to not reduce the activists merely into volunteers – an approach that has been long-cultivated in Kosovo by the development world – instead giving them ownership of the project. Moreover, the General Assemblies were meant to give a space for everyone to voice their opinions, concerns, agreements and disagreements as part of the radical democratic nature of the Kosovo Season 1 Pilot. This approach was chosen to challenge the existing crisis of democracy in the country. With democracy here we mean a broader crises, starting from the lack of democracy within the civil society sectors to governmental institutions, municipalities, etc.

Internal governance of the Kosovo Pilot is distributed between the Coordination Collective (project staff) and the Committee Members. The agenda is proposed by both parties, and the decisions are made by consensus within the General Assembly. For example, when the 'targeted measurements' were introduced, the proposal was drafted by the Coordination Collective, then it was forwarded to the Committee Members who reviewed, commented and then approved it at the General Assembly. This process happened regularly with other elements of the project. However, it should be noted that the radical participatory processes can be time-consuming, requires immense effort for listening, patience, dialogue and discussion, and it is a culture that needs to be cultivated and curated with persistence and care.

Another important element that is the internal communication between the Coordination Collective and Committee members. During the first General Assembly, it was approved by Committee Members that internal communication should proceed as following:

- Every Friday, a brief notification was sent to Committee Members, describing the main work of the week and reminding Committees of their tasks
- Any discussion then happened in a dedicated Whatsapp Group, which is also the main dashboard for internal communication
- It was also agreed that a Facebook closed group was used, although on reflection it wasn't used as much as Whatsapp
- Lastly, when the feedback or opinion of Committee Members was required, usually it's done through Google Forms

3.3 Planning

Overall, this phase entails the selection, provision, and setting up of teams, tools, skills, methods and goals.

This phase of the framework may have some overlap with the previous phase. However, where the previous phase was focused on engaging and bringing the community together, this phase focuses more directly on preparing the community for data collection, interpretation and action. To that end, training new skills within the community, including making sensors and understanding how they work as well as understanding what data is and how to interpret it, should encourage better engagement within the community as well as empowerment.

Deciding what the goals are for the project is vital at this stage, this decision will have implications for the sensing strategy chosen as well as what sensors are chosen and what methods will be used for other types of data collection. Mapping and deciding on other indicators, such as photographs or data journals, to annotate the sensor data can be useful for a deeper understanding of the sensor data. Finally, once other decisions have been taken, the sensors must be calibrated prior to the sensing phase. This is important to ensure the accuracy and reliability of the data.

Potential stakeholders: Communities of practice and interest, project team, external experts

Planning

Kosovo Season 1 & 2

The below example illustrates how the Kosovo team worked with their Committee members to train them in a variety of skills, calibrate their sensors and choose a sensing strategy.

Training of activists and selection of tools for measurements

From July-September 2017, Kosovo Committee members jointly with Coordination Collective selected the tools for measurements and then received training by the Coordination Collective

in various skills including how to calibrate the tools, how to run measurements and how to upload data online. The Impact Calibration activity aimed to calibrate the sensors and to make the link between calibration and the project outcomes. In terms of process, impact calibration is part of the scientific experiential education of participants (especially students of environmental science who haven't have the chance otherwise to work with similar tools), as the requirements of calibration capture the key aspects that differentiate citizen science from other kinds of activity.

In terms of content, it enables the project team to make clear statements about the reliability of the readings so that they can be used for campaigning. Impact calibration recognises that policy impact and community engagement are related to trust in the sensor data. During the activity the following sensors were calibrated: Airbeam and Dylos DC1700.

The calibration of the devices was done in close collaboration with the US Embassy in Kosovo. The central institutions such as Kosovo Environmental Protection Agency, as well as local institutions such as Municipality of Prishtina, were contacted to assist and support the calibration process. Although positive feedback was received from both institutions, they failed to support the calibration process in practice, and hence, the efforts were directed towards US Embassy in Kosovo.

Impact Calibration was implemented in three separate 'sprints' for several reasons: first, to ensure that the data collection sample is taken from different parts of Kosovo and it is calibrated against scientifically reliable measures such as diffusion tubes; second, with the recruitment of new Committee members in different time periods, the aim was to ensure that all Committee members receive hands-on skills on the calibration process, in order to contribute to skill-transfer and the future sustainability of the project itself; and finally, the calibration process is seen as an ongoing methodological process that is constantly checked-in, verified, adopted and eventually updated.

The following method was used to complete the calibration process:

The devices were run alongside the two Met One Instruments BAM-1020 (beta attenuation mass monitor) installed at the US Embassy in Prishtina. The BAM-1020 has US-EPA certification (EQPM-0798-122) as an Equivalent Method for ambient particulate monitoring. The different devices were run (e.g. Dylos DC-1700 and Airbeam) next to each other for whole day measurement periods, to calibrate the different scaling factors, response times and saturation curves. See Reprogram Your AirBeam[1] for details of firmware recalibration of the Airbeam device, and Steinle et al. (2015), for details of similar Dylos calibration.

Sensing Strategy

The strategy for Kosovo Season 2 was to further develop our practice of 'science for change' i.e. a participatory science practice that is directly connected to people wanting to make a change. One part of the strategy is our shift to differentiate ourselves from statutory monitoring by embedding our measurements within society through targeted measurements.

Making measurements in and around the school was a strategic means to link air quality to the health effects on a vulnerable group, and to engage with people impacted by that: the children, their parents, the school and the wider community and society. This strategy was discussed and agreed by the General Assembly. A discussion document prepared for the General Assembly expressed the strategy in the following way:

Personal exposure to pollution is more important for individual health impact than legal limit values. Knowing what you've actually been breathing over an hour is just as important as what the average value in the city is over 24 hours. This has been shown by a lot of research, and the government, European Union & World Health Organisation all know this. However, it's a lot harder to measure local and personal exposure. Small, reliable and cheap devices like the Airbeam and Dylos are fairly new. Governments haven't figured out how to use them. But we can! We can use them to make measurements for our campaigns. It's hard to change the pollutant level for a whole country. But we can measure things that can be changed.

- We can measure if there's too much traffic next to a school making dangerous levels of pollution for the children, and campaign for the traffic routes to be changed.
- We can measure if new blocks of flats are creating high, narrow street spaces ('canyons') which trap dangerous levels of pollution, and campaign for better planning.
- We can measure if the air inside buildings has high levels of pollution and campaign for air filters to be installed.
- We can measure which kinds of vehicles are the most polluting (probably the buses!) and campaign for improvements (e.g. electric-gasoline hybrid vehicles).
- We can see if certain communities are being exposed to unfair levels of pollution. (This is known as 'environmental justice').

We can use the limit values to say whether levels are dangerous, even if we are not measuring for 24 hours. For example, the WHO PM limit value is 25 ug / m3; so if the average level in a street for an hour is more than 50 ug / m3, for example, it is reasonable to say that the people on the street are breathing unhealthy air. Even though our devices are not as accurate as the expensive fixed monitoring stations, they can be accurate enough: the readings can be good enough to show where there's a problem.

We can also measure relative values, which means looking at the differences between levels. If the level on street A is 3 times the level on street B, it is better to walk down street B! We can measure relative values between areas, between buildings, between types of transport. We can measure relative values for the different activities in someone's day.

But we need to try to make scientific measurements. Otherwise the people who don't want things to change will say "your measurements can't be trusted". So we need to calibrate our detectors, repeat our measurements, and keep a careful record of our activity. We should control for background levels i.e. compare our measurements to the levels in somewhere like a park, which is away from the main sources. Remember that when we're talking about exposure levels, we need to use averages e.g. a high level for a few seconds is not significant, a high average level for an hour is significant. But it's also useful to keep a record of what causes the spikes in the data e.g. a lorry going uphill. Seeing what makes the spikes can tell us about sources of pollution.

We can discover things that are unexpected, that are important, and that the fixed monitors that the ministry uses can never tell us. We don't need to imitate fixed monitoring stations; we can do something more interesting. We can measure things that need to be changed.

3.4 Sensing

This phase is where the main data collection of the project takes part. Sensors are used to measure the local environment and then this sensor data can be fed back to participants if the technology allows it, such as via apps, displays on the sensors or through websites. Other measurements, called indicators, can be used to annotate this sensor data.

Conducting surveys or interviews with citizens about their experiences can be a valuable way to find out how successful the project is. Within Making Sense, the project has a

principle of openness so that sensor data collected is available in using the principals of open source.

The first Amsterdam pilot, Urban Air Quality, illustrates a sensing process using the Smart Citizen Kit sensor below. They also conducted questionnaires to further their understanding of the citizens' experiences with the pilot and any attitude changes that occurred due to the pilot.

This phase of the framework may appear to have some overlap with the previous phase, Community Building. However, where the previous phase was focused on engaging and bringing the community together, this phase focuses more directly on preparing the community for data collection, interpretation and action. To that end, training new skills within the community, including making sensors and understanding how they work as well as understanding what data is and how to interpret it, should encourage better engagement within the community as well as empowerment.

Potential stakeholders: Communities of practice and interest, project team, external experts

SENSING

Amsterdam Urban Air Quality

The Smart Citizen Platform comprises a sensor kit, the Smart Citizen Kit (SCK), an online platform, and a mobile application. The SCK consists of an Arduino-based electronic board and shield, a battery, a Wi-Fi antenna, a MicroSD card, and a set of sensors to monitor humidity, temperature, nitrogen dioxide, carbon monoxide, sound, solar radiation, Wi-Fi hotspots, and battery charge level. The kit has been developed using open source technologies to allow advanced users to add features to their SCKs. The Smart Citizen online platform (smartcitizen.me) allows users to upload data from their SCKs, share them through social networks and make them available to everyone online for free.

It was decided that a sensor kit that could sense the difference in air quality between streets and between floor heights in buildings was required. This was part of a strategic plan to empower citizens to answer the questions that were important to them through the deployment of sensors.

Sixteen sensors were distributed to the participants. These were adapted and updated with better sensors (e.g. the NO2 sensor) from the Smart Citizen Kit described above. The sensors were connected to the participant's Wi-Fi networks and calibrated to measure: NO2, particulate matter, humidity and temperature. Sensors were placed in such a way that they could produce data that answered all of the citizens' questions, including the difference in

air quality between ground floors and higher floor levels. During the two months the sixteen sensors were online they captured one minute averages, these were later calculated as hour averages to be able to filter out the outliers.

The customized sensors were produced in the Amsterdam Fab Lab that is an integral part of Waag Society, which is a place designed for education, experimenting, testing and creating prototypes. This created some issues with scale where it was difficult to produce the required amount of sensors in time. Production at a specialized site could have potentially been more efficient.

The citizens also filled in a baseline survey at the beginning of the pilot and a follow-up survey at the end of the pilot. These surveys included items of concern for specific environmental issues, what they felt were the causes of issues, what they wanted from the pilot and what they needed to support change.

3.5 Awareness

Sharing, visualising and **understanding the data between the citizens and the project team is vital for transparency, collaboration and empowerment**. Understanding the environmental and/or health impact of the data collected can lead to identifying where the potential areas are for change or action and leads directly into the next phase.

Once the data has been collected, it requires interpretation in order to be understandable and actionable for citizens. Depending on the type of data collected, this expertise may be available within the community of practice or interest, or within the project team or it may be that external experts are needed for this step.

Potential stakeholders: Communities of practice and interest, project team, external experts, local leaders, local businesses

AWARENESS

Barcelona Gracia Sound

Within the Barcelona Gracia Sound pilot, two different groups of external data experts were brought in to help the citizens think about and understand their data. These external experts had experience and skills that the project team and communities of practice and interest lacked and their involvement enabled the citizens to think about the data that they had collected in a new ways.

Indicators and Insights

During the sensing period citizens received booklets to record insights and notes over the 20 days of measurement. Citizens used these booklets to record insights such as when they heard specific sounds or when they are and when they are not at home. These insights were compared to the sensor data from the Smart Citizen Kits to aid understanding of what is causing the most noise and when.

After the sensing period, the research team printed up graphs with the data gathered from all of the Smart Citizen Kits, and overlaid the times of the day to get a better sense of when noise levels were at their highest and lowest. They also compared the data they collected from the data gathered from Barcelona City Council's sensors. They and the citizens were amazed at how high the noise levels were in Placa del Sol on a consistent basis.

Data Visualisation

The next step was to look at what to do with this data. The citizens were visited by the people from 300.000km/s, a firm of architects, urban planners and engineers, who joined them to start a conversation about how to use big data to paint a picture of Barcelona. They demonstrated ways of visualizing data in order to create different ways of seeing and understanding the city, including a map that marked a location in the city each time it was tagged on social media. This started some great conversations within our group about what kind of stories we were trying to tell about Placa del Sol, and about how people use the square. It also demonstrated the power of visuals to open doors for communication.

Art and design were part of another workshop the citizens had with the design team Domestic Data Streamers. The design team showed the citizens and project team some of their innovative data visualization projects, and then engaged Placa del Sol residents in an activity to think about how to share the data findings, who they want to communicate with, and what they are hoping to achieve. This was a great first step to think creatively about the data and how it can be used to make a real change in the community.

3.6 Action

In this phase the **data that has been collected, analysed and interpreted is used to create actions and interventions that can lead to impact**. This action can take many forms, such as protests, artistic creations and displays, public forums or presentations.

The idea is that such actions lead to impact or change, such as local policy change based around the environmental findings. The actions and impacts in this phase would tend to come from the citizens and be locally based i.e. where the project was conducted.

Potential stakeholders: Communities of practice and interest, project team, external experts, local leaders, local businesses

ACTION

Barcelona Community Champions

The Barcelona Community Champions pilot example action detailed below shows a comprehensive participatory process of choosing, co-designing and making an action. Their chosen intervention is a creative installation that shows the issue of noise pollution in an easy to understand and interactive way.

Action Workshop

Using the insight the community champions gained from the sensors and the associated workshops on data sensemaking and visualisation, they co-designed a public action to bring more awareness to the issues of noise pollution. To begin this process, they used a futures thinking approach to develop a newspaper of the future. Using a template of a newspaper, they identified a change that they want to see happening in reality. They then described the news story by providing detail on how the intervention made change possible and what was required in the process. The task allowed the group to envision creative and impactful interventions as well as to describe and plan what would be required to implement them. All the proposed ideas were provocative and interesting, and both had pros and cons. This became clear during the post-voting debate, in which the group discussed how to adapt the most voted idea to be feasible in the time available. Ideas were voted using dot stickers and the chosen idea aimed to raise awareness about noise levels in the Plaza del Sol in Gracia, Barcelona, an area renowned for its problems with noise pollution. (January 2017)

Action planning

From January - February 2017 community champions worked to verify the viability of the proposed Action by developing the ideas through further discussion and research. Prototyping started with the most voted idea but also included aspects of the other three ideas proposed by the other groups. The key aims identified for the action were to create an awareness of noise in the urban environment, encourage citizen participation and to have the intervention stimulate debate. Using sketching to develop a final plan of a participatory urban installation, the details of the idea began to form [Figure 4]. The Noisebox would allow anyone to discover noise levels in situ. A trigger button mounted on a box that contained a Making Sense SCK sensor would be connected to a long LED floor display. The installation would contextualise the sensed data by providing a “MAX” line; indicating where the level of noise had reached the maximum based on current local regulations and medical information. In addition, stencils and chalk provided would allow local residents and people in the Placa del Sol to express their perceptions, desires and concerns about noise and sound in their neighborhood.

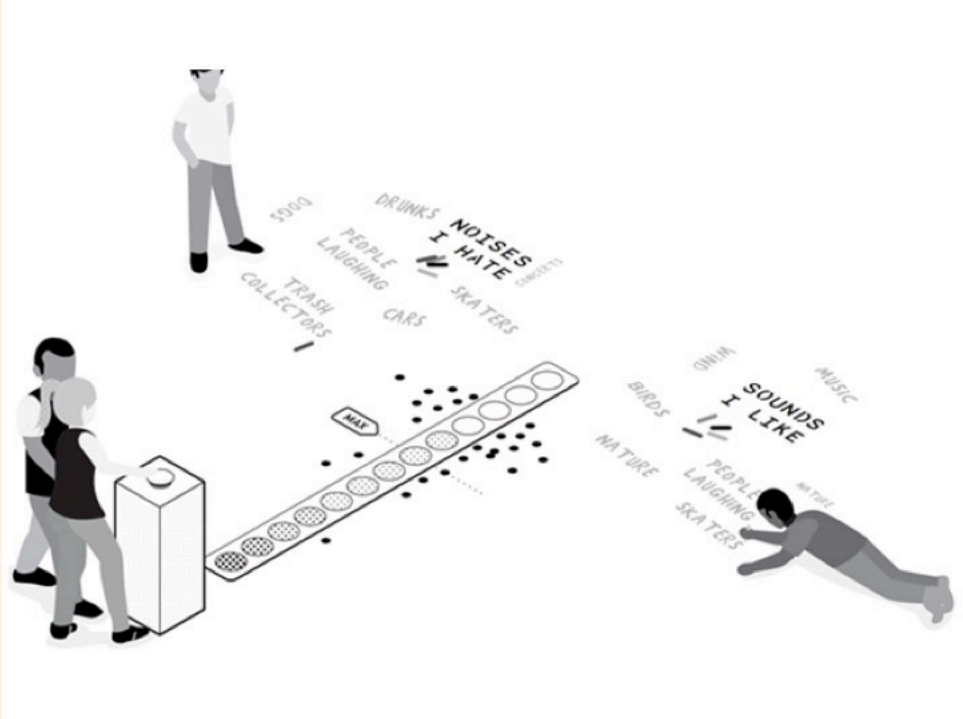

Figure 4: A sketch of the Noisebox installation

Action Making

At the Barcelona FabLab, the tasks needed for the deployment of the action were organised around five work stations: **wood box, stencils, chalk, electronics and branding**. Community champions moved from the different stations according to their interests, having the opportunity to be involved in the whole making process for the installation. Some built the physical structure of the Noisebox by cutting the plywood, shaping and assembling the pieces. Others worked on the electronics: drawing the circuit and programming the arduino board in order for the LED strip to display the level of noise registered by the attached SCK. The aim was to support the community champions in the co-design process, as well as introduce them to the technical equipment in the FabLab and other creative low-fi making skills, i.e. creating giant chalk pieces. The branding and communication team discussed and designed the general aesthetics of the intervention: the vinyl branding for the box, the take away souvenirs for the event, and social media actions before and during the event. (January - February 2017)

Test Deployment

A test deployment of the Noisebox allowed for reflection and led to identifying areas for improvement, like how it would be helpful to face the stencilled questions outwards to encourage people to approach and contribute. Running through the whole experience of the installation from the perspective of a participant, the community champions made a list of further considerations. (February 2017)

3.7 Reflection

In this phase the pilot leaders can **take the opportunity to evaluate the process so far and consider lessons learned**. This can involve iterating on any of the methods, technology or protocols used. It is also very important at this stage to consider the sustainability of the community and how it can continue after the formal pilot process has ended.

Making Sense is attempting to give tools to communities so that they can be self-sustaining after the completion of the pilots. This is a vital step in the process of creating change and it is critical to consider the citizens and how they can continue with sensing or creating actions after the research has been conducted.

Potential stakeholders: Communities of practice and interest, project teamexperts, local leaders, local businesses

REFLECTION

Kosovo Season 3

The Kosovo pilots had the same committee members throughout all three of their pilots. This enabled them to iterate their methods and processes in step with their members' skill levels. This strategy also helped to create a sustainable community that can continue after the pilots officially end.

Same issue, different approach

Air pollution remains the main environmental issue in Prishtina, and municipalities around the capital city. Therefore, in the Kosovo Season 3 Pilot we see the same issue—air pollution—being tackled transversely across three pilots. In other words, the issue remains the same, the participants remain the same and the general participatory approach remains the same – what changed are the locations of investigation, methodologies, tools, and seasons. While in the Pilot #1 and #2, we covered periods of summer, autumn and winter, in this pilot we covered spring and summer, closing thus the whole cycle year.

New types of measurements were introduced by a member of the Monitoring and Research Committee and student of Environmental Science at Univeristy of Prishtina, who measured air pollution through bio-indicators (i.e. lichens). This strategy was built upon the experience of "European Guideline for mapping lichen as an indicator of Environmental stress" (Asta et al, 2008) and its protocol consisted a rigorous scientific discipline, combined with creativity of citizen science. A professor and students from Department of Environmental Science, University of Prishtina, helped in the field-work, to implement the bio-indicator measurements.

Location fluidity

In the first and second pilots we started to run air quality measurements across the whole of Kosovo, narrowing down to Prishtina, and then further narrowing down to one location (around the primary school). In this pilot we have again expanded, or iterated, our sites of investigation, putting the municipalities (Obilic, Fushe Kosova, Krushevc, and Plemetina) that are located near coal-powered power plants Kosova A and B at the center of our investigation. The locations which were selected in the beginning were: Obilic, Plemetina, Fushe Kosova and Prishtina. However, while interviewing citizens, speaking to people who live and suffer the impact of air pollution, we have included Krushevc, a small town located just near the power plants, as one of the sites of investigation. This was done thanks to fluidity of the group to be flexible and agile in terms of following the sensing strategy and resisting orthodox scientific rigidity.

Creating a sustainable community

Through the digital bootcamp & non-formal environmental education events held during Pilot #2, another community was established called the "Green School Community" which included children from Faik Konica School and their parents, carers and teachers. This community was mentored by three Committee Members, developing the competencies of the Committee members to work with partners, and giving a reference and guiding point to the Green School Committee.

In this Pilot, a considerable role was given to Committee members in terms of carrying out important tasks, such as:

- Mentoring, training and guiding the Green School Community;
- Developing and running bioindicators' measurements;
- Supporting, co-organizing and co-coordinating the campaign action;

Embedded and evolving

An important outcome of Pilot 3 is the way it demonstrates the way in which Making Sense as a movement is in embedded in Kosovo and is evolving above and beyond the activities mandated by CAPS funding. On the one hand there is the development of autonomous & networked activities such as the Green School Committee, bio-indicator research, and practical cooperation with the Institute for Biology Research, and on the other hand the engagements with the wider field of innovation and institutional activities e.g. Doku:Tech and the EU office in Kosova.

3.8 Legacy

The final phase of the framework considers the impact of the project and potential continued life of the tools used. **Ideally, the main impact from the work conducted would be change in the world**, such as better air quality in the local environment. Other impact in this phase would come from an external source, such as a local council, to differentiate from impact in the action stage.

Making Sense is also focused on providing all the data and tools used in the project to be appropriated by other projects. This is key to some of the main principles of the project: openness, change-making and empowerment. This external appropriation is encouraged by posting tools and methods from Making Sense online on our website and our data in places such as the Smart Citizen platform and github. Publishing academic papers and reports on our work is also a key strategy at this stage. Due to Making Sense just coming to an end at time of writing, is it expected that there will be a more varied legacy from the project in the future.

Potential stakeholders: New communities of practice and interest, project team, other project leaders, local leaders, local businesses

LEGACY

Smart Kids Lab Amsterdam

The Amsterdam Smart Kids Lab activities that were initially created for one of the pilots in Amsterdam, have been taken up by pilot leaders in the other two pilot cities. In addition to this, teachers that used the Smart Kids Lab activities in their classrooms have indicated that they would like to use them again next year in their classrooms.

All of the Smart Kids Lab activities were designed to be conducted in the classroom with easy to source materials. The activities are downloadable or printable and include instructions and pictures on how to create homemade sensors to measure various aspects of the environment. Because of this simplicity of access and use, both of the other pilot cities have used the Smart Kids Lab activities. Initially in Amsterdam, there were used in three different primary schools for their second pilot. In Barcelona, they were used in a 4 day cultural exchange visit with Kuwaiti children as part of their second pilot. In Kosovo, they were used in their second pilot in a non-formal education event with children from the primary school where their pilot was based.

In Amsterdam, the schools have indicated that they would like to use the SKL materials again in class next year once their feedback has been taken into account and the materials have been adapted. They want activities that are fun for both the teachers and the pupils but that are also meaningful and felt some of the SKL activities fit that category. They felt that these type of activities were win-win situations, they are something different and it's good to have interactive experiences in the classroom.

> I think [the pupils] like it very much…I think I will collect some of the experiments that were successful and do it again…it's fun for children but you want to be meaningful with your lessons

> It's almost always a win-win situation, because we experience other things and it forms the mentality of our students. They like to invite other people like you [researchers and Waag], they like to give their opinion and it makes them reflect also. For those projects that we join, it's a side result but it's very important for the children

The teachers thought that the SKL activities would have an impact on the pupils' attitudes and behaviours as part of a wider programme on sustainability activities.

> I started this year with a project on the climate thing in Paris. At this age they are very concerned and we want to give them perspective so you can do something about it…I know that the children I teach in this class are thinking about it [the climate].

3.9 Crosscutting factors

Making Sense has applied the principles & goals of Openness, Co-Creation, Change-Making and Empowerment at the heart of activities. In addition to these principals there are also factors and actions that occur throughout the pilot process and do not fit in any one phase.

Information dissemination is vital to create interest, promote the project and encourage awareness throughout the process. Making Sense regularly posted blogs on a dedicated website, wrote Facebook posts, Tumblr blog posts, maintained a Twitter feed, posted photos on social media as well as engaged with traditional media for articles and interviews. A benefit to disseminating information at all phases of the process and not just focusing on dissemination at the end is that many people can get involved and provide feedback at different stages. This can help the project team with iterating their process.

Planning is a dedicated phase that includes fostering new skills, but it is also something that happens throughout the process.

Building capacities of citizens and communities was a focus on Making Sense, this occured wherever possible as part of the philosophy of **building sustainability** into the pilots so that any actions can continue after the project ends.

Documenting the process as it happens is also not confined to one phase and will help with transparency and accountability of the project team.

4. QUALITATIVE ASSESSMENT OF PARTICIPATORY STRATEGIES

This section is focused on ten key topics where we chose to observe how citizen engagement and community building were addressed inside Making Sense and how the project's participatory strategies developed from there on. Our observations are drawn from ethnographic field research made in all three cities throughout the duration of Making Sense, and complemented with content analysis of dissemination materials and internal documents produced by the partners in charge of the pilots. Moreover, our discussion around these topics is rooted in debates coming from literature ranging from DIY/DIT practices and tools emerging from citizen science and technology projects to broader participatory strategies in community driven research and similar bottom-up experiences.

4.1 Onboarding Pathways

Making Sense was anchored from the beginning in the idea that any participatory sensing initiative needs to take into careful consideration its recruitment and integration strategies. This comes from the condition not only to attract participants that would truly contribute to the project's main goals, but above all to facilitate their step-by-step familiarity with the technical and social processes needed to reach those goals.

With the exceptions of Amsterdam and Barcelona second pilots that targeted children and educational experimentations while aiming for lateral contamination of educators and families, we believe that a good participatory balance was struck on the large majority of pilots. This balance was between, on one hand, recruitment and retention of volunteers, and on the other hand, the consolidation over time of an environment where participants are respected, recognized and valued by their contributions and efforts, and where they also experienced ownership and trust about the outputs (Bell et al. 2008).

We were also able to observe in all pilots how a wide variety of recruitment strategies was used to identify and reach target communities. It ranged from plugging into previously existing projects in the same field, as PEN did in partnership with Science for Change in Prishtina at the beginning, or starting with already existing communities of interest such as Amsterdam did in their UrbanAirQ pilot, or going full on into the mapping of issues and possible communities where citizens would want to engage, such as Barcelona did with the Community Champions. Commonalities were always achieved, however, in the meaning of onboarding for all cities. Onboarding means the ways a participant would be introduced to the pilot, to the project as whole, and to its fellow citizens and project organisers in order to help foster their integration from the very first day.

Overall, the onboarding of participants in all Making Sense cities was probably the most successful dimension regarding the project's participatory strategies. Good examples can be directly mentioned in all the initial pilots. The engagement messages were nearly always tailored to the participants. They also showcased not only how citizens could help meet the specific needs of the pilots they were being invited to join, but also the benefits to themselves and how their skills and motivations would be in the mix (Silvertown et al. 2013). This was in line with previous research on recruitment strategies. When a project in the realm of community research is initiated, materials can emphasize the inherent interest of the topic and the chance to learn, but also emphasize the opportunities for recognition, advanced training, and social engagement (Rotman et al. 2012).

Furthermore, we can mention how the diversity of best practices in engagement and onboarding channels also became a key staple. The use of such channels was able to showcase the efficiency of Making Sense participatory strategies in their multiplicity at several moments. Even if all cities combined multiple channels for their onboarding we can easily tag some of them as key in their context. Making Sense pilot organisers were quite effective at this level. They always looked to expand their physical reach to other locations beyond the core contexts where they were being coordinated or conducted. Beyond the initial onboarding stages, all coordinating parties were constantly aware that it is important to foster a sense

of community when attempting to orchestrate sustained community engagement from the onboarding onwards. This includes a way for participants to engage and communicate with each other, with the project organisers, and keep track of the project's activities and results.

Online promotion via related websites, mailing-lists or newsletters, together with dissemination via social media and other online sources, played a relevant part in Amsterdam strategies, as for example in the GammaSense pilot. Recruitment targeted at local groups through local media was key to Prishtina's public calls for participants from the first pilot onwards. It gave a situated point of interest for local communities or people more attuned to the local context, even counting with the presence of citizens coming from precedent projects. And word-of-mouth proved to very powerful in Barcelona, especially considering the transition from their first to the third pilot. Here the project became a topic of conversation and even curiosity with neighbours, friends, family, other community groups, and policy makers, and within this context attracted new participants in line with other projects (Evans et al. 2005).

Previous projects in our conceptual and empirical spaces have shown us the importance of introducing initiatives physically in the local surroundings, for instance by distributing printed materials like brochures or flyers, placing posters in public places commonly frequented by local residents, or even more importantly, to organize physical events in local community centres, organisations or settings (Becker et al. 2013). And in fact, citizen science projects that need to rely on engagement and community building make a big effort in visiting related events, giving talks in conferences, or organising public events to spread the work throughout the duration of the project (Cornell Lab of Ornithology 2017, Silvertown et al. 2013). Making Sense is also a good example of this trend. We believe it even surpassed other similar projects in community-driven citizen science and crowdsensing considering all three cities made a considerable effort in their outreach activities to onboard new participants.

This was visible for instance in Amsterdam with either small events within related communities dealing with IoT or SenseMaking, either in larger events as the regular Smart Citizen Talks co-organised by Waag at Parkhuis de Zwijger or the CineKids movie festival that kicked off their second pilot. In Prishtina, beyond specific local group meetings aimed at recruitment, the project was present in larger events such as the environmental festival "Change is in the air!", or the 2016 and 2017 editions of Doku:Tech arts and technology festival. This presence was key to establish their engagement strategies through barcamp talks, presentations, bootcamp workshops, music sessions, open discussions or presentations of the project's sensing tools. In Barcelona, the onboarding efforts were directed towards specific events at FabLab Barcelona and other partner spaces such as Kubik. Participants were often welcomed with onboarding toolkits that contained the necessary physical components of the project, such as Smart Citizen Kits or log books, as well as accessories

that sought to establish a common identity among the participants, such as badges, stickers, and others.

4.2 The Physicality of Spaces

For Making Sense as a crowdsensing project, the physicality of the spaces was always at the forefront from the beginning through our data collection activities. Moreover, many of the pilots had specific locations as focal points for citizen engagement, such as Valkenburgerstraat and Weesperstraat in Amsterdam's UrbanAirQ pilot, or Plaça del Sol in Barcelona's third pilot with the same name of the place it was based on.

The spaces where citizens and communities meet and go about their sensing activities always have an important role in the participatory running of the activities themselves and often also on the vitality of the community dynamics. In addition, dealing with issues that often lack tangible visibility for citizen themselves such as air pollution, physical spaces help to bring materiality into the mix by offering a corporeal spot to focus on, such as polluted rivers in a myriad of other citizen science projects dealing with water contamination. Here, the choice of Prishtina to expand their sites of investigation in the third pilot into the coal-powered power plants Kosova A and B was heavily influenced by such a pathway. Local citizens were engaged by reporting visual and odour increases in smog and linking them with the operation of the power plants. This in turn led Prishtina committees to put a bigger emphasis in data measurements around these areas.

Through the growing availability of low-cost and mobile technologies, participatory sensing has further expanded the possibilities to conduct such activities in a multiplicity of places, including citizens' everyday environments as their homes and streets, or in hybrid or grassroots settings, as local associations, co-working spaces or shared machine shops (Maisonneuve et al. 2010, Ganti et al. 2011, Balestrini et al. 2015b). Such expansion became visible in Making Sense at multiple moments, going from the spaces of measurement or data collection of the GammaSense Amsterdam's pilot, where citizen's homes and personal computers were used as a strategy to lower participation thresholds and promote participation, to UrbanAirQ and Plaça del Sol pilots, both established in the places where communities were already considering an environmental issue which Making Sense was able to pick up through its participatory strategies.

In Plaça del Sol, the pilot was even able to successfully combine public and private spaces in their engagement strategies. A few residents involved in the pilot installed the Smart Citizen Kits in their houses and terraces, and others spent weeks gathering data on noise levels in the Gracia square. Broad discussions happened between both these spaces beyond data scoping and often centred on the events, elements and circumstances that led to the actual status of the square.

But here, we should not forget also how Making Sense participation strategies are and have always been heavily linked to the physicality of shared machine shops (Troxler and Maxigas 2014). Ranging from FabLabs, Hackerspaces or Makerspaces (Smith et al. 2013), such shops can be defined as physical spaces where tools and equipment are made accessible to the larger public, while fostering the building of communities of practice with similar interests and meaningful physical interactions (West and Greul 2016). As some argue, and Making Sense can empirically back up, these spaces can serve as intermediaries sites for translation between scientific knowledge produced in the labs of academic and research institutions, and the everyday interests, practices and problems of ordinary people (Kera 2012). At the center of Making Sense from the beginning we saw how spaces such as FabLab Amsterdam and FabLab Barcelona became crucial. They helped to establish the community building strategies of the whole project and became hubs for participatory activities of citizen infrastructuring at technical and social levels. Other shared machine shops and similar places such as Prishtina Hackerspace, or the Green FabLab and Kubik in Barcelona were also added to these main spaces.

On another strand, the use of specific locations such as schools and other children's educational environments in all the three cities was also quite positive considering the participatory goals of the project as a whole. There is mounting evidence that physical learning environments used in informal ways can also feed or stimulate participants to engage positively in science inquiry and to further reflect on their experiences through sense-making discussions with others (National Research Council 2009).

Such schools or other community-based educational spaces played a big role in the second pilots of the three cities: Amsterdam, with Smart Kids based on participatory sensing communication and experimentation taking place outside and inside curricula in schools such as the Boven het IJ Montessori school, the St. Jan Montessori school, and Rainbow Montessori school; Barcelona, engaging children in their Green FabLab educational space and expanding it into the nearby forest with a playful activity where sensors were hidden and had to be found; and Prishtina, with their investigation focused in the primary school "Faik Konica", located in the heart of Prishtina. In this last case, the strategy to physically anchor the pilot was even fully discussed and agreed in one of PEN and Science for Change participatory General Assemblies. Such anchoring was considered as a pathway to link air quality to the

health effects on a vulnerable group, and to engage with the impacted people: the children, their parents, the school and the wider community.

Overall, no matter the physical settings where Making Sense pilots were developed, the project fell in line and backed up previous research, which has highlighted the crucial aspect of enabling participants to interact with each other in meaningful ways and to allocate enough time in these space for social interactions to unfold (Van Den Berg et al. 2009). In a case regarding volunteer programs at park and nature-based recreation agencies (Jacobson et al. 2012), engaging in social interactions was rated positively among other motivations for volunteering, like helping the environment, enhancing personal use of the environment, having opportunities for learning, being involved in effective projects, or expressing and sharing values. In another study, the social benefits of engaging with others were a strong sign of commitment to a volunteer programme (Ryan et al. 2001), and could help to encourage sustained participation or increase retention of long-term volunteers.

4.3 Interacting Online

Any participatory sensing initiative is strongly rooted in the type of interactions it is able to foster and build with and between participants, and especially how far this impacts the communities it works with. Face-to-face interactions or engagements in physical spaces can be paired with online channels for communication and community building. Depending on each local context or available resources, the use of such online channels can highly boost, complement or expand the project's participatory reach. Making Sense followed this extended frame with a clear strategy to engage participants and augment its action space through digital tools and media.

The main standard practice in projects like ours is to establish a website as the main interface with a general database where public data is submitted, and where you can also find data displays through interactive visualisations and mapping, research findings, educational materials, blog posts, or updates and news. This was achieved in Making Sense at a central level with making-sense.eu that captured and disseminated all main activities from its three cities and overall outputs emerging from partners such as Dundee and JRC. But it was also achieved at each city level: Amsterdam used Waag Society's main blog, Kosovo used PEN and Science for Change's Facebook pages instead of a dedicated page, and Barcelona established

a very comprehensive repository with the open blog makingsenseeu.tumblr.com that proved to be an effective way to communicate not only with participants but also with broader audiences.

It needs to be said that such decentralisation may often have fragmentation effects when it comes to community building and citizen engagement. There is the danger that participants from each city may only interact with each other and only get information about their own context. But we believe that Making Sense's overall strategy for online communication and engagement through the main website was able to circumvent this type of effects. It amassed in near real time what was produced at local level, and this was often evident when questioning participants from Amsterdam on what was happening in Barcelona, or discussing with citizens from Prishtina what they thought about Amsterdam developments.

Making Sense even ended up by slightly following the route of more digitally-oriented projects through some of its pilots, taking into account a focus on crowdsourcing capabilities and on building digital communities. This is at the core of "crowd science", "networked science", or "massively-collaborative science" (Franzoni and Sauermann 2014), where online and interactive social networks are designed to enable participants' sharing of materials, photos or views (Davies et al. 2016).

Good examples of such a resemblance can be seen in the use of Instagram and Facebook in the Winter is Coming campaign conducted in Prishtina within their second pilot, or in the use of Making Sense's general hashtag #MakingSenseEU by participants in Barcelona's Plaça del Sol pilot to detail their own activities and share outputs with other citizens and the broader public. But it was especially visible when the community created, owned and managed the Twitter account @placadelsol, which registered high levels of activity during the pilot's main events and planned to continue after the project ends.

Nonetheless, the space for online interactions can and should always be expanded inside projects as Making Sense to more interconnected ways of working and communicating between participants, organizers, or contributors, within new collaboration paradigms of online networks and communities (Albors et al. 2008).

Barcelona should be pointed here as a good example of exploration. They strongly considered and studied several options for digital community building in their first pilot Community Champions, including Facebook, Reddit, Slack, Whatsapp or Muut. They ended up by creating the Tumblr page and turning to Typeform for scoping out each participant's interest, potential contribution, availability and propensity to become an engaged participant. On the other

hand, Prishtina managed this by making good use of Whatsapp groups as main dashboard for internal communication among participants in all of their pilots. These groups allowed for real time coordination of day to day activities, enabling even participants' autonomy, and voluntary substitutions in case of participants' absences in a measuring or dissemination activity. But they also became a key channel for discussion and generation of shared affect, especially through 'measurement selfies' and real-time reporting from the field when new information was collected either by sensors or citizens.

In the end, intersection between physical and digital should also be mentioned here in Making Sense. It pertains to organizational aspects emerging from the online realms, with a strong example given by Amsterdam and the Smart Citizen Meetups that permeated their first and third pilots and showed how community driven citizen science projects should strive to combine both worlds. Local meetups groups have grown in popularity to pursue locally relevant issues (Breen et al. 2015), particularly in distributed communities or networks, often leading to increased bonding social capital among participants (Shen and Cage 2013, Sessions 2010). This is an evident effect in Amsterdam's Making Sense participants that contributed to the first and third pilots.

4.4 Upskilling and Autonomies

A participatory sensing approach embodies a disposition to empower citizens and communities through ways of collecting and making sense of data that could enhance their autonomy in multiple dimensions. And most citizen science projects or initiatives acknowledge at least in general terms the goal to allow citizens to adopt more active roles in society, to protect their environment and to drive forward more participatory forms of democracy (Rowland 2012, Mueller et al. 2012).

Making Sense is not different within this context, but from the beginning one of its main motivations was rooted on the idea that if citizens are indeed to contribute to more participatory paths. Such activities should be inclusive and accessible to all, and not only to those who have access to the latest technologies or are well educated (Haklay 2013).

Tackling the issue of access in participatory sensing, main evidence has showed that people are often not confident in their data collection abilities or in conducting science process tasks. In one study targeting general public not engaged in citizen science activities, fewer than half of the respondents were confident in their abilities (Lewandowski et al. 2017). And in previous quantitative and qualitative research on crowdsensing at the basis of Making Sense itself, this factor proved to be one of the main barriers to citizen engagement (Balestrini et al. 2015a).

Appropriate training is considered by previous research on bottom-up monitoring initiatives as an important factor that can affect volunteer performance. Here the importance of hands-on practical training, which needs to include the actual tasks in the planned settings, can be underlined (Foster-Smith and Evans 2003). All Making Sense cities made an effort to address this specific issue in their pilots, following studies that have showed how citizens involved in participatory or community driven science projects can increase their confidence over time after training, or when they acquire repeated experience in such activities (Riesch and Potter 2014, Finn et al. 2010, Savan et al. 2003).

Prishtina for instance designed and conducted several training activities such as Barcamps, Bootcamps and Hackathons through the decision making mechanisms of their Member Committees, thus pursuing such goal in an extremely participatory way. This included upskilling participants in technical tasks such as how to calibrate the tools, run measurements, upload data online, etc. But it also included participatory training events in action and campaigning where participants were able to acquire new skills from organisers and peers, as well as make their own collective decisions on how to apply these skills in the context of the three PEN and Science for Change pilots, and conduct several activities with full technical and decision-making autonomy. This process fulfilled one of objectives of the overall Prishtina pilots, that is, to build competences and create a sustainable community of citizen scientist and activists.

Other good practices that facilitated participation inside Making Sense included for instance co-creating the actual monitoring tools with participants, as it happened in other citizen sensing projects (Gabrys 2017). In Barcelona, it involved meetings with initial community champions over a period of time to develop a monitoring kit that coupled the Smart Citizen Kit with other elements to create a Noise Box according to their specific concerns or local conditions. In this period, the tasks were focused on dimensions going from technical to social, such as building the Box itself, using a laser cut machine, printing questions on plywood boards to invite other participants to share their impressions, or establishing the branding and campaigning strategies.

Moreover, this upskilling revolved not only around the actual sensors, devices, digital monitors or online platforms for data display and community building, but also around journals or logbooks. In the latter, participants could get more instructions and references, and record their observations during their monitoring practices so that links could be made between what the sensors were recording and what was happening. Such a strategy eased the introduction to the technologies themselves, inherently improving the later stages of

collection and interpretation, and adapting the tools to the needs of the monitoring process as defined by the participants.

On a related point, the importance of improving or facilitating the ways participants can engage with and use data collection tools and processes was also addressed extensively in several pilots. What may be called “data literacy” can greatly vary depending not only on the people involved, but also on the data sources and the purposes of the actual data gathering. To overcome these initial barriers, Barcelona for instance emphasised the value in building collectively a flexible frame for data use with their participants, which is clearly close to existing frameworks and guidelines (Environmental Health Summit 2016).

This flexible frame included the capacity to incorporate multiple types of data and metadata, together with the development of guidance documents, in-person and hands-on trainings, or web and video trainings with interactive interfaces. Participants in the first and second Barcelona pilots were always encouraged to explore data uses on individual and collective ways, either when taking sensors home to apply their new skills, offering suggestions and advice online to other participants, or writing data postcards over Christmas, either when engaging face to face to discuss questions such as: do you see the value in sharing this open data? Will you leave it online? Who should own this data? Who should be able to use it and under which type of agreement?

Furthermore, best practices in upskilling can also be drawn from all Making Sense pilots involving children and educational activities. The main focus can be placed here on Amsterdam’s Smart Kids Lab explorations and materials, which were later adapted and used in both Barcelona and Prishtina second pilots. This pilot, which was kicked-of by sensing demonstrations at interactive plateaus in Amsterdam’s CineKids festival and later had its activities refined to fit into a small set of schools, can be flagged as a good experience outside the traditional scope of crowdsensing as a more complex and long standing venture. Such an idea can be underlined even if the pilot has sometimes been affected by the difficulties of activating and engaging younger participants in environmental monitoring activities often dependent on a larger understanding of its potential. And it can also be underlined even if the pilot was also challenged by the children’s expectations of playfulness, the educators traditional assumptions on science, and ultimately, Making Sense main goals of infrastructuring communities to support citizens in moving towards their own autonomies beyond baseline sensing or awareness levels.

The Smart Kids Lab made it possible for children to learn how to sense their environment in a different way by combining daily life objects such as an empty milk carton, a jar of Vaseline or an old fashioned vinyl LP, with more complex artefacts such as Smart Citizen Kits that

were installed in some of the schools. Being asked at first if there was something they were worried about, or if they ever noticed the quality of their environment, the children were later encouraged to find their own answers by directly monitoring their own surroundings. This happened in all schools with several hands-on measuring sessions on air pollution or UV radiation for instance. In these sessions, sensing tools were mainly based on small scale organic tests and DIY/DIT sensors created with things such as cabbages, lemons or sunscreen.

4.5 Experts, Non-Experts and Organisational Partnerships

The roles of experts and non-experts are undergoing significant changes when it comes to knowledge production – by whom, where and how. Beyond middle ground projects that almost became synonymous with citizen science in the past decades through crowdsourcing initiatives that only rely on networks of participants to collect and sometimes interpret data, the current accepted spectrum is now broader (Bonney et al. 2009, Collman 2014, Shirk et al. 2012). It now ranges from more conventional scientist-driven research projects that include some type of community engagement alongside partnerships with traditional or already established research organisations, to more collaborative and bottom-up projects mostly driven by the stakeholder communities themselves to maximize positive impacts for their local contexts.

Making Sense as a whole tried to position itself from the beginning in the latter category. Some pilots such as GammaSense, or even those engaging children to mainly explore science experimentation with sensing activities, such as Fab Kids and Smart Kids, may not be considered well developed examples in this context. It can be argued that they remained attached to a clear division between those who know and those who still need to learn. Nonetheless, at times pilots such as UrbanAirQ, Community Champions, Plaça del Sol, and maybe even all of Prishtina pilots were able to go near a fair exploration of this category. They combined expert and non-expert knowledge with valid participatory inputs coming from many different places and social groups who are usually not part of such projects. In doing so, through this combination they achieved pertinent and useful outputs for the problems at hand in ways that were able to generate new answers for what was being considered.

Initiatives closer to bottom-up interventions such as Making Sense should mean an acceptance of knowledge co-creation and sharing beyond the traditional divide between experts and non-experts. In what some call “extreme or collaborative science” (Haklay 2013), the level of collaboration between citizens and experts is geared towards co-design of problem definition, data collection, analysis, publication and dissemination. We can easily state that what Making Sense as a consortium always strived for collectively was related to post-normal and transdisciplinary frames. In general, the latter have the goal of generating knowledge through collaborative platforms that are able to mingle horizontally and vertically all types of knowledge towards common and practical goals (Funtowicz and Ravetz 1992, Nascimento and Pólvora 2015).

However, we also acknowledge how full collaborations between professional scientists and citizen scientists are yet relatively uncommon at a horizontal level (Lewandowski et al. 2017). In itself, this does not imply a direct deviation from a bottom-up approach that should heavily rely on community driven research. A good balance should be always reached and DIY/DIT knowledge should not suffer from any kind of epistemological sovereignty in the process. That is, if we want to move forward with a full acceptance of what is participatory or community-driven science and what does it bring without too many strings attached to traditional settings.

We still saw inside Making Sense how often traditional science and research actors and institutions are called upon to add epistemological recognition and heuristic validation to data generated through our low-cost sensing tools, as well as to some of the produced outputs beyond data capturing, interpretation and validation. But we hope that somewhere in the near future this will diminish. Still we recognise the strength these partnerships may often carry into a community driven project such as ours, and even fully acknowledge that this can be done in a positive, inclusive, and highly respectful way for citizens contributions, as it happened in Amsterdam’s partnerships with KNMI, University of Wageningen or Alterra, and Prishtina’s collaborations with Extreme Citizen Science (ExCiteS) project at University College London and Global Community Monitor.

One of the main obstacles to the blurring of the division between experts and non-experts comes from the challenge to traditional assumptions and standards about what is valid as knowledge, or in case of participatory sensing, as data and its uses. However, on one hand, several studies attest to the accuracy of citizen science models in providing reliable data in geographical information (Haklay 2010), bird habitat (Nagy et al. 2012), air pollution (Tregidgo et al. 2013) or ecosystems (Gollan et al. 2012). On other hand, sometimes projects operate in different organisational settings and therefore require different approaches to quality assurance (Haklay forthcoming).

This reflects heavily on our idea of participatory science. We believe that pilots such as UrbanAirQ and Plaça del Sol were quite effective in addressing it by regularly following the notion that in some instances projects might just require "just enough data" (Gabrys et al. 2016). It helped to legitimize low cost and open sensing as well as citizens' inputs and outputs. In the process it also enabled claims about environmental processes and the start of conversations with regulators and local authorities, towards eventually "data citizenships" defined as data-related engagements of political subjects and collectives (Gabrys 2016).

Going back, research partnerships can fit into a range of perspectives, some still anchored on the figure of the "scientist", for instance as a "community scientist" working closely with communities, schools, local governments and other organisations (Davies et al. 2013). In other cases, "citizen-expert alliances" for example in environmental justice movements can push this collaboration a bit further (Allen 2003, Kinchy and Perry 2011, Ottinger 2011). Making Sense also aimed for other kind of partnerships and is now able to illustrate how contacting directly, tapping into or partnering with existing groups or organizations is also very effective in citizen science projects for environmental monitoring (Cooper et al. 2007).

Partnerships with a diversity of community organisations, even those not explicitly engaged with science nor positioned as experts in a relevant field, have proven a successful means for growing a participant base in other projects before Making Sense (Purcell et al. 2012). Prishtina Hackerspace, Open Data Kosovo, Domestic Data Streamers, Civic Lab, Ouishare, Public Lab, Cinekids Festival, or Wise International, just to name a few, were all crucial for several of our pilots activities and can attest this idea. Moreover, citizens have often reported creating new, unanticipated projects and activities through successful partnerships. Even if we have yet to see concrete spin-offs and lateral projects coming from Making Sense, we trust that through its technical and social legacy outputs we will still manage to observe these type of projects emerge from the ground in any of the three cities.

4.6 Decision-Making and Internal Governances

Observing the roles of involved parties in any project is crucial to understand not only the level of participation but also the actual processes in place that allow for equitable collaborations (Stoecker 2005).

In most community-centred approaches, such as community based participatory research

where Making Sense as a whole can be incorporated in, a strong focus should be put in integrating citizens in all phases of the process (Stringer 2007). If taken into its fullest expression, it means encouraging citizens and communities to participate not only in data collection, or defining the strategies, tools and places for data collection, but especially putting them at the forefront of democratic decision-making or governance of as many processes as possible. Such governance can range from knowledge production to the ultimate definition of goal oriented frameworks and how far the project may take its outputs in terms of civic or political action for instance.

Excluding the Smart Kids and Fab Kids pilots where this particular dimension was not sufficiently taken into consideration given Making Sense's main goals, the governance and decision-making dimension was unevenly addressed and developed inside the project. This depended not only on the type of communities engaged within each pilot and the available technical and human resources, but also on the institutional contexts attached to each of the three cities and the organisational and target choices made for each pilot.

It is true that in a wide number of bottom-up projects based on communities of activists, practitioners, citizens and partner groups, an extended variety of arrangements for collaborative governance may be previewed. For instance, open source projects have placed community needs and decision-making processes at the centre of data definition, collection and interpretation efforts. And in such cases, the initiatives from beginning to end are directed by the communities of participants with a set of shared goals, which results in a strong sense of ownership and broad shared authority (Breen et al. 2015, O'Mahony 2007). But this is not always the case as we've observed in Making Sense. Participatory governance was sometimes considered a dynamic concept depending on the particular requirements of a pilot at specific points in time (O'Mahony and Ferraro 2007, Dahlander and O'Mahony 2010, Mateos-Garcia and Steinmueller 2008). In addition, such fluidity sometimes allowed project organisers to take on central decision-making powers by framing the process from the beginning, determining most of the tasks to be performed, or restricting access to technical or budgetary resources.

Based on observational research and content analysis from public and internal outputs, we can roughly position the three cities and their pilots in an internal Making Sense governance and decision making spectrum. Amsterdam pilots often approached the low end of this participatory governance spectrum, with limited agency granted to participants beyond data related activities in UrbanAirQ and more prominently in GammaSense. Barcelona can be positioned from mid to high depending on the pilot: Community Champions showed a promising openness after its early mapping stages, and Plaça del Sol enlarged this openness by allowing for citizen participation in nearly all levels of decision making. Last but not least, Prishtina reached usually high points with their flagship member committees in all pilots,

including the second one with focus on the Green School community. Here they were able to illustrate how even when focusing a pilot on children and educational environments you can enlarge your activities and goals to include directly children, educators and families in the governance of the pilot itself, together with all parties involved in committees and those interested in self-sustaining the pilot activities beyond its completion. Moreover, as mentioned by the pilot organisers to better frame their choice in working collaboratively in such a context, children do not usually have the capacity to act by themselves and discover the quality of air. Hence the pilot aimed also to act for their rights in collaboration with those who surround them and would be able to pass from sensing, to awareness, to action on their behalf.

PEN and Science for Change Kosovo's option to distribute participants into Committees and give them defined roles from the very first days of engagement, allowed for their extreme involvement in almost all governance aspects of their three pilots. This can usually be a time-consuming choice for both the organisers and the citizens and even increase friction and a mismanagement of expectations between the different parties. And governance arrangements, such as member committees and formalised decision rules, may be too restrictive and potentially exclusive of community members not familiar or with limited experience with formal governance settings (Runnels and Andrew 2013). But when done properly it helps to develop a sense of ownership that is uncommon in most citizen science projects.

The Prishtina pilots seem to have able to do so when granting equal decision making powers to all parties excluding major budgetary decisions. And above all they seem to have managed to do it in extremely successful and participatory grounded ways when they decided to do it through specific events such as the General Assemblies promoted regularly between organizers and all participants, and through specific channels of communication, such as the Whatsapp groups where all parties were highly engaged in, and above all, where information disclosure became key as conversations moved through.
Transparency and openness have been a part of discussions in recent decades over participatory approaches, particularly when it comes to the changing relationship between citizens and organizers. Making Sense taken as a whole or even seen through its pilots was never indifferent when it came to paying close attention to the issue. It has done so mainly considering that citizens are co-producers or active actors at several parts of the process or even in the whole process of (Riesch and Potter 2014, Resnik et al. 2015). Even if at different moments in time and through different approaches, citizen engagement and the project's participatory strategies in all pilots always implied a sharing of techniques, tools, advice and data not only between cities but also between organizers, citizens and any other relevant stakeholders such as partner organizations or external experts. Sometimes invisible in day to day discussions, this was an integral and crucial part of Making Sense, particularly in moments where the principles of open design, open science or open data were key to achieve

a community based governance of the project (Stodden 2010).

Furthermore, not only the Prishtina experience evoked above but also the Barcelona first and last pilots allowed Making Sense to counteract positively some of the limitations denounced by previous research on participation in project governance by community members (Runnels and Andrew 2013). This was patent for instance in the way that PEN and Science for Change replied positively and as soon as possible to issues such as payment of expenses or transfer of funds to community members that needed to cover their transport or food expenses when conducting data measurements, or even accommodation costs for participants from outside Prishtina that would engage in Bootcamps or other longer activities.

It was also visible in different aspects in both first and second Barcelona pilots each time FabLab Barcelona organizers made several efforts to create open and fully participatory community building sessions. In these sessions, citizens were allowed to make key decisions not only on the kind of environmental pollution they wanted to focus on, and how would they like to do it even if the sensor was predefined as the Smart Citizen Kit, but also where citizens often had extended agency in the governance of the pilot from start to end. This happened when right at the beginning, the community members engaged in Plaça del Sol pilot were faced with the questions that then nurtured the whole process beyond the data collection and treatment: What do we want for Plaça del Sol? What can we do to change the actual behaviour in the square?

4.7 Ownership, Appropriations and Continuations

The issues of ownership of any outputs by citizens and communities during a participatory sensing initiative are embedded in the level of collaboration between all parties that are agreed upon right at the beginning (McQuillan 2014). And we believe that such idea should be understood and visible in the most explicit ways within citizen or participatory science projects as Making Sense that wish to remain closer to collaborative or co-created models.

Multiple projects similar to Making Sense are able to clearly set the conditions for participants to take full ownership and appropriation of outputs without the need for the project's team

or any engaged experts to intervene and direct such processes. This happens when merely considering data sets or sensing tools, or in a higher ground any social or environmental changes potentially brought by the projects' activities into the communities and contexts it was developed.

Barcelona's Community Champions pilot could be seen as a good example in allowing this to take place in a progressive way. It was aimed directly at engaging participants that would later become key to the whole process, considering other pilots in their own city, or their contributions to the work being developed in other cities, or even the sustainability of the project itself after its completion. This example substantiates the notion that over time participants can not only make decisions about project developments but can also become themselves innovators (Van Oost et al. 2009).

These participants shaped a large part of the other pilots outputs by starting to integrate themselves in many of their open activities, by appropriating some of the tools and methods to directly influence the design of the new Smart Citizen Platform and the Noise Box where the new Smart Citizen Kit was placed in, and then gradually by being invited to be part of the Barcelona's Making Sense core organizing team due to their sense of ownership. Moreover, through the use of generative and foresight design tools such as a "journal of the future" they ended up being stimulated in their own sense of belonging and rapport with issues as noise pollution that eventually led to a bigger notion of ownership. Furthermore, in the Community Level Indicators or feedback forms used in this first pilot they were even asked to consider their own impressions on appropriation considering what they had taken with them in terms of technology or possibilities for action for instance.

In such circumstances, participants can easily become more autonomous in running their own measurements and confident enough to compare results with other participants. They can also start using the data to engage directly with official bodies, experts or other stakeholders to make their case, as we've also seen happening in Barcelona's pilot in Plaça del Sol. Reaching the end of this third pilot, participants demonstrated quite some interest for example in knowing how the process was going to move forward and how they would get proposals to the Barcelona City Council. They also started self organising themselves to discuss solutions to the problem they had just collected empirical data on.

From replacing the stone floor with sound absorbing materials, to creating moss vertical gardens in order to protect the facades of the residential buildings, participants had plenty of suggestions for improving the square. This only became possible as they ended up gaining a full sense of ownership of the project they helped to build, define, and govern from the beginning. They ended up proposing to organise a calendar of silent events such

as yoga sessions or open air cinema, and contacting other associations operating in their neighbourhood in order to take back the use of the square and counteract the noise pollution they were always so keen in measuring.

It is true that we can always argue that this is easier when participants framed themselves the guiding questions and take on a direct role in interpreting and choosing how to use the data coming from the environmental monitoring (Gabrys et al. 2016). But it is also true that such tasks are not always as easy as they seem due to well documented factors such the lack of space given by some organizers to the participants, or even the lack of access to any required resources and tools.

However, Making Sense appropriation practices by participants were often able to surpass these kind of challenges in similar ways to other citizens engaged in projects emerging mainly from the maker and digital fabrication worlds. The proliferation of low-cost open source tools, such as the Smart Citizen Kit in Barcelona's three pilots and the Bora Sensor in Amsterdam's UrbanAirQ, the creation of shared machine shops like Hackerspaces, as the one in Prishtina which supported their three pilots on a technical level, and especially like Fab Labs, which both Barcelona and Amsterdam partners can claim to be the first in Europe and were at the base of these cities pilots, have brought along more opportunities for citizens to produce knowledge in terms that ease up appropriation practices and stimulate process ownership (Nascimento and Polvora 2016).

This will be one of the pathways through which Making Sense as a project will most likely be able to continue beyond its completion. There is already enough empirical evidence that ideas which work well in one community can be translated to and recontextualised within other communities (Belone et al. 2016). But we currently foresee it happening for instance if participants in any of the cities are able to continue using even if only a fraction of the tools and processes put at their disposal during the pilots, if they are able to appropriate such tools and processes and iterate them in many ways as possible to create new social and technical frameworks, and above all, if in doing so they showcase any sense of ownership regarding the processes they previously were involved with.

New strategic collaborations and partnerships may be necessary to garner the resources and even a new participant pool to sustain it over the long term. New primary challenges may emerge when the partner institutions behind the pilots in Amsterdam, Barcelona or Prishtina withdraw part or the sum of their resources from the ground, including funding for cyberinfrastructure, sensor and database maintenance, and also organizational robustness (Purcell et al. 2012).

But for instance Prishtina is already showing us how one important outcome of their participants' sense of ownership is how Making Sense became a de facto environmental movement embedded in Kosovo. The project is already evolving above and beyond the activities mandated by the current funding, including for instance the development of autonomous activities such as the Green School Committee, spinoff activities such as the bio-indicator research that came directly from the project's appropriation by one of its leading participants, cooperation agreements with the Institute for Biology Research, and multiple engagements with the wider field of innovation and institutional activities in Kosovo such as the Doku:Tech community.

Furthermore, Making Sense as a whole will also definitely leave behind a wide pool of technical and social resources and learning. It includes what will be in the Making Sense toolkit to be produced at the very end of the project. But it also includes materials such as the ones created by the Smart Kids Lab pilot in Amsterdam and already translated into the second pilots of both Barcelona and Prishtina, as well as all the sensors scattered throughout the three cities, from the one still transmitting data and attached to one of the main walls of Regenboog school in the outskirts of Amsterdam, to all those still measuring noise in and outside several houses in Barcelona's Plaça del Sol.

4.8 Citizens Leading and Community Champions

Some citizens and community members can take on a more prominent lead in certain participatory sensing projects (Balestrini et al. 2015b). If framed properly this can have a positive impact from execution to higher visibility or easier spreading of outputs into external contexts.

The majority of Making Sense pilots is able to showcase this aspect in one way or another. Several observations made throughout the three cities showed how getting buy-in from specific participants highly interested in a specific topic helped to gain attention for the project and potentially convince other citizens to join. We can find evidence on it in Amsterdam as well as in Prishtina. But no city was more keen in exploring this aspect as Barcelona in their first pilot, which was primarily entitled Beta Testers and later properly renamed into Community Champions due to the level of engagement reached by their first participants.

Previous community-based monitoring activities have underlined the value of "champions", individual or organizational, as instrumental for building capacity, enhancing coordination and communicating the benefits of monitoring to the wider community (Pollock and Whitelaw 2005). And in some cases project organizers may even invite participants to undertake a more active role in decision-making because they have experiential knowledge of the problems at hand, they represent a particular group within the local community, or they enable privileged access to other participants (Runnels and Andrews 2013).

This was easily noticeable in the communities of interest that became base for Amsterdam's first pilot around two of the city's most polluted streets. A good number of citizens took a lead in this pilot based on their own personal environmental motivations or health related circumstances. They made use of these same factors to deepen both the awareness and action dimensions of the pilot and push for their impact at a political level. Other projects in the field of community action for environmental change show us similar trends for instance, when an array of local organisations, grassroots projects or informal neighborhood group are already active before any participatory sensing project. As it mainly happened here with UrbanAirQ, citizens coming from already existing informal groups ended up committing themselves to this Amsterdam pilot through individual or collective agendas that were ripe for it. Some citizens even permeated the pilot with experiences from previous environmental and air quality justice campaigns as observed before in other contexts (Gabrys et al. 2016).

In addition, this type of prominence was also clear in all Prishtina pilots in a slightly different way. It follows previous research showing that often lay citizens and activists without organizational links are positively perceived in the way they process the needs of the communities they belong to, without the constraints of more structured agendas or institutional bodies (Kone et al. 2000). Apart from a few experiences with NGO trainings in other contexts, some committee members who had never been involved in any environmental or social action projects gradually progressed from simpler sensing activities into leading roles in communication, engagement, or high levels of community management and decision making. One specific participant and committee member even took it a couple steps forward by designing and coordinating new environmental monitoring tools which later became a key aggregating element for other participants of Prishtina's third pilot. These were based on bio-indicators and were rigorously built within a citizen science framework upon the "European Guideline for mapping lichen as an indicator of environmental stress".

Nonetheless, Barcelona's first pilot may be definitively singled out here as a Making Sense flagship exploration of this dimension. There we saw participants, who would later turn into community champions, becoming increasingly more of community leaders or organizers. In such roles, they facilitated the continuity of other participants, influenced the direction and

structure of participation, and overall removed barriers for others to join and engage in the activities or tasks.

Barcelona's strategy from the beginning of this pilot was to work with several types of participants who could later take a bigger or leading role. First, they looked for participants who were keener than most to learn the methods for technology fabrication, and ended up helping them take on tasks on the iteration of the Smart Citizen Kits into the Noise Boxes. Second, participants who were willing to invest in data literacy to make sense of the information captured, which later they were able to do in multiple public events related to data visualization and its potential uses for awareness and action. And ultimately, participants who would like to explore and learn about methods to develop future communities through co-creation and collaboration workshops. All this turned out to be one of their main assets in subsequent citizen onboarding waves in this first pilot, and above all in the third pilot when all of these champions became crucial to infrastructuring the community in Plaça del Sol.

Such participants were integrated in the pilot coordinating meetings, planning tasks and activities, collecting and analysing data, planning and evaluating the work plan, mobilizing resources, solving problems and resolving conflicts between participants, and facilitating group processes or dynamics. This reflected highly on the whole Barcelona participatory strategies and placed them definitively in line with previous research, illustrating for instance how work plans and outputs were of higher quality and participants' satisfaction was greater when the pilot organizers managed to support efforts coming from leading participants with such community champions as a sort of hub (Goodman et al. 1998).

Graduation Certificates were offered to all Community Champions at the end of the first pilot, and a significant part of this initial group chose to continue working in the following pilots based on ideas expressed by Barcelona's pilot organizers at their graduation and also printed on their certificates. These ideas namely conveyed the message that this was not the end of their experience, but a new beginning of their involvement in the Making Sense community, and that Making Sense looked forward to a continued collaboration with them on developing citizen-led sensing initiatives for positive social change. As such, there was an official recognition on their extended set of responsibilities not only considering their past but also their possible future.

In fact, some of these participants were even offered a written official agreement document nearing the end of the first pilot to insure their deeper rooting and continuation in present and future Making Sense activities and to establish tangible benefits and obligations for both sides. Specific tasks and obligations detailed in such agreements included for instance the

research and creation of onboarding toolkits together with digital and analog data annotation tools, implementation of such toolkits and tools, or pilot community championing with other participants through task leadership and sensor guidance. After the pilot their involvement became continuous and some of these champions even decided to stay on a more informal basis in FabLab Barcelona and are already contributing to other community based projects taking place outside the scope of Making Sense.

4.9 Diversity and Social Composition

Disparities in terms of age, gender, ethnicity, education, cultural and economic resources, are fairly present and acknowledged as hampering factors in citizen science initiatives, and more specifically in participatory sensing or community based environmental monitoring. In all Making Sense cities this issue was probably most present as a potential for disruption in Kosovo's pilots due to the specific composition of its population and its cultural and historical contexts.

From the beginning, there was an intended and targeted effort in this case to address the barrier of diversity considering for instance continuous efforts to engage citizens from Roma communities established in and around Prishtina. Inclusiveness in the socio-economic sphere was also addressed by establishing budgetary and other support mechanisms to prevent underprivileged participants to be left out due to low-income or unemployment situations. But perhaps the biggest push in Prishtina was their resolution to strike a gender balance through their open recruitment calls for an equitable selection of participants that became crucial throughout the project. Many of the female participants progressively assumed bigger roles both in technical activities, such as data capturing and interpretation, and in social activities, such as the coordination of specific committees and awareness raising campaigns.

Researchers have found that citizen science participants do not reflect country demographics, considering the under-representation of historically underserved populations or certain ethnic groups (Pandya 2012, Ockenden 2007, 2008). Some groups, such as unemployed, low-income or with disabilities, also continue to be under-represented in environmental monitoring projects (Ockenden 2007), especially when there are financial implications for participation (Hobbs and White 2012). In this respect, reimbursing expenses of community members for their transport or food, or even accommodation costs for participants from outside Prishtina, was crucial to overcome potential problems in their participation and reinforce the diversity inside the project.

For many citizen science projects, average participants tend to be educated, caucasian and from middle and upper socio-economic strata (Evans et al. 2005). This was perhaps more visible in Amsterdam, but also in Barcelona even if on a smaller extent taking into account that their last pilot ultimately targeted a quite mixed socio demographic population in the nearly gentrified inner city area of Gracia. But the age gap was addressed at least partially in some Making Sense pilots. This started with Prishtina for instance, where the participants in all their pilots were nearly all between the ages of 16 and 26 in an effort to engage and raise awareness in younger populations, or when children became active participants in the main activities of their second pilot with the Green School committees. But it became even more visible with Amsterdam's Smart Kids Lab, which involved more than 1500 children in local elementary schools with their starting point at the Cinekid Festival, followed by Barcelona's Fab Kids targeting the same age range.

There is no major evidence that such disparity effects happened inside Making Sense, apart from some anecdotal evidence. For example, language barriers played a small role in the engagement of non-Albanian speaking citizens in Kosovo, or at Plaça del Sol in Barcelona regarding community building efforts between Castellan speaking organizers and Catalan native inhabitants. But as cautionary tale for the future it should still be noted that demographic, cultural and socio-economic factors can present barriers to participation or engagement from community members, beyond their motivations related to personality traits, beliefs and values attuned to social good or environmental concerns. And for example, something that we indeed observed in all Making Sense pilots, even those involving children, educators and families, time pressures are one of the most important barriers to environmental volunteering (O'Brien et al. 2010), when people also believe that volunteering requires more time than they have to give (Unell and Castle 2012).

In general, accounting for and planning for diversity is crucial for participatory sensing initiatives such as Making Sense. This can include for example broadening the places to meet up with citizens and communities, avoiding institutional or conventional settings and instead privileging others where communities already meet (streets, squares, cultural associations, neighbourhood gatherings, etc.), or lowering as much as possible potential barriers for social interaction, for instance meeting hours or associated costs or fees which may exclude people with low income, childcare responsibilities or with special working hours.

When looking also at the composition of communities of practice, for instance in more technically oriented groups, the situation is still far from ideal. Previous research has made explicit the predominance of a biased group of users, predominantly students, young, male and with an academic background, in the maker community (Carstensen 2014). However, there are some encouraging signs in a part of the open knowledge and open source hardware

movement towards a stronger and sustained inclusion of women, under-represented groups and economically-marginalized communities.

In this regard, Making Sense did an explicit effort to attract and integrate participants with a diversity of backgrounds and experiences, beyond simply tech-savvy groups or communities of practice. Prishtina had students of different profiles at undergraduate and post-graduate levels in environmental science, film, law, economy, or even from high school, while some of them were holding part-time or full-time jobs, such as teachers, bar waiters, etc. Barcelona had a diverse and multitalented community composed of local residents, designers, teachers, developers, economists and activists. And Amsterdam for example in their third pilot GammaSense gathered environmental activists, students, experts, local authorities, institutes, programmers, hackers and designers in several locations.

Social asymmetries can even reflect certain ingrained patterns. In many cases, higher levels of pollution are concentrated in disadvantaged communities, particularly in black, minority ethnic, and low-income areas (Bullard 2005, Bullard and Wright 2009), or in general, the burden of environmental harm falls disproportionately on disadvantaged communities around the world (Laurent 2011, Martinez-Alier et al. 2014, Walker 2012). Particularly in the context of Kosovo, the issue of environmental injustice was at the core of many of their activities, taking in account the context of environmental marginalization of parts of their population living in toxic areas. In particular Obilic, Fushe Kosova, Plemetina and the rest of locations fall into this category.

Furthermore, this environmental injustice seems to be aggravated by ethnic based divisions in the location of Plemetina, where an often marginalized Roma minority community lives only a few kilometres from the coal power plants. In other contexts, researchers have documented cases of communities facing extreme harm from environmental exposure but with little engagement with alternative monitoring or campaigning, most evident in communities with strong ties to industry and jobs, or with high levels of poverty and marginalization (Taylor 2014, Boudia and Jas 2014, Mah 2017).

4.10 Citizen Visibility in the Public Eye

Making Sense partner institutions placed a strong emphasis on the public visibility of the activities conducted by participants in each city pilots, particularly when it came to public dissemination and contacts

with media. Learning from previous experiences, advocacy in this turf always turned out to be a crucial part of participatory sensing initiatives in moments when communities are able to use news strategically in order to have far-reaching public exposure, and to stimulate awareness, interest and actions on the issues at hand (Green et al. 2001).

This was the case for example of the media and campaigning efforts that the Prishtina pilots took charge of at several occasions. A unified document was prepared for instance in their first pilot and shared with all participants, which included an overview of their positions, counter arguments and other data that could support their claims when faced with media inquiries. And in their second pilot, the effort was even more prominent, when the campaigning committee had a key role in putting together their campaign action #VoteForCleanAir during a crucial period of early national elections in Kosovo.

Participants together with PEN and Science for Change movement, set up mannequins in the main square of Prishtina to attract attention of by-passers, while also running real-time measurements in the same square. Making Sense and other projects show that community members themselves can be empowered to bring their claims directly to the media by presenting the collected data from their sensing activities and telling their stories and experiences (Gabrys 2017), or generally directing the attention of the media towards lack of compliance with regulations and other practices dealing with environmental pollution (O'Rourke and Macey 2003). And in certain cases, as we definitely saw in Prishtina and Barcelona, community members with a high degree of media savvy, in terms of writing, messaging online, photographing or video reporting, were even able to be more active when reaching out to media, and enhanced the overall influence of the project (Brown et al. 2016).

It was crucial for Making Sense to have in place effective communication strategies to boost the visibility of the work throughout the pilots. Such strategies were often enacted jointly by the pilots organizers and the participants through continuous forms of communication, such as newsletters, press releases blog, or social media (Purcell et al. 2012). By the same token, Making Sense also aimed at capturing the citizens' engagement in each of the pilots or in the project as a whole via a general documentary to be released towards the end of Making Sense. However, before this documentary's release, local documentaries captured in the wild were based on short personal storytelling mechanisms. This it happened for instance in Plaça del Sol to portray the experience of neighbours in the pilot, their problems with noise and how they envisioned the current situation changing, or through journaling tools which in the end were closer to data stories or open tools for interpreting and visualising soft data (Carslaw and Ropkins 2012).

Reporting or dissemination of Making Sense was often picked up by national and local media or instigated by more direct contacts with news outlets and journalists. This happened extensively in all cities throughout the whole duration of the project, and most significantly all cities allowed their participants to take a front seat in the public space. Already in the early stages of Making Sense, the project was included in a documentary about Smart Cities by the Dutch national broadcaster VPRO in their programme Tegenlicht, a critical series that is successfully amplifying the idea of transformative cities to a larger audience. Barcelona had also high visibility through news reports in national newspaper El País, and in regional media like El Periódico, Naciódigital, betevé or Independent. This coverage made participants feel like a united group with the possibility of finding a definitive solution if they continue working together beyond the project's completion. In their third pilot, Amsterdam's team and participants were part of a large public demonstration against the nuclear power plant of Tihange, covered by local tv station RTV Maastricht, and in which a human chain was formed between the cities of Aachen, Maastricht, Liège and Tihange.

Such public attention to Making Sense as a whole and above all to the participants on the ground was unequivocally boosted during external and high-profile public events. Such events acted as opportunities to present the work to a wider audience and at times to partner with national and international organizations. For instance, Smart Kids Lab had their kick-off installation in Cinekid's Medialab, where not only children had the opportunity to measure things themselves, but also teachers, professionals and policymakers could experiment and learn through the tools made available, like a photo/selfie showing the "scream" measurement device. Prishtina's work was presented from the beginning in events such as Doku:Tech organized by IPKO Foundation, and in #ClimateDiplomacyWeek organized by European Union Office in Kosovo. Barcelona was able to engage in several occasions with the City Council and Barcelona's Mayor in public displays of their pilots, in which citizen participation was singled out by policy makers as one of their main features. And Barcelona also invested in the organization of events as a joint strategy co-created with participants with a clear aim to reclaim public space and co-create proposals for new uses of the square. For example, at their final event in Plaça del Sol, life-size figures representing the neighbours were put in the square, attracting thousands of people also to participate in "activity tables" to generate as many action proposals as possible to improve the quality of life both for citizens living around it and for those who use the square.

All these events were unique opportunities to give further visibility to the project, attract other citizens for current and future activities, and most importantly, allow discussions on environmental pollution to enter the public realm through citizen and participatory science outputs. In this regard, Making Sense was inspired by recent trends in participatory sensing which are mixing up low-cost technology, art forms and political discourse to enable at the same time public participation, expression and activism. Previous research has already experimented with the notion that urban technological interfaces can serve as "ice

breakers" or support to shared encounters in public places, and ultimately foster community connectedness (Balestrini et al. 2016).

Low-cost sensors such as those at the base of Making Sense should not only be tools for data collection, visualization and sharing, but also a means to intervene in a wide range of public spaces by the communities and citizens, when for instance sensors are placed and moved across a number of surfaces both for environmental monitoring and for public expression (Kuznetsov & Paulos 2010). A clear example of this was indeed Barcelona's participatory intervention in the public space with the collectively designed and produced Making Sense Noise Box that acted an experiment to create curiosity and inspire by-passers to participate, while making this temporary engagement easier and clear.

5. RECOMMENDATIONS FOR COMMUNITY DRIVEN OR PARTICIPATORY SENSING PROJECTS

This section puts forward a set of recommendations for community driven or participatory sensing projects, with origin in lessons learned from and for Making Sense as a whole. The aim is to provide grounded information to other initiatives within our fields of action and research so that they could better devise both their technology action plans and their strategies for participatory citizen engagement and community building.

They were mainly harvested and developed from the activities and debates that took place inside Making Sense until now, and correspond to an augmented iteration of a previous version presented in D4.2 and later published in the Making Sense blog in three separate blogposts. As such, they continue to be an ongoing effort open to contributions from all possible sources and actors, and will ultimately be part of the Making Sense toolkit to be produced at very the end of the project.

5.1 Focus first and foremost on the needs and concerns of citizens and their communities

Everything we do must matter to citizens and their communities. This may seem obvious at first, but even when collaboratively developing processes or deploying solutions, we might end up by ignoring it in favour of other technological, scientific, cultural, or even political

agendas. Making sense refers to what should make sense first and foremost to community members in their local contexts, in particular tools and data that are easily and timely understandable, and above all, tools and data that are useful and actionable according to their own individual or collective needs. This has to be the main focus at the beginning, middle or end of all our processes.

5.2 Learn to manage internal and external expectations to fight frustration and manage conflicts

There's a cautionary tale on the need to manage expectations by setting up realistic goals both internally and with engaged citizens and communities. Even when we are highly motivated and fully trust our capabilities to deliver, we need to assume and prepare ourselves and others for the fact that not everything we imagine to be possible at technical or social levels will end up materializing itself. This should never be an excuse to limit our ambition or restrain our plans no matter how wishful they might be. But a decrease in internal participation or citizen engagement often comes attached to frustration for instance, and we need to anticipate and plan here for this kind of contingencies in a careful and timely manner.

5.3 Don't push technological or social solutions just because you can

Even when technology or social pushes are effective on initial stages as quick and dirty solutions for a specific problem, their effectiveness or appropriateness will likely diminish over time if not immediately linked to communities of interest and good technical and social support structures. Ours are not commercial ventures and we don't need to spread ideas or solutions at all costs as if the project's success and impact depended on fast product uptakes. Find space to consider which are the optimal moments to deploy something and pay attention to what those already on the ground might be saying. Always be ready to remove something from the pipeline if it's not time for it.

5.4 Still prototype and test fast and early as much as possible

We don't need to wait until everything is place to start testing our data and toolkits within ordinary and ground level contexts. We should always keep in mind to never push solutions in a hasty way. But we can and should use early stage prototyping and testing of social and technical processes and instruments if and whenever it feels adequate, as long as we keep them from being crystallized as ultimate solutions without space for further explorations. Incremental iterations are crucial when you aim for participatory innovation and truly wish to engage as many different voices as possible.

5.5 Facilitate the transition of "passive downloaders of data to active uploaders of action"

Do not overload citizens with content or tools on their very first engagements. One way of avoiding this is going for progressive disclosure, although always remembering transparency. We can engage citizens with basic technical or social information they need to get started, and then give them more as they become involved. We need to understand how not everyone needs to be fully engaged in all stages and how this will not compromise the process if done in an open way. Some people just want to observe while others prefer to explore at maximum speed, and this needs to be understood by all. Citizens will be able to make a better use of their own skills and power within this mindset, thus moving in much more sustainable and convivial ways from sensing, to awareness, to action.

5.6 Build trust and ownership processes with citizens and their communities

Consider granting citizens extended decision-making powers in several steps along your processes, even if you need to simplify or slow down things you had already planned. Do it

for example through open processes of internal organization and governance, or even just by creating more participatory communication and feedback channels. Consider also assigning small budgets to be run by the communities themselves. This will not only allow them to have extended knowledge about the project and what it often takes to make it happen, but it will also enhance their sense of ownership and responsibility while promoting a more sustained engagement.

5.7 Envision tools and processes that can be directly hacked and appropriated

Start by involving citizens and their communities in all possible processes in your first day. Bringing them in at later stages may be a good choice in some cases, but if you can, you should open all your activities at the beginning and insist on keeping them open until the end. Promote things that everyone can use, hack and reinvent directly and remember to mention that you trust them with this type of processes. Reflect on the fact that sometimes technical efficiency and quality are not the most adequate criteria to allow for appropriation. If done right, this usually leads to non experts acquiring new skills that will in turn strengthen their autonomy and allow new ventures. In the end you should always make it simple for communities to continue without your support.

5.8 Be aware of how the lack of technical skills can hamper the impact of your tools

Average to high levels of technical proficiency are still needed and even expected from citizens and communities to operate and maintain most of the technical tools we develop. But if they are expected to get such tools successfully running we need to grant them access to material, technical and methodological resources and assistance that they can easily access online or offline while working on their own or within their communities. Providing such advice in the form of online video or interactive tutorials might be more useful than creating technical reports and guidelines. Offering starter kits as onboarding tools with step-by-step instructions of a first batch of projects with a growing level of difficulty may also be a good option to stimulate skills.

5.9 Always consider knowledge, cultural, economic or contextual asymmetrics

Do not assume that most citizens can or will engage in equal terms in the technical or social activities you want them to be part of. We often need to start by arguing about who is or should be part of the community we're aiming to engage or build. And we need to discuss simple things beforehand, such as if our onboarding messages should be mainly technical, issue-based, or both. Take into account possibly existing asymmetric distribution of resources that may hinder participation. If disregarded they can jeopardize good work or social bonds inside the project. Also, never ignore that local and contextual circumstances in which you establish your activities might matter in ways that you do not plan for, and can turn into serious material or symbolic constraints to participatory sensing.

5.10 Account for, plan and promoste multiple forms of diversity and inclusion

Start by considering and reflecting about gender, education, ethnicity, family composition, income or geographical origin of the citizens and communities you want to engage. These will impact the capabilities or intentions some of your community members have and above all the type of collective you're aiming for. Sometimes you might need to adapt or restrict original plans if this becomes the only way to avoid building unidimensional groups of citizens, which might turn your project into a flat venture at the social level. Consider meet-up places where your target citizens or communities are already getting together, and lower potential barriers for social interaction such as meeting hours or associated fees which may exclude people with low income, childcare responsibilities, special working schedules, etc.

5.11 Explore all possibly social spaces and media channels for community engagement

Online forms of communication and engagement are efficient and can easily expand our outreach activities. We should always try to report what we do through specific or general online platforms. And citizens can easily share our activities and their engagement through

their own social media accounts using dedicated hashtags for example. But people like to be with other people and exchange experiences and ways of thinking and doing. Face-to-face meetings can show us how strong and active our communities of interest and practice can be. Possible activities to explore can be simple meet-ups, committees of participating citizens that serve as decision-making teams, bootcamps with social and technical trainings, or even targeted guerrilla street interventions.

5.12 Consider mixed physical and digital worlds for extended outreach

We should never neglect the power of mixing online with offline interactions and all the good unplanned things that may emerge. This kind of mingling needs to be a constant in our community building efforts. Some citizens may be more comfortable meeting others in person. And computer mediated interaction may be the preferred option for others. But they don't need to be disconnected from each other if we envision good middle ground activities that feed and combine both worlds. Moreover, using shared outputs for both can be a good solution to tackle resource constraints and maximize efforts. A hard copy newsletter that can be disseminated in face to face public events can also become a targeted blogpost or social media publication, and the other way around.

5.13 Standardize tools for documentation, data collection and reporting as soon as possible

Start by embracing a mindset of minimum viability in all process and tools. Understand that a shared process or tool that is used in real time and works across all contexts will ensure that insights can be shared along the process of community building and sustaining. This will help all partners and engaged citizens to integrate both sensor data and human perceptions in a similar fashion for instance. Which in turn will help everyone to better interpret, visualize, enrich and disambiguate the captured information, and we will get common points of understanding and comparison. One way of doing it is making documentation as easy as possible to interpret and apply in multiple contexts and by people with different levels of expertise wherever and whenever possible.

5.14 Explore and iterate alternative

ways to use documentation and the data itself

In standardizing processes and tools we should never neglect experimentation and iteration in the ways we present and use our data and documentation. Multiplying these will mean that citizens and other stakeholder ultimately have different entry points into our outputs. Its usefulness is always the key point we need to consider. If what we get out of sensing is not readable and usable by those who should benefit more from it, we need to rethink and iterate more the sense making part of the participatory sensing as a whole. We will often need embedded technical to social translation mechanisms by design, and this not a bad thing if done within an open fashion.

5.15 Celebrate the difference between pilot and testbed contexts

Pilot testbeds can be characterized by incredibly diverse material conditions, issues and people. Communities in each place can start and end with completely different resources, existing technical solutions, social awareness platforms, or even issue driven community champions. This situation poses challenges not only for common tools and processes, but also for choosing action and documentation strategies. But it will also provide tremendous opportunities for the outputs as they become richer through the granularity of testbeds, the diversity of best practices and lessons learned across contexts, and above all, the possibilities for cross fertilization between contexts.

5.16 Plan to expand and enrich the project over time with potential forks and spin-offs

Go after possibilities to make your project grow from its initial context and players. Use specific communities to get to others. Engage children to engage parents and teachers for example. Seek connections with other individual or collective actors even if you they are not tuned with all your goals. Consider starting by adding like-minded people or organizations, profiting from them to integrate technical or communication experts for example. Bring in more diversity as you integrate those who came before. Establish links with collective players already established in the physical or conceptual territories you want to work in, and turn to them for expanding your activities. Aggregate external innovators, storytellers, curators of

information, media influencers, local champions, and others, and stimulate them to fork or spin parts or the entirety of your project.

5.17 Build new governance models and don't be afraid of divergent and unpredictable outcomes

Open and inclusive relationships between citizens, communities, NGOs, public administrations, companies and others, are to be encouraged and supported towards common goals. This entails an environment of mutual respect between citizens, experts and decision-makers, together with availability to exchange views and to change the issues at stake. But consensus needs not to be the only model of governance and interaction. We need to allow for mutual acknowledgment of competing and divergent ideas of common good. And we need to support 'sharing of power' frameworks where all involved allow the outcomes to be unpredictable and with present and future substantial consequences.

5.18 Engage as many forms of knowledge that you can in a transdisciplinary way

Transdisciplinarity generates comprehensive knowledge for solving concrete issues through collaborative platforms, which operate both horizontally, to involve and mix different areas of expertise such as design, computer science, IT development, social sciences, environmental sciences, etc. and vertically, to include stakeholders and non-expert knowledge from civil society, may it be from institutional private and public sectors, or lay citizens dealing with vernacular knowledge. Bringing together everyone interested in this mix and keeping their involvement is a challenge to be tackled from the beginning. Not all forms of knowledge are created equal but they all deserve an opportunity on the clear assessment of both problems and their possible solutions.

6. FINAL REMARKS

Making Sense had a central focus on the transition from collective awareness to collective action, towards change and transformation of local environments in three European cities. In particular, the Making Sense approach to participatory sensing was to push for open and collaborative approaches and argue for the articulation of a full end-to-end process. The Making Sense Framework discussed and illustrated in this document, is a step by step process for designing and conducting participatory sensing studies. We have shown how the framework reflects an understanding of the key phases of practice developed across the diverse pilots. All of the phases have been designed around the principles of openness, co-creation, change-making and empowerment.

Such interventions can start by devising appropriate recruitment and onboarding strategies to identify and reach target communities as exemplified in the scoping section of the Making Sense Framework. This can include plugging into previously existing projects and communities of interest, clearly mapping the issues citizens would like to focus on, or promoting the initiative online and physically via printed materials, dedicated or related websites, mailing-lists or newsletters, social media, or through the organization of local group meetings and larger events.

Taking into account the increasing influence of digital tools and media, a clear process to engage participants and increase their action space through these channels needs to be in place. In Making Sense all these means proved to be an effective way to communicate with and between participants but also with broader audiences in campaigns and main events, taking full advantage of the diverse features of websites, blogs, Facebook, Instagram, Twitter, or Whatsapp groups run internally or externally by partners, communities or other related projects. This dissemination strategy ran throughout the pilot processes and the framework.

The spaces where citizens meet and go about their monitoring activities are at the core of any participatory sensing project. The variety of spaces of measurement, data collection and discussion, ranging from citizens' homes, streets, public spaces, schools to associated shared machine shops such as FabLabs, Hackerspaces and Makerspaces run by the team of associated partners, has an added value to community building and overall impact and visibility.

When it comes to democratic decision-making or governance from knowledge production to the definition of goals and public actions, what is achievable can greatly vary depending not only on the type of communities engaged or available technical and human resources, but also on the institutional contexts and target choices. A participatory governance spectrum can range from an openness to citizens' contributions from the beginning to granting them a full voice in the decisions made at all stages in collaboration with the project's team, for instance through general assemblies or online groups.

Training for citizens and their repeated experience in sensing activities can be considered crucial elements for successful interventions and form part of the third phase of the framework. This means upskilling participants in technical tasks such as how to calibrate the tools, run measurements, upload data online, etc., but also includes participatory training events in action and campaigning. It can also require the ability to incorporate multiple types of data and metadata, together with the development of guidance documents, in-person and hands-on training, or interactive web and video training. The ultimate goal here, though not always achievable in all contexts, is to enable full technical and decision-making autonomy for citizens and communities.

Participatory sensing projects such as Making Sense need to make the best of available knowledge and expertise beyond traditional or conventional divides. This means, for instance, reaching out to experts and practitioners for assistance with data awareness, involving and partnering with external organizations, and supporting when possible potential spin-offs or lateral projects initiated by citizens or other stakeholders. For a full acceptance of participatory or community-driven initiatives, there is still more work to do in the future in order to integrate or give a central role to citizens and communities' contributions in comparison to the privileged status still granted to experts or professional scientists.

Making Sense placed a strong emphasis on the public visibility of the activities and actions conducted by participants in the pilots. Coverage from national, regional and local media gave public exposure to the project and in some cases stimulated awareness and interest about the issues at hand. In such types of project, participants can assume a key or leading role in media and campaigning efforts by presenting the collected data themselves, deciding on the actions to be pursued and telling their own stories and experiences.

Best practice also comes from diversifying as the forms of communication as much as possible, including newsletters, press releases, blog updates, social media, documentaries, or video reporting. Planning for external and high-profile public events, and even interventions in public spaces mixing sensing, artistic expression and civic action, can act as unique opportunities to present the work to a wider audience and at times to partner with other

organizations.

Ideally, projects closer to collaborative or co-created models can set the conditions for citizens and communities to take full ownership and appropriation of outputs, such as data sets, sensing tools, or the potential social or environmental changes, without the need for the project's team or any experts to direct such process. Participants could take on key roles, for instance as champions or leaders, where they are able to appropriate sensing tools, use the data to engage directly with others, self-organize to discuss solutions, make decisions in an autonomous way, or even integrate with the project's team at several stages. Such ownership is a measure of boosting the legacy and sustainability of any project, especially when it fosters sustained new movements, spin-off projects, cooperation agreements, or strategic collaborations and partnerships to garner the resources or even new participants. Projects such as Making Sense also produce a wide pool of technical and social resources and learning, free to be appropriated by citizens, communities and other potential parties, such as the Making Sense toolkit, materials produced during the pilots, and even the environmental sensors distributed throughout the cities.

It clearly came through that any participatory strategy needs to pay careful to the subtleties and complexities of the process from the beginning to the end. One of the issues observed throughout some of the pilots in Making Sense was the difficulty in not only building new communities for the pilots, but maintaining them beyond each pilot's last activities.

Dealing with this issue, Amsterdam opted for not connecting any of their pilots and established their legacy mechanisms through a general dissemination of outputs to other organizations and general publics. Their first and second pilots were included in pre-existing frameworks in their institutional context. Urban Air Quality was positioned as part of the Amsterdam Smart Citizen Lab initiative, The Smart Kids Lab was inside their children's engagement activities, with the third pilot Gamma Sense also positioned inside the Smart Citizen Lab but with an expanded reach through partnering with organisations such as WISE. Both Barcelona and Kosovo made a sustained effort to create hybrid approaches. Barcelona connected their first and third pilots through the same issue of noise pollution, and invited participants to come back with their Community Champions strategy at the centre. PEN and Science for Change Kosovo opted to do instead what we can now consider to be a big pilot with different geographical, methodological and activity contexts.

In retrospect, these two latter approaches seem to be more effective in guaranteeing concrete legacy mechanisms for Making Sense, not only considering citizen participation and the main gains for those who were engaged, but also the long term existence of the communities of practice and interest mobilized or built in each city without the constant need

of referring back to mainstream or already established institutions.
Persistent disparities in terms of age, gender, ethnicity, education, cultural and economic resources need to be addressed explicitly in any participatory sensing initiatives. They can become serious barriers to participation or engagement from community members and can be counteracted by a series of measures. These measures could be: allocating financial resources to cover expenses for community members, planning for adequate language skills in the project team, broadening meeting hours in order not to exclude people working during the week, or with childcare responsibilities, privileging places where communities already meet, or making sure participants have a diversity of backgrounds and experiences.

Our overall assessment of participatory strategies across the pilots and throughout the Making Sense project was a positive one in the different dimensions we chose to focus upon. All partners provided specific and complementary experiences on how citizen engagement and community building were addressed inside the project and how their approaches contributed to the success and impact of the activities in the pilots.

With all its success and challenges, the experience developed throughout Making Sense and all its pilots allowed for some best practices to stand as contributions to other projects and initiatives that are closer to collaborative, co-created and bottom-up interventions. It is hoped that these experiences and examples can provide a structured way for other research teams, communities or others to design and conduct participatory sensing activities.

7.
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8.

ANNEX

Our final section outlines a descriptive account of each pilot campaign in more detail than is possible in the body of the deliverable. At the time of writing the final round of pilots are drawing to a close, therefore in these cases it has not been possible to fully represent the longitudinal reflection afforded to earlier pilots, this particularly affects representation of the latter stages of the Making Sense approach exemplified in the framework.

CASE STUDY: AMSTERDAM URBAN AIR QUALITY

BACKGROUND

Amsterdam currently has a network of 11 official air quality measurement stations that give accurate and reliable real-time measurements of air quality across the city. However, this network is too small to give a real-time picture of street-by-street level pollution, and the stations are expensive. To increase the density of sensors an alternative, affordable, and inclusive solution was desirable.

The community of practice was made up of Waag society, Fab Lab Amsterdam, University of Wageningen, a local and national official measurement organization (GGD Amsterdam & KNMI (Koninklijk Nederlands Meteorologisch Instituut - Royal Netherlands Meteorological Institute) and The Lung Foundation. These partners were involved in scoping the issues and planning out the study from the outset. The Dutch environmental defence organization Milieudefensie found that the Valkenburgerstraat and the Weesperstraat in the heart of Amsterdam were the most polluted streets of the city. Subsequently, recruitment focused on these two streets.

AIMS & OBJECTIVES

This pilot aimed to empower citizens in who live in streets with poor air quality in Amsterdam, with knowledge and experience in understanding air quality. It aimed to enable citizens to come up with questions about air quality around their homes, to have those questions answered and to be able to change their behaviour or routines depending on the air quality around their homes.

METHOD

A targeted campaign around the Valkenburgerstraat and the Weesperstraat in Amsterdam led to a group of 25 residents joining the pilot. The pilot began in March 2016 and ran until August 2016. There were three citizen meetings, a workshop and a meetup conducted prior to sensors being installed. During the workshop, citizens listened to experts in the field of air quality and heard about the kinds of technologies that were available for measurement. The citizens co-created measurement strategies using their own experience combined with the newly received expert inputs at the meetings. It was decided that a sensor kit that could sense the difference in air quality between streets and between floor heights in buildings was required. This was part of a strategic plan to empower citizens to answer the questions that were important to them through the deployment of sensors.

16 sensors were distributed to the participants. These were adapted and updated with better sensors (e.g. the NO2 sensor) from the Amsterdam Smart Citizen's Lab study conducted

prior to the pilot and described above. The sensors were connected to the participant's Wi-Fi networks and calibrated to measure: NO2, particulate matter, humidity and temperature. Sensors were placed in such a way that they could produce data that answered all of the citizens' questions, including the difference in air quality between ground floors and higher floor levels.

OUTCOMES

1. After the pilot was completed, one of the participants contacted one of the partners from Waag in order to access their sensor data. This participant had organised a meeting with the Municipality to discuss air quality in their area.

2. Three students approached Waag after the pilot to access the data collected during the pilot. They have created a platform that will allow citizens to see data and compare to current data, this will be shared with the citizens from the pilot.

3. TreeWiFi (http://treewifi.org/) is a project that was inspired by the pilot in Amsterdam, this project consists of bird houses that contain sensors that measure air quality. If the quality is good, the bird house will offer free wifi.

4. The Lung Foundation have created a campaign about air quality where citizens can find area quality in their post code as a follow on from the pilot.

REFLECTIONS / DISCUSSION

An important finding was that for detailed interpretation of environmental information, there is a great need for expertise. For quality assurance, interpreting data and calibration of the hardware, the experts involved in the pilot were essential. It is important to keep in mind for designing future work around participatory sensing, that experts will only see the benefit of joining an initiative if there are incentives for them. Innovation of sensing technology is one way to attract expertise, the other is by showing that low-cost sensors will not replace official, more expensive and highly accurate sensors. Indeed, accurate, high cost sensors are indispensable for calibration purposes, and low-cost sensors can complement them and lead to more situated data.

The participatory process was a success in that it brought together experts and citizens to share experience and information. There were benefits to having experts interpret and present the data which would have not been possible without their help. Due to the complexity of measuring air quality, the expert input was needed. One challenge was the perceived understanding of roles of the citizens. Waag was focused on keeping the citizens' questions at the heart of the study. The synergy between the experts and citizens could have been improved by managing expectations of different roles from the beginning.

CASE STUDY: SMART KIDS LAB AMSTERDAM

BACKGROUND

The Smart Kids Lab (SKL) was first conceived as an installation at the 10 day Dutch Cinekid Festival 2016. The Cinekid MediaLab is a 1200m² digital playground where children and their parents can learn in an active way about the possibilities of different media alongside teachers, professionals and policymakers. Waag society created an interactive installation where children could easily measure different aspects of their environment with sensors. The idea was to create environmental awareness with children and make 'making a sensor' fun.

Initially the Smart Kids Lab activities were designed to be conducted by children on their own without assistance, with the presentation at Cinekids planned as the start of a roll out for all children in Netherlands. After the Cinekids installation, the plan changed to include adults to help children in making the sensors and focused on schools with a structured environment and a teacher to help. Waag decided to test the school method more thoroughly and the activities were adapted for the classroom with the cooperation of teachers and schools.

AIMS & OBJECTIVES

The aims of the Smart Kids Lab activities are: to educate and raise awareness about the feeling that you can measure your environment; to help children understand their local environment and to help them to understand what they can do to improve it. The activities were designed to be low tech and to trigger the idea of measuring in children and the idea that these measurements can be compared in the local environment by doing some tests. The activities were designed in an artistic way to attract attention.

METHOD

Three schools were chosen in Amsterdam to cover different geographical and socio-demographic contexts. One school was based in the West of Amsterdam, one in the North and one quite far East from the city centre. In two of the schools, 50 pupils took part in each and in the last school, 20 pupils took part. All pupils were between 10 and 12 years old.

The teachers in each class arranged their own Smart Kids Lab timetable as well as how activities were run. All of the classes used the Smart Kids Lab booklet, described here: http://smartkidslab.nl/. Activities could be run in the classroom or outdoors, depending on the sensor being created. All of the Smart Kids Lab activities are designed to be conducted in the classroom with easy to source materials. The activities are downloadable or printable and include instructions and pictures on how to create homemade sensors to measure various aspects of the environment. One example of an activity is an acidity metre that measures the acidity of liquids by using blended red cabbage. The red cabbage is mixed with various liquids

and the difference in colours shows the acidity of the liquid. In addition to the homemade sensors from the SKL activities, the schools also had a Smart Citizen Kit running during the pilot. There was also a Lora Bora sensor hanging at the schools, which senses air quality as well, using the LoRaWan network from the Things Network.

OUTCOMES

In Amsterdam, some of the teachers have stated that they would like to use the Smart Kids Lab materials again once the materials have been adapted to reflect their feedback. In general, the teachers were happy and felt that the activities were a fun and meaningful way for children to learn about the environment. They also felt that the SKL activities would have an impact on the pupils' attitudes and behaviours as part of a wider programme on sustainability. The pupils' feedback was very positive, they stated that they enjoyed the activities, particularly testing the acidity of liquids with red cabbage. They also stated that they found it fun and interesting and that they would like more activities like this in class.

Subsequently, another two pilots have used Smart Kids Lab. Barcelona has used the materials as part their second pilot based on participatory sensing with children from Kuwait who were visiting on a cultural exchange. The Kosovo team also used the Smart Kids Lab materials in their second pilot with children from the local primary school that they were working with.

REFLECTIONS / DISCUSSION

Some of the teachers' feedback stated that some of these activities would be more suitable for slightly older children. They would also have liked more information on each activity, including whether it can be conducted in a classroom or outside, how long the activities take and more about the underlaying reason and background. For example, one teacher did not fully understand science behind the microbe metre, and therefore could not explain it as fully as they would have liked. There wasn't always time for data interpretation after the sensor creation and measurement. It would be better conduct activities when there is more time, avoiding exams, and daylight for activities e.g. in the weeks before summer holiday.

When showing the data from the sensor in the school, interesting questions from the kids arose. What is this peak in noise and air quality level? Could it be that this is around the time that the school opens? How is the air quality in the school compared to other ones? While the accurate, calibrated and reliable answers to these questions are sometimes hard to deliver, the sensor brings up questions and the idea of do-it-yourself measurements. And therefore the presence of the Smart Citizen Kit in schools is a step towards this.

The Smart Kids Lab fits into the idea that children shouldn't just learn from books but that they should make things like sensors to help them learn and include an interdisciplinary approach to learning. Activities like the Smart Kids Lab can help to play a role in this shift.

CASE STUDY: GAMMA SENSE AMSTERDAM

BACKGROUND

Since the nuclear disasters in Tsjernobyl and Fukushima, there is widespread concern about the safety of nuclear power plants. More and more of these plants are running out of their technical lifespan, and although reports show that some of the plants are falling apart (thousands of cracks in the concrete hull), they are kept open for political reasons.

The Dutch Environmental Protection Agency (RIVM) currently has around 150 official measuring stations for gamma radiation in the Netherlands, where every 10 minutes accurate and reliable values are determined and uploaded. According to RIVM's own reports, this number is insufficient should a disaster result in a radioactive cloud over the Netherlands, and the government wants to learn where and how radioactivity is spreading to advise the public.

From the beginning of this decade, it has been known that webcams could theoretically be used as sensors to register gamma radiation by covering the lens with black tape. Since black tape blocks all visual light, all 'hits' on the photosensitive semiconducting material, must be something else. In practice, this 'something else' is a combination of noise plus background radiation. These parameters are relatively quite stable, so if there is a sudden increase in the sum of these parameters, it can be due to an increase in man-made radiation. If this happens in one location, it could be due to a faulty webcam or a local source, but should this happen simultaneously in multiples places in the network, something extraordinary is going on.

Since around 2012 there are a host of different smartphone apps on the market that claim to measure gamma radiation. Some of these have been tested by independent labs and function quite well. The "problem" is that the gathered data is not open, the results of are not public and not on the map and the formulas for determining values from the images are secret.

Following this work, Waag Society set itself a goal to produce a web based, open test that can be used in case of an emergency to quickly generate data with devices that people have already at hand. In order to be able to guarantee a minimum reliability of the data, we worked together with the RIVM in the calibration process. At the same time, we defined a useful tool and involved local governments, safety coordinators, local politicians and civilians.

AIMS & OBJECTIVES

This pilot aimed to empower citizens in this area by showing them how they can turn their smartphones, laptops and tablets into gamma radiation measuring units by simply covering the camera of the device with a piece of black tape.

METHOD

The pilot began in January 2017 and run until the end of June 2017. We organized three workshops on location, and one developer meetup in Amsterdam (Nieuwmarkt).

To be able to create our system, we needed to build an internet application (based on WebRTC) that converts stills from the video-stream to values (specifically: Counts per Minutes) that are commonly used in the field of gamma-radiation monitoring. We selected a web based solution since apps have a due-date and we do not know when citizens will need this tool, we adopted the most stable and cross-device option, a webpage. An added benefit is that it has not been previously attempted so will appeal to platforms like Lifehacking, here we can get a lot of people involved to potentially adopt the tool and enhance it where necessary.

Not only is Gamma Sense on one specific webpage, but the information on how to set up an measuring network for gamma radiation is 100% available on Github. This includes the formula, and the text-files, so people can easily fork the code and translate the text-strings to Korean or French when needed: https://github.com/waagsociety/GammaSense

OUTCOMES

To restate the aim of this project: the creation of an emergency infrastructure for nuclear incidents. This means that the building and developing itself, although it has been done together with the community of interest & the community of practice, has not directly had a large impact on the daily controversies surrounding nuclear power plants at this time.

The sustainability of the project is mainly guaranteed through the storage on Github of all the code. Furthermore we will keep the project alive on www.gammasense.org in the years to come, and will offer the data to emerging data-platforms like AMS Datahub and others.

REFLECTIONS / DISCUSSION

Gamma Sense has taken a closed technical solution that generates hidden outcomes, and opened it up to the public domain. This makes quick adaptation in the hour of need very easy for people with a certain level of computer literacy: access to Github and a webserver is sufficient to start a local clone. Institutions can update the way the tool computes Counts per Minutes, and enhance the formula to implement this into their version of Gammasense.

The impact has to be shown on the day governments will need tens of thousands of measuring stations online quickly, to learn how a certain impact is spreading through a certain area.

CASE STUDY: BARCELONA COMMUNITY CHAMPIONS

BACKGROUND

In Europe more than 30% of the population is exposed to noise levels exceeding what is deemed healthy limits. At night, recorded levels can exceed 55 db(A), which is 15 db(A) over the recommended maximum (WHO, 2017). Noise pollution is a serious problem in many European cities and 40% of citizens in Barcelona are exposed to dangerous levels of noise. 44% of calls to the local police are noise-related complaints, often triggered by the concentration of people in the public space. However, the main source of noise in urban environments is traffic (80%). Elevated environmental noise can cause both physiological and psychological threats from hearing impairment, hypertension, ischemic heart disease, annoyance, and sleep disturbance. Furthermore, changes in the immune system and birth defects have been also associated to noise exposure. As a result of scoping the phase of identification we have decided to organise our first Making Sense Barcelona pilot around the issue of noise pollution.

AIMS & OBJECTIVES

This pilot was based around fundamental questions: How can citizens use technology to act at the civic level? How can data be used for the common good? How can people in Barcelona be more aware of their urban environment? The Making Sense team did not choose the issue of noise pollution as the focus of the study, it was only through scoping and understanding that this was an issue of concern for the citizens of Barcelona that it was selected.

METHODS

The campaign ran from November 2016 to February 2017, with project scoping dating back to eight months prior to the launch. The campaign deployed over 25 sensors, allowing the community champions to collect data on noise levels in different areas of the city.

The community champions in this campaign were a combination of communities of interest and practice. The community of interest, were those with high interest and variable technology skills. In this case, those would be the citizens who were attracted to the campaign by the issue of noise pollution, but also had a desire to use and form a better understanding of sensing technology. Also, the communities of practice, who have variable interest and high technology skills. Within this community there were those with a background in sound engineering, coding, and technology enabled visualisation. These individuals sought to employ towards ideating solutions for the noise pollution issue in the city, however they had not been involved in similar projects before. The campaign was structured to strengthen the

community through the sharing and skills and interest, and the regular workshops and social media allowed for the community champions to form a strong network.

For this campaign, the role of community champion required an active participation in the pilot, including: adopting a Smart Citizen Kit 1.5 to be deployed at home; joining a series of workshops aimed at developing skills, learning about sensors and open source technology; making sense of data and using it; and learning about digital fabrication and maker practices.

OUTCOMES

The community champions continued to be part of the Making Sense project after the Community Champions Pilot. Having gained the knowledge and experience from the first pilot, they were in a position to take more of an ownership and leading role in the Gracia Sound pilot. This included: the planning and delivery of activities; sharing their experiences with the new cohort of Making Sense community champions; and supporting the Making Sense team with organisation, facilitation and teaching others about the sensors and data sensing.

The pilot team have been approached by two universities for continued research around Community Champions and their relationship to data, their interest is in long term sustained engagement and building a COMMUNITY of citizens. One University is interested in interviewing the Community Champions about awareness of their local environment and understanding how their practices have evolved. Another wants to work with the Community Champions on co-designing new displays for smart systems in the home to change behaviours.

REFLECTIONS / DISCUSSION

The approach in this case study is grounded in the lessons learnt from existing studies in participatory sensing, citizen sensing and citizen science and on the use and integration of the first version of the SCK. Previous studies demonstrated that although providing the technology is important, alone it is insufficient to trigger collective action and decision-making. Participatory sensing requires methods that support orchestration, democratic participation, ownership and co-creation (design for social innovation) and a group of people that can act as agents for change, appropriating tools and methods and motivating others to join in and take action. From the insights gained, this case study argues that community champions are a necessary link between design for social innovation and IoT to drive change from the bottom up. Therefore, the team provided the infrastructure for actionable knowledge, campaign orchestration support and the process of co-design to foster collective awareness on ecological related issues; achieved through design for social innovation.

The pilot was carefully crafted around the framework and its different phases by creating activities that respond to each phase. It brought each phase of the framework down to earth and made them actionable.

CASE STUDY: BARCELONA FAB KIDS LAB

BACKGROUND

This pilot used the Smart Kids Lab (SKL) activities from the second Amsterdam pilot. The SKL was chosen as the foundation of this pilot with the idea of conveying abstract concepts such as the internet of things, sensing and data to young people in a way that would enable them to understand these concepts and the importance and process of them. Finding a narrative that pulled these ideas together in a way that made sense for children involved storytelling about how pollution affects birds. This included identifying different bird species in order to create 'empathy' with different birds, e.g. a shy bird or a happy bird. The narrative also included learning about migration patterns, eating habits and examining the local environment around the Green Fab Lab.

AIMS & OBJECTIVES

The pilot was developed to convey environmental change to children and to help them grasp these issues and why it is important to their life. A narrative was designed to make those issues relevant. This was focused on understanding the local environment, and learning about how pollution can affect local species, in particular birds. This built on Waag's work and was an opportunity to resituate aspects of the Amsterdam approach to Barcelona. Another aim was to utilise a unique opportunity to examine how Making Sense tools would work in a different cultural context.

METHODS

The participants were 15 students from Kuwait aged 7-16 years old. They were already planning a cultural exchange trip to Spain and the Making Sense pilot was presented as an opportunity to take advantage of this visit. This pilot was carried out at Fab Lab Barcelona.

The Smart Kids Lab activities were translated into English and The Smart Citizen Kit was used as a sensor. In addition, several maker tools were used for the pilot, such as: laser cutters, milling machines, wood/plastic, hammers, glue, etc. An Arduino workshop was given to understand how sensors work, including using a Kinect to help them understand how sensors can capture information and reproduce it.

The first phase involved the students learning about various bird species native to the area surrounding the Green Fab Lab in Valldaura. They looked at the behaviours of the birds, where they prefer to nest, and the types of foods they eat all with the aim of building bird feeders suited to each species. The Fab Kids Lab workshop then asked the students to con-

sider how sensing air pollution and the acidity of water and soil (pH) level, might be helpful to maintaining a healthy environment for the birds.

In the second phase, they tested the acidity of soil samples and some common household liquids using red cabbage juice as a gauge. The red cabbage gauge provided immediate and useful information on acidity levels, but technology may offer a different perspective. To look at the differences, the Smart Citizen Kit (SCK) was introduced to show how digital sensors can provide information over a longer period of time by tracking levels of environmental factors. The pupils went through the Onboarding experience with the SCK, they put together the kit and connected it to the smartcitizen.me platform where they saw how sensors are located across the world and how data can be compared across various sites.

In the third phase of the study, the students created air pollution monitors using juice cartons and Vaseline to capture particulate matter in the air. These sensors were deployed alongside bird feeders to visualise air pollution levels around birds' feeding spots. The pupils also participated in an intensive workshop to create beautiful feeders suitable for the different species.

The final activity was designed to support data sensemaking in a creative way. Several Smart Citizen Kits were hidden around the woods and streamed data from their secret location. The students were able to access the data from smartcitizen.me and were asked to look at this data so they could discover hidden sensors. The data powered a scavenger hunt and the students had to discover hidden sensors based on environmental readings, such as temperature, light, humidity and sound. The students managed to find every hidden sensor.

OUTCOMES

One main impact of the pilot was an understanding of how to frame citizen science and sensing for young people. This further understanding has been incorporated into the next Barcelona pilot for a workshop with schools and sensing with young people in Gracia/Placa del Sol.

REFLECTIONS / DISCUSSION

The sensing approach for this pilot was the shift from analog to digital sensing and from data to sensors rather than sensors to data as is the approach in the other pilots. This pilot was designed to broaden Making Sense to a more diverse context. The strategy was to work with a different cultural group of children in order to enable them to explore an environmental context they had not engaged with before. The Making Sense team collaborated with Muslim teachers and children to do a pilot. The Kuwaiti teachers were not as open to co-creation in the way that they teach so the organisation of the pilot required cooperation and discussion.

The Making Sense Framework needs to be flexible to the needs of the group. In the case of this pilot, it was carried out with a group from a cultural context that was less open to the concepts of co-creation compared to the other pilots.

CASE STUDY: BARCELONA GRACIA SOUND

BACKGROUND

This pilot directly builds on the work conducted in the Barcelona Community Champions pilot. The aim of the Making Sense journey begins with citizens, concerned or curious about the environment, coming together in groups of varied backgrounds and capabilities, to capture environmental data, learn how to question data (scientifically and emotionally) and look for lessons within the numbers. Then, together, public interventions are fabricated to raise awareness of the findings. By becoming aware and understanding the data of the world around us, we have a better chance to improve our quality of life.

The Making Sense team wanted the Community Champions to build on the knowledge from the first pilot, using what has been developed in terms of structure, methods, and experience. The Community Champions designed this pilot, by drawing on their experiences, and the tools and activities that had been developed by the Barcelona team. This pilot focused on the issue of noise pollution specifically located in the Placa del Sol in Gracia, Barcelona.

AIMS & OBJECTIVES

How to understand the issue of noise in Placa del Sol?

METHODS

As well as the Community Champions from an earlier pilot, the team was keen to recruit residents of the Placa who could place sensors outside of their apartments, street facing. The first event of this pilot presented the work done in previous pilots, discussed the objectives of the Making Sense project, and began to recruit and build a community of citizens who wanted to participate in the third and final pilot. The subject mapping had been altered from the initial pilot so instead it could capture how the participants would want to participate: by deploying a sensor, capturing and managing the sensors' data, being involved with the technical side, or involved in communications and planning. This was to align the new participants with the sub groups that had been created by the Community Champions and Making Sense team.

A workshop was conducted to start the citizens thinking about the types of noise that come from the Placa and how sensors might be deployed. The Community Level Indicators Tool was introduced at this stage to assist the participants in thinking about other types of data that could help inform the sensor data. One week later, participants came together to decide on measurement strategies. They decided on three different measurement strategies:

weekdays vs. weekends, ground floor vs. upper floor and square vs. streets with vehicular traffic. Each host resident had 2 SCK sensors, one for measuring noise inside the house and one for measuring noise outside. Sensing happened over a period of 20 days. After the data was collected the citizens were visited by two different expert groups to assist with data awareness.

In one of the final sessions, the residents worked in groups, trying to understand who the actual users of the square are and why they are attracted to this specific place in the city. What message could start a productive conversation between residents and actual users of Plaça del Sol? Participants came up with 2 main objectives for the final action:

1. Change and broaden the variety of uses of the Plaça
2. Generate empathy between neighbours and the actual users of the square

OUTCOMES

The final action took place on the 22nd June in the Placa del Sol. Around one thousand citizens joined the closing event of the 3rd pilot of Making Sense in Plaça del Sol, Gràcia. The event consisted of an installation and a citizens' assembly. There has been significant media coverage of the pilot, including articles and interviews with the citizens. Below is a description of the contents of the kit that we intend to co-create:

- **A Report**: Describing the experience of the pilot and presenting quantitative data captured by the sensors that illustrate the problem of acoustic pollution in the square, along with qualitative data on the experience and perception of the neighbours
- **A Documentary**: A video that relates the experience of neighbours throughout the pilot, their problems with noise and how they envision the current situation changing
- **A Web page**: A portal that allows neighbours to present the pilot's history and the problems in question, and to share sensor data and Tweets in real time
- **An Event**: Composed of an urban installation and an assembly, with the aim for neighbours to reclaim public space and co-create proposals for new uses of the square

REFLECTIONS / DISCUSSION

On reflection, the project lead said that the goals of the Community Champions had shifted from the beginning of the first pilot. This movement was from building technological understanding and capabilities and more towards wider ambitions of change. The data from the Community Champions pilot helped to infrastructure this subsequent sound pilot. Time was very important for this process and to have the Community Champions and their previous experience was important. The researchers found it useful to compare the experiences of the Community Champions in the first pilot to the Gracia pilot. A complex understanding of issues in the first pilot was useful for this pilot.

CASE STUDY: KOSOVO SEASON 1

BACKGROUND

The data from World Bank (January, 2013) shows that "air pollution is estimated to cause 852 premature deaths, 318 new cases of chronic bronchitis, 605 hospital admissions and 11,900 emergency visits each year." Moreover, the Progress Reports (2014, 2015 and 2016) that European Union issues for countries who are in process of visa liberalization and/or european integration, gives a strong critique of Kosovo's Government—particularly its Ministry of Environment and Kosovo's Environmental Protection Agency—on the lack of air monitoring systems and lack of maintenance or calibration of existing air pollution monitoring tools.

Additionally, Kosovo's vision to ensure the visa liberalization and join the EU remains one of the top priorities for the country's government. Although Kosovo has made steps to address issues related to the environment by adopting a number of EU-friendly framework laws covering the main environment areas of acquis communautaire, including the implementation of EU air quality standards - the application of these laws are poor and problematic.

According to UNICEF Kosovo programme's Youth Opinion Poll conducted in 2010, "with 50% of its population under the age of 25 Kosovo is known for having youngest population in Europe. However, young people's participation in the decision-making process in all areas remains a major challenge."

AIMS & OBJECTIVES

The aim is to establish a youth environmental movement to investigate air pollution at local level and re-frame the public narrative around air pollution in Kosovo through public campaign interventions.
Objective are to create, consolidate and empower a youth-led environmental movement that promotes and functions under direct democratic principles; To develop competencies of young people on air pollution investigations through citizen science, campaigning and mobilization tactics and non-formal environmental education; To investigate the existing conditions and governmental infrastructure of air quality in Kosovo as well as advocate for air quality data transparency; To develop processes for participatory campaign development and counter the existing narrative around air pollution through campaign actions; To increase awareness among the general public about air pollution and provide alternative information to people on air pollution levels

METHODS

The strategy of the first pilot has passed through the following stages:

Recruitment of new youth activists and consolidation of the movement - Environmental Festival "Change is in the air" - April 2016. Strengthening the internal governance based on radical direct democratic decision-making (May-June 2016). Training of activists and selection of tools for measurements (Impact Calibration sprints – July - September 2016). First air pollution monitoring (air pollution monitoring at Doku:Tech, Prizren - July 2016). Kosovo snapshot of air pollution hot-spots (air pollution monitoring around Kosovo - August-September 2016) Localising in Prishtina and identifying the hot-spot locations (air pollution monitoring in Prishtina - September 2016). Local air pollution investigations through 'targeted measurements' (primary school "Faik Konica" in Prishtina - October 2016-January 2017). Transform data into action (participatory campaign Digital Bootcamp and launch of campaign – October - December 2016)

There were 43 participants, known as Committee Members (24F / 19M). Committee members' ages varied from 17 to 30. They came from different cities in Kosovo, but the majority of them live in Prishtina (either studying or working).

OUTCOMES

Due to campaign actions which generated a public discourse never seen before – especially the period between November 2016 and February 2017 – the Kosovo Environmental Protection Agency has started to regularly publish their data, a behaviour that was not adopted before. The Agency then disclosed all data since 2013, which previously had been kept hidden or published partially. Media coverage has been a major outcome of the Pilot 1, mainly through our campaign actions.

REFLECTIONS / DISCUSSION

Air pollution, but environmental issues generally, were never part of the public discourse. It was the period of November 2016 where for the first time people started to protest, all the major media outlets started to speak, and social media channels were filled with concerns about air pollution. Framing the narrative around air pollution, packaging scientific research for citizen-friendly language, and being in media headlines have been key outcomes on changing and reclaiming the public discourse.

We have created a strong group of community of practitioners, that is, youth activists who authentically engage in three fronts: education; research and monitoring and campaigning and mobilization. Using radical democracy forms, a participatory approach, non-exclusive models, semi-horizontal structures as well as giving ownership of the project and building their competencies – the existing community has proved to be immensely useful at running the investigations, taking actions against air pollution and carrying the project forward. No other examples are to be found in the past where Kosovo's youth have engaged for such intensive and long-term work on environmental issues.

CASE STUDY: KOSOVO SEASON 2

BACKGROUND

The background for pilot 2 drew largely on same background as pilot 1 i.e. the poor state of both the air quality and the political process. The additional background for pilot 2 was our experience of doing pilot 1 and the lessons that we learned about what it means to do 'science for change'. In particular, how to make the most of our capacity to measure the pollution that actually affects people's health, rather than attempting to measure the statutory city-wide averages.

Many research studies have shown that children are at most risk of long term damage from air pollution. For example, children living in areas with high levels of nitrogen dioxide have up to 10% less lung capacity than normal (link) and children from highly polluted schools have a smaller growth in cognitive development than children from paired lowly polluted schools (link). In particular, the recent report from the Royal College of Physicians ('Every breath we take: the lifelong impact of air pollution' link) provides a damning summary of the pollution burden for children and young people.

The specific context for pilot 2 was Faik Konica, the central Prishtina school for 11-14 year olds where some measurements were made in the final part of pilot 1. The school is near the main M9 road in Prishtina. So from the start of pilot 1, where measured widely, we have progressively refined our focus; first to Prishtina, and now to the specific context of a school.

AIMS & OBJECTIVES

1. To make participatory measurements of air pollution in and around Faik Konica school
2. To campaign about the impact of this pollution on children's health
3. To engage children, parents, teachers and the community in science for change

METHODS

The participants for pilot 2 were the same Committee Members from pilot 1 who made decisions in the General Assembly and who carried out the air quality measurements. In addition, through the digital bootcamp & non-formal environmental education events, the participants included children from Faik Konica school and their parents, carers and teachers.

The project practiced direct democracy and self-governance through the same mechanism of the General Assembly as pilot 1. For example, in February's General Assembly the committee members discussed ideas for a new set of targeted measurements and decided to focus on buses, the university and the hospital.

Our sensors give us the ability to measure local levels, to make mobile measurements in the micro-environments that determine people's exposure, and to measure air quality indoors (where people spend a significant amount of their time).

The pilot proceeded as follows with measurement sessions: **74 Airbeam sessions**: PM2.5 measurements in the school grounds and local area. Also some sessions in the main bus station, the university and the hospital in Prishtina. **15 Dylos sessions**: PM2.5 measurements inside the school. **20 NO2 tubes, 20 SO2 Tubes, and 3 NO2 Rapid Air Monitors**. A **Digital Bootcamp** engaged parents and teachers in the campaign. **Non-formal Environmental Education** – using the SKL materials as well as other activities with pupils from the school. **Impact Calibration 4** was conducted. **Earth Day action**: 'Winter is Coming' - action was based in the main square in Prishtina and involved banners, leaflets and a stall giving away anti-pollution masks that had been artistically decorated by the members

OUTCOMES

There was significant media coverage of the campaign including a popular Kosovan TV channel, Klan Kosova, screening an extended piece about Making Sense Kosovo.

During the bootcamp, parents and school staff gained a better understanding of our work and the results we have collected as well as an increased awareness about the risks of air pollution among the children. A Green School Committee of parents & teachers was established.

In February, Making Sense Kosovo were invited to participate in the civil society consultation ahead of the first Stabilisation and Association Agreement (SAA) Subcommittee on Transport, Environment, Energy and Regional development. The SAA has been signed between the European Union and Kosovo as part of the preparation for accession. The consultation aim was to enable input and share information for the EU to feed into discussions with Government.

REFLECTIONS / DISCUSSION

The strategy for pilot 2 was to further develop a participatory science practice that is directly connected to people wanting to make a change. Making measurements in and around the school was a strategic means to link air quality to the health effects on a vulnerable group, and to engage with people impacted by that; the children, their parents, the school and the wider community & society. This strategy was discussed and agreed by the General Assembly.

It proved challenging to organise the Green School Committee through the institution of the school itself, where meetings were often cancelled. Instead, the committee members have worked directly with the biology teacher & the head of the council of parents. The period immediately following pilot 2 was also difficult for the GSC as it coincided with school exams.

CASE STUDY: KOSOVO SEASON 3

BACKGROUND

Air pollution remains the main environmental issue in Prishtina, and municipalities around the capital city. Therefore, we see the same issue—air pollution—being tackled transversely across three pilots. Whilst the issue, the participants and the general participatory approach remain the same – the locations of investigation, methodologies, tools, and seasons, change. While in the Pilot #1 and #2, we covered periods of summer, autumn and winter, in this pilot we covered spring and summer, closing thus the whole cycle year.

In the first and second pilots we started to run air quality measurements across the whole of Kosovo, narrowing down to Prishtina, and then further narrowing down to a school. In this pilot we iterated, our sites of investigation, putting the municipalities (Obilic, Fushe Kosova, Krushevc, and Plemetina) that are located near coal-powered power plants Kosova A and B at the centre of our investigation. What is interesting to mention is the fact that the locations which were selected in the beginning were: Obilic, Plemetina, Fushe Kosova and Prishtina. But while interviewing citizens, speaking to people who live and suffer the impact of air pollution, we have included Krushevc, a small town located just near power plants, in our site of investigation. This was done thanks to fluidity of the group to be flexible and agile in terms of following the pattern and resistance to orthodox scientific rigidity.

Both environmental injustice and racism are present in this pilot, and were among reasons that encouraged the approach we have taken. Two clarifications need to be made: first, 'environmental injustice' here refers to a process of environmental marginalization that is conducted upon part of population that lives in toxic areas. Certainly, Obilic, Fushe Kosova, Plemetina and the rest of locations we have investigated, fall into this category. Secondly 'environmental racism' here is an environmental injustice within a racialized context. This category is present in this pilot with the location of Plemetina, populated by a Roma minority, living only few kilometers from power plants and coal mines.

AIMS & OBJECTIVES

1. To investigate air pollution in the locations around coal-powered power plants Kosova A and B during spring and summer seasons, using new and existing participatory methodologies, tools and approaches
2. To further campaign and advocate against air pollution, and increase engagement and awareness among general public
3. To increase the visibility of the "Making Sense EU" project in Kosovo, and collaborate with other external partners, stakeholders, and organizations

METHODS

The participants for Season 3 were Committee Members who participate in the General Assembly and carry out air quality measurements. External supporting groups were also introduced, such as, a Professor and students from Department of Environmental Science, University of Prishtina, to help in the field-work to implement bio-indicators' measurements.

The strategy of this pilot can be divided into three parts: 1) measurement strategy which consists of the biggest work of this pilot and it is broken down into two sub-points, which are systematic measurements and bio-indicators' measurements and 2) campaign action during national election campaign and 3) presence of our work in external high-profile public events.

This pilot involved two types of measurements: a) systematic measurements executed by the Committee members; and b) the new types of measurements which was introduced by a member of Monitoring and Research Committee and student of Environmental Science at University of Prishtina, who measured air pollution through bio-indicators (i.e. lichens).

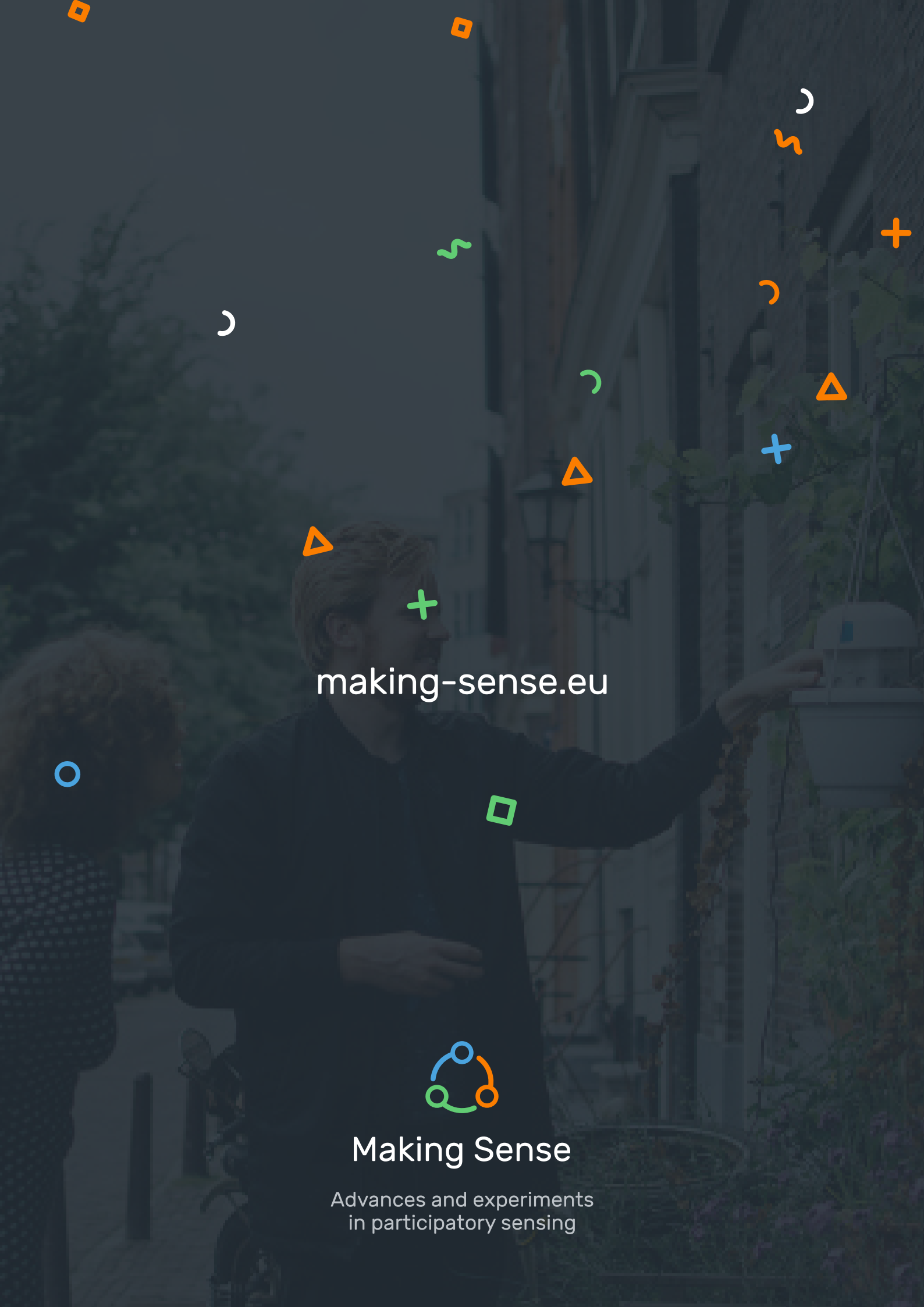
OUTCOMES

The project had a good media presence during the snap election despite the high level of 'noise to signal' that was generated and the political tensions that caused it. In May we publicised the fact that no Environment Ministry data on air quality had been published since December 2016. Four days later, and after some dialogue, the 4 missing months' worth of data was published by the ministry.

REFLECTIONS / DISCUSSION

An important outcome of Pilot 3 is the way it demonstrates that Making Sense as a movement is in embedded in Kosovo and is evolving above and beyond the activities mandated by CAPS funding. On the one hand there is the development of autonomous and networked activities such as the Green School Committee, bio-indicator research, and practical cooperation with the Institute for Biology Research; and on the other hand the engagements with the wider field of innovation and institutional activities e.g. Doku:Tech and the EU office in Kosova.

Our strategic decision to undertake campaign actions transversely across pilots has proved to be successful in maintaining a consistent appearance in media outlets, in public spaces and discourse. There was success in embedding local knowledge in scientific strategy. This pilot evolved the data collection field methods to incorporate street-level interviews with local residents. Preliminary findings were used to inform further measurements: The observations by residents in Obiliq that they experienced increased discomfort & breathing issues after 10pm. The local reporting of a location experiencing direct pollution from the power stations i.e. Krushevc.



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