Project no. 265432

EveryAware

Enhance Environmental Awareness through Social Information Technologies

http://www.everyaware.eu

Seventh Framework Programme (FP7)

Future and Emerging Technologies of the Information Communication Technologies (ICT FET Open)

D6.3: Report on participation fostering activities

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Lead contractor for this deliverable: University College London (UCL)

Executive Summary

This document describes the participant engagement processes and the outcomes of the final Case Studies for the EveryAware project, reporting on activities carried out between Months 18 and 36 of the project. Specifically, it reports on Deliverables D3.2 ("Final report summarising the conclusions of all of case studies") and D6.3 ("Final report on participation fostering activities").

Given the tight dependence between the processes of fostering participation and engagement and the outcomes of each Case Study, it was agreed to merge deliverables D3.2 and D6.3[1]. Building on work described in the interim (Month 18) reports D3.1 and D6.2, this document represents the merger of the two required deliverables. Thus, each Case Study described below is firstly described in terms of participation fostering activities that were undertaken and then in terms of the outcomes of these activities and of the Case Studies as a whole - both in quantitative terms (e.g. number of points captured) and qualitative terms (e.g. observation and feedback from the participants about engagement and participation).

The main aims of the second part of Work Package 3 is to investigate **what motivates people to participate in community-based activities** such as the sensing processes underpinning this work and to **describe the outcomes of the activities**. These are tightly coupled with the main aims of Work Package 6, which investigates **engagement:** recruiting and engaging participants for the various EveryAware Case Studies described in [UCL, 2012a]. This engagement process is, of course, by its very nature a disseminative activity, **dissemination** also forming a focus of Work Package 6.

Combining the above goals, this report presents the engagement activities carried out for the Large Scale case studies held in London for noise measurement, and in London, Antwerp, Kassel and Turin for air quality measurement. For the noise-based case study, engagement and participation was fostered via multiple channels that include a Local Authority becoming a core promoter of the activity with the specific aim of informing a response to a proposed expansion of Heathrow Airport in London. For the air quality large scale case study, engagement took place via means of an online game coupled with measurement activities - the AirProbe International Challenge (APIC), which was conducted across the four cities simultaneously. In both cases, method of engagements included mails to e-mail lists, posters, online posts and face to face meetings. Participants' length of engagement and activity was logged and a follow-up questionnaire issued to APIC players. The gaming aspect of the APIC activity, when contrasted with the more issue-focussed engagement for the noise capture activity, also permits a comparison of the consistency of data coverage obtained via these means.

A total of 1770 noise points were captured as part of the second phase of the Large Scale case study, bringing the overall total to 6666, or 13% of the noise points gathered world wide through three years of the project. Over the course of the game, approximately 7.6 million air quality data points were gathered, split in to approximately 1.5 million in London, 0.3 million in Antwerp, 3.8 million in Kassel and 1.9 million in Turin.

The results in terms of engagement and participation highlight the importance of a multi-faceted approach to recruitment and ongoing engagement in Citizen Science activities that involve environ-

[1] See confirmation e-mail from Aymard De Touzalin to Vittorio Loreto, dated Friday 13th December 2013.

mental information capture. Participant motivation can be quite varied - for the noise activity, this related primarily to a specific response to potential airport expansion. For the air quality activity, a general interest in learning more about air quality featured highly. The results also highlight the importance of initial and ongoing involvement of the scientists and activists in Citizen Science activity in order to encourage participation - it is not sufficient to build tools and assume that these will be used in a manner as to provide useful results. This, along with the development and refinement of the tools required for any similar activity (including, for example, calibration) require significant investment of time from the scientific team. In turn, significant amounts of time are required on the part of the participants to engage in these projects. While measurement accuracy using the low cost tools that form part of this project was not high, the time required for participation on behalf of the citizens has been used as an indication of the importance of the specific environmental issue to participants.

The Case Studies and the project as a whole also contribute to a wider framework of Citizen Science for Environmental Data, highlighting important issues relating to motivation, data quality, data coverage, positional accuracy of measurements and overall data management. EveryAware has contributed to the significant body of knowledge of the operation of systems with and without financial compensation to participants, and some understanding of motivations of participants which are more complex than might seem at first sight. In particular, the general participation activity observed in other projects, where many people participated with one or a few readings and only a few actively participated in a long-term process, is reflected here. Additionally, the questions relating to how to recruit and retain high contributors and how to encourage contribution remain open. It is likely that the factors that influence the success of a specific project will be a mix between aspects that are under control by the project coordinators, and those that are a mix of luck and circumstances which are beyond their control and as the Large Scale studies above show it is not necessarily possible to predict the success of one method over another.

Outline of the document

Combining information on recruitment, participation and Case Study results, the document first presents a short overview of the Air Quality Integration Case Study carried out in Turin at the outset of Phase 2 of the project. This study served to test the integration of hardware and software, and provided useful feedback as to the guidance to participants in the Large Scale Case Study on Air Quality. A description of the Turin study is followed up by a review of the ongoing noise-related Large Scale case study carried out in the London Heathrow area. Results for Phase 2 of this study are presented, followed by an overall summary of the Study. Details of the Large Scale Case Study on Air Quality carried out in Turin, Kassel, London and Antwerp, and combining online gaming with measurements are then presented, and the document concludes by detailing how the EveryAware project has contributed towards a larger framework for Citizen Science and Environmental data capture.

Dissemination of the Results

By its very nature, the work described in this document is disseminative, involving as it does the recruitment and ongoing engagement of participants in various Case Studies. Thus dissemination activities range from public meetings to blog posts, tweets and web page posts (including those by various local organisations and by media such as the BBC). The work described here has also contributed to a journal paper [Becker et al., 2013] as well as to an overall framework for Volunteered Geographical Information and Citizen Science currently in the process of publication as part of a FIG (Federation International de Geometres) Commission III Report relating to Crowdsourcing.

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Chapter 1

Introduction

This document describes the participant engagement processes and the outcomes of the final Case Studies for the EveryAware project, reporting on activities carried out between Months 18 and 36 of the project. Specifically, it reports on Deliverables D3.2 (“Final Report Summarising the Conclusions of all Case Studies”) and D6.3 (“Final Report on Participation Fostering Activities”). Building on work described in the interim (Month 18) reports D3.1 and D6.2, it addresses issues raised in Work Packages 3 and 6 of the project, including what motivates people to participate in community-based activities such as the sensing processes underpinning this work. It examines at the processes carried out in relation to recruiting and engaging participants for the various EveryAware Case Studies. The engagement process is, of course, by its very nature a disseminative activity.

Given the tight dependence between the processes of fostering participation and engagement and the outcomes of each Case Study, it was agreed to merge deliverables D3.2 and D6.3[1]. This document represents the merger of the two required reports. Thus, each Case Study described below is firstly described in terms of participation fostering activities that were undertaken and then in terms of the outcomes of these activities and of the Case Studies as a whole - both in quantitative terms (e.g. number of points captured) and qualitative terms (e.g. observation and feedback from the participants about engagement and participation).

The work described here builds on the work previously reported as part of the EveryAware project and it is suggested that the reader of this report familiarises him/herself with the interim reports D3.1 (“Report on the EveryAware platform performance in the Pilot Studies”) and D6.2 (“Report on dissemination strategies and participation fostering activities”) prior to reading this report. These contain background literature relating to participation and engagement activities, descriptions of the EveryAware architecture and Apps for noise capture (“WideNoise”), details of the participation and fostering activities for the interim Case Studies, and of the outcome of these studies. Importantly, key details relating to the Large Scale case study on noise (Heathrow Airport) forming part of Deliverable 3.2 (Task 3.4) due in Month 36 are also included in the prior reports as a substantial part of this Case Study was undertaken earlier than planned. Additionally, it is suggested that the reader refers to deliverables D2.2 (“Final version of and report on the web-based infrastructure”) for an in-depth description of the AirProbe software and EveryAware sensor box referred to in this document, along with D4.2 (“Report on analysis of sensor and subjective data, and comparison of measured vs perceived environment”) for additional analysis of the captured data. The reader is also referred to D5.2 (“Report on Analysis of Sensor and Subjective Data”), and in particular Section 3.1 (“Emergence of Awareness in the AirProbe Web Game”).

Three Case Studies were proposed for Phase 2 of the EveryAware project, one in Turin relating to Air Quality, and two Large Scale Case Studies, one in London and one in Rome. However, as described in D3.1, work on one of the Large Scale Case Studies (in London, relating to noise)

[1] See confirmation e-mail from Aymard De Touzalin to Vittorio Loreto, dated Friday 13th December 2013.

was commenced in anticipation as part of Phase 1. The latter part of this study is reported here. Additionally, the project has gone beyond the proposed Air Quality Case Studies, firstly conducting an Integration Case Study in Turin and following this up the second Large Scale Case Study which was extended to four cities (London, Kassel, Antwerp and Turin) rather than the one proposed (Rome). The remainder of this document describes the Turin Case Study, the continuation of the London Noise Study and the final Air Quality study across the four cities.

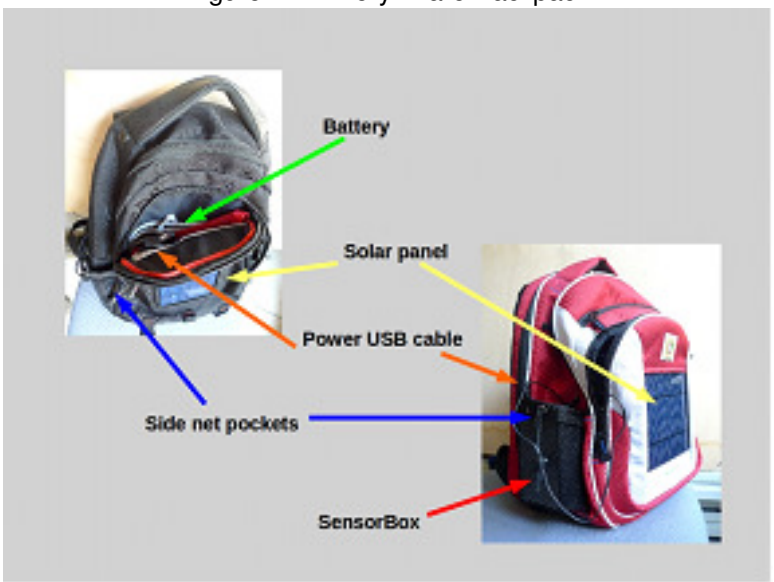
Chapter 2

Air Quality Case Study in Turin System Integration (Task 3.3)

2.1 Introduction to the Case Study

Following the Air Quality study in Antwerp (reported in D3.1 and D6.2) a second Air Quality Case Study was carried out in Turin in June and July 2013. The area of Turin chosen for the Case Study covered a wide range of contexts including very dense zones with a high traffic concentration, but also included locations where there are gardens and open spaces, and the main aim of the test was a final integration test to ensure that the Air Quality Sensor Boxes, AirProbe App and accompanying equipment (e.g the solar charger on the back packs) worked as a whole, prior to conducting a large scale case study. (Details of the equipment configuration can be found in D2.2). Figure 2.1 below shows the back-pack configuration that was tested as part of this Case Study.

Figure 2.1: EveryAware Backpack



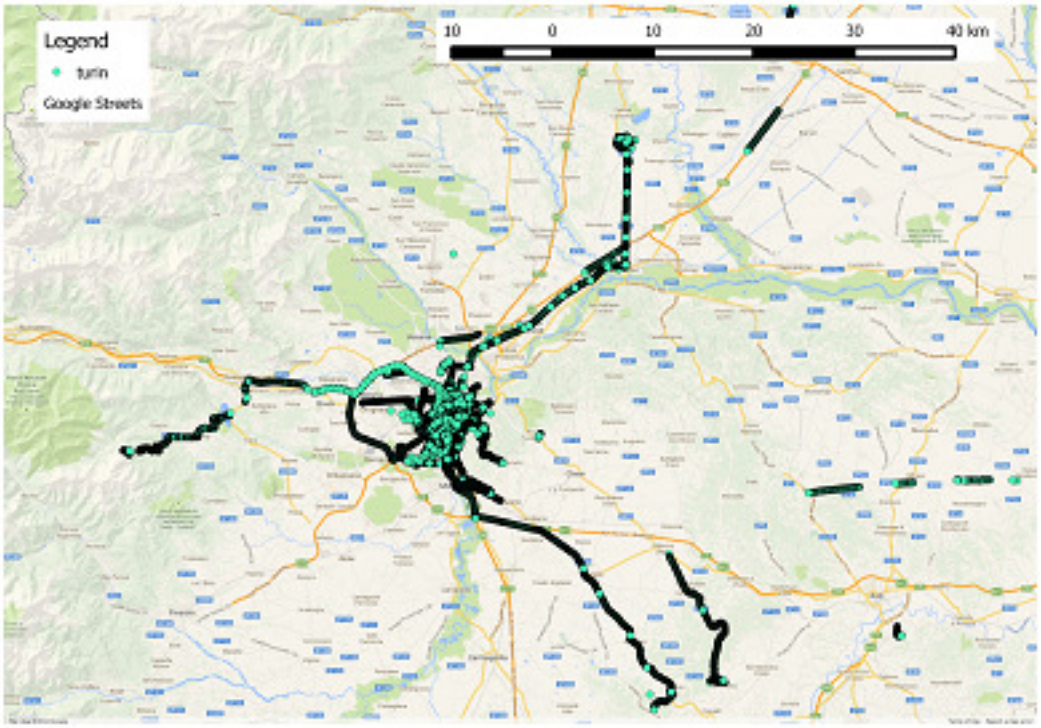
2.2 Recruitment, Participation and Engagement

Given the focus on integration of software and hardware, the test was primarily carried out by staff from CSP (one of the project partners). A total of 20 participants were recruited from within the organisation (via e-mail and personal contacts), with 5 external participants (personal contacts of CSP staff). Participants were provided with the EveryAware sensor box and the solar-panel back-pack, along with access to the smartphone App used to collect data. Participants were selected from across Turin in order to ensure a good coverage of the area.

2.3 Results - Air Quality Data

A total of around 25,000 geo-referenced Air Quality measurements were made during June and July 2013, giving an average of 28 hours of data capture by each of the 15 participants who participated in the project for the duration. A peak of 1.5 hours a day of data capture was observed, with one user peaking at 92 hours of measurements. Figure 2.2 below shows the resulting data.

Figure 2.2: Air Quality Data for Turin Integration Study



2.4 Results - Recruitment, Participation and Engagement

Although no formal recruitment techniques (flyers, meetings, engagement with community groups) were involved here due to the primary focus of the Case Study being integration testing, the project was met with enthusiasm and curiosity by colleagues at CSP and the mailing list approach was sufficient to recruit volunteers for the 20 sensor boxes available at the time of the study. Feedback was also received in terms of making improvements to the system.

2.5 Discussion

As expected given that the primary focus was on integration, the test itself and the subsequent feedback highlighted a number of technical issues. In particular, a number of measurements were taken by users using only the sensorbox, while the mobile phone App ("Air Probe") was switched off, meaning that Black Carbon estimates were not directly available to them, although this was accessible indirectly once data was uploaded to the server. It was also difficult to estimate the spatio-temporal coverage of the dataset in real time due to the delayed upload, since direct upload only takes place when the App is switched on and connected to the internet via a mobile or wi-fi signal.

This case study, therefore, served as a Beta testing of the Air Probe App, the sensor box and backpack. Lessons learned, in particular in terms of the relevance of keeping the App switched on, served as input to the guidelines given to users for the Air Probe International Challenge Figure 2.3 [1].

Figure 2.3: Extract from Guidelines for Air Probe Usage

Guidelines for using the EveryAware sensor box

1. **Switch on/off**

Switch the sensor box on by connecting it with the external battery. The fan at the air inlet will start rotating when the connection is good. Switch off the sensor box by removing the connection with the battery. We suggest to switch the box on for some time before going out to make measurements, so that the sensors 'warm up' and measurements become stable. If possible, 1.5 hours in advance would be best, but even half an hour helps.

[1] http://www.everyaware.eu/wp-content/uploads/2013/10/MeasurementProtocol.pdf

Chapter 3

Large Scale Case Study - Heathrow Airport (Continuation) - Noise (Task 3.4)

3.1 Introduction to the Case Study

Following the Beta test using the Widenoise App, described in interim deliverable D3.1, a decision was made to anticipate the next stage of the study, following on from contacts with HACAN (Heathrow Association for the Control of Aircraft Noise) an issue-based pressure group focused around noise and the Heathrow Airport extension (see [UCL, 2012c] for details). To initiate the first large scale case study using the integrated hardware (smartphone) and software (the WideNoise app and the web-based interface) components of the platform, a local issue focused approach to environmental monitoring was applied. Communities surrounding London's Heathrow airport were recruited and encouraged to download the app. They were then instructed to take measurements over a four week period during June 2012. This was carried out with support from UCL through an Inclusion Award, which provided additional funding for advertisement and recruitment (see [UCL, 2012c]). The results from this study are detailed in D3.1 [UCL, 2012b] and D6.2 [UCL, 2012c].

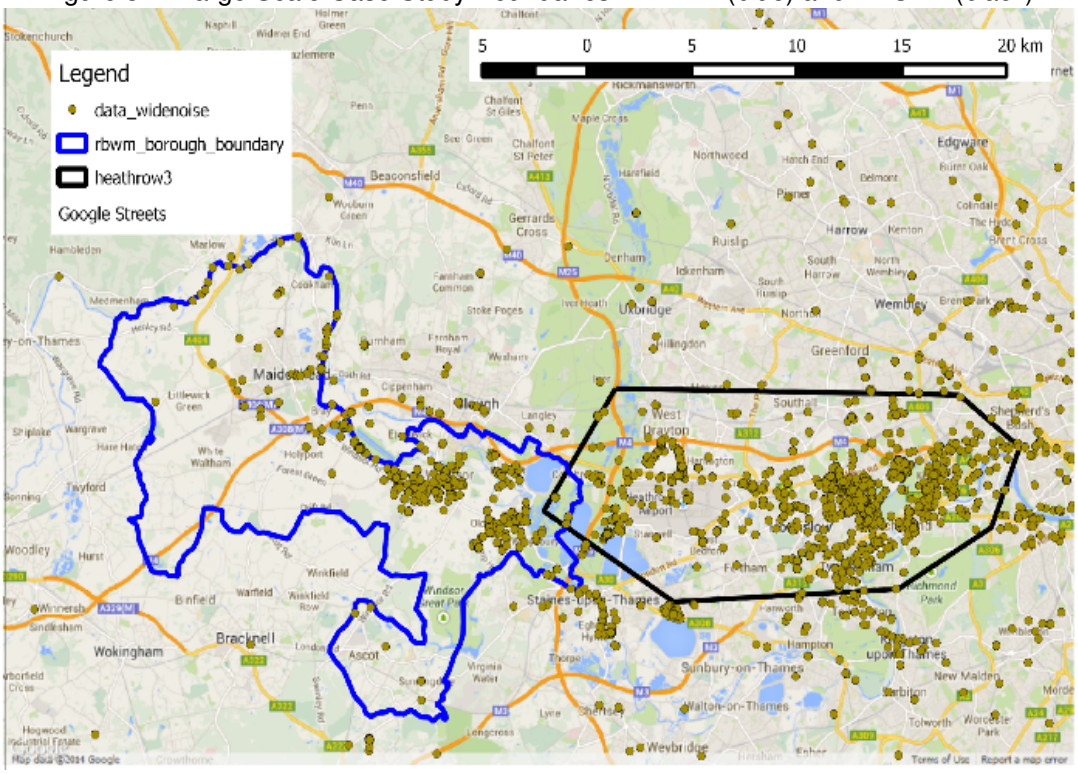
This document describes the continuation of the Heathrow Case Study (from Month 18 to Month 36 of the project), continuing the analysis of the remaining data and describing the second campaign, which was carried out in conjunction with the Royal Borough of Windsor and Maidenhead (RBWM). Summary results pertaining to the entire case study are also given.

3.2 Recruitment, Participation and Engagement - RBWM

The second part of the Case Study involved an additional campaign conducted with the assistance of a Local Authority (Council) in the Heathrow area - specifically, the Royal Borough of Windsor and Maidenhead (RBWM), which is situated to the West of Heathrow Airport (see Figure 3.1). The Borough has an estimated population of around 150,000 and covers an area of approximately 200 square kilometers. The involvement of RBWM allowed the expansion of the case study into the area of interest for the Borough, with some overlap with the previous area (shown in black in Figure 3.1).

The Authority contacted the project team as one of their residents had heard about the previous WideNoise monitoring trial. The resident wanted to bring a coordinated sound monitoring project to her area, so she encouraged her local council to collaborate with the UCL team. One of the key motivations for the RBWM to carry out the study was the initiation of 'operational freedom' trials at the airport, which involved changes to long-standing flight patterns around the airport and which

Figure 3.1: Large Scale Case Study Boundaries - RBWM (blue) and HACAN (black)



would increase noise exposure for residents. Thus, the WideNoise App formed part of a process to allow RBWM to formulate a response to the Davies Commission[1]. The Davies commission is a UK government research project setup to report on the South East of England airport capacity and make recommendation as to where to expand it. In the Heathrow context this means it will make recommendations on the contentious issue of a third runway for Heathrow which opponents argue, would radically increase noise levels for local Heathrow residents.

Following approval of the WideNoise study by the Borough in January 2013, RBWM, in conjunction with UCL piloted the Widenoise application with local residents to capture the community experience of aviation noise to the west of Heathrow Airport. As part of the process a 'how-to' guide was produced for residents[2] providing instructions on how to use the App and detailing how the data will be used, as follows:

How will the information be used?

- "The information automatically sent by the Widenoise application can be seen instantly online (http://cs.everyaware.eu/event/widenoise/map) and will also be collated each month in order todisplay local data on a map - to be developed shortly on the Borough's own website (www.rbwm.gov.uk). This map will not only display the noise data collated by the application, but will also display the experiences as described by local residents."

- "It is this extra level of detail that will be used to help inform local decision making regarding aviation and legitimise residents' experience of noise from Heathrow. The future intention is for the collated information to be passed on to government as part of the on-going (and very imminent) deliberations into future aviation proposals for Heathrow." [3]

[1] https://www.gov.uk/government/organisations/airports-commission
[2] See: http://www.rbwm.gov.uk/public/eh_how_to_use_WideNoise_guide.pdf [Accessed 1st April 2014]
[3] See: http://www.rbwm.gov.uk/public/eh_how_to_use_WideNoise_guide.pdf [Accessed 1st April 2014]

The limitations of the Widenoise App in terms of accurate decibel readings were clearly communicated to potential participants by the RBWM team, and restated in their report of findings.

- "It must be noted that the noise sampled by smartphone devices cannot be compared readily to those results obtained by a Type 1 Sound Level Meter. A calibration study was undertaken by UCL within an anechoic chamber. This study discovered that at the decibel range under scrutiny (70 – 80dB) the results obtained from residents smartphones are still of value."

From the RBWM side, activity was lead by Christopher Nash, RBWM Environmental Protection Team Leader, and Carwyn Cox, RBWM Council Member for Environmental Services. Both of these have extensive links into local environmental groups and in turn recruited participants from these groups (following a similar approach to the partnership with HACAN that proved successful in the initial stage of the Heathrow Case Study).

3.2.1 Recruiting Participants

The initial call for community champions was launched at a meeting of the Aviation Forum on 28th February. This call was renewed at a public meeting held at The Windsor Boys' School on 28th March to discuss aviation issues. Nigel Milton, the Director of Policy and Political Relations at Heathrow Airport, was present at this meeting and warmly welcomed the community initiative. These initial calls were followed by a press release in April 2013[4] which was disseminated on local forums[5] calling for community champions, which stated that:

- "The application not only enables residents to get involved in dealing with an issue very close to home but also we will be able to see where the incidents and impacts occur and their relative severity, and allow subjective accounts of how aircraft noise is actually affecting borough residents by recording their own experiences."

The initial recruitment process was followed up by media campaigns such as those in the Maidenhead Advertiser[6] (the local paper), Facebook, the websites of two political parties (Conservatives[7] and Liberal Democrats[8]) and the BBC[9], in September 2013. Figures 3.2, 3.3, 3.4, 3.5 and 3.6 show screenshots of these pages. In all cases users of the WideNoise App were instructed to capture noise information but also to detail their subjective views of the noise.

3.3 Results - Noise Data for RBWM

A total of 1770 noise readings were captured in the RBWM area over the course of the EveryAware project, with a total of 1257 of these being collected between April 2013 and December 2013, when the active campaign was ongoing. A peak of 261 measurements occurred in July 2013, coinciding

[4] http://www.cookham.com/forum/index.php?topic=3045.0;wap2

[5] http://windsorlibdems.org.uk/en/article/2013/718947/body-sensors-to-measure-heathrow-noise-stress

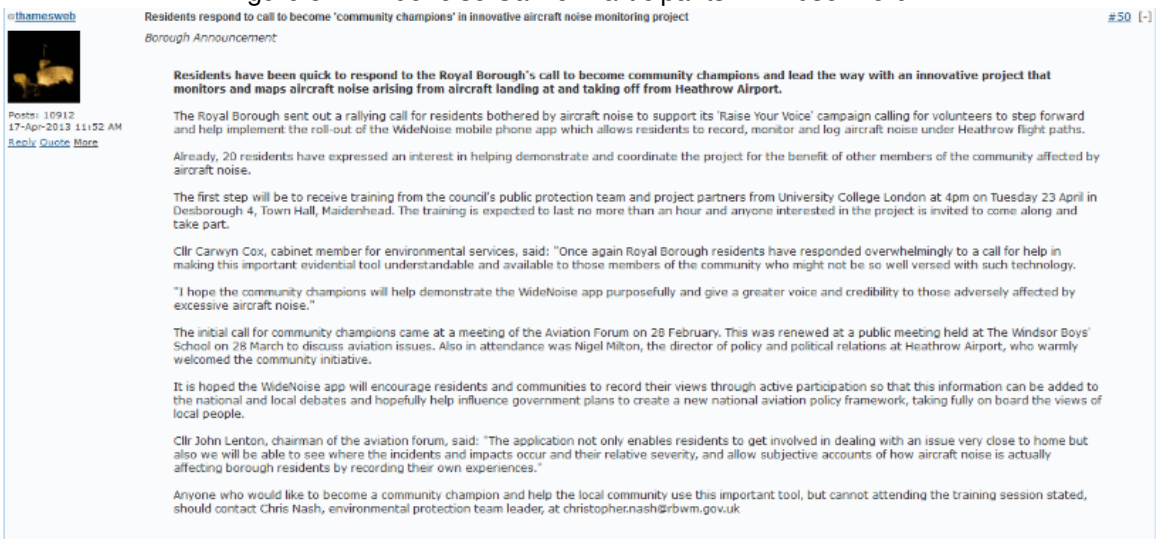
[6] http://www.maidenhead-advertiser.co.uk/News/Areas/Maidenhead/Noise-map-of-aircraft-movements-over-Windsor-and-Maidenhead-to-be-made-04092013.htm

[7] https://www.facebook.com/conservativesmaidenhead and LibDems: http://windsorlibdems.org.uk/en/article/2013/718947/body-sensors-to-measure-heathrow-noise-stress

[8] http://windsorlibdems.org.uk/en/article/2013/718947/body-sensors-to-measure-heathrow-noise-stress

[9] http://www.bbc.co.uk/news/uk-england-berkshire-23955999

Figure 3.2: Widenoise Call for Participants - Windsor Forum



thamesweb

Residents respond to call to become 'community champions' in innovative aircraft noise monitoring project

#50 [-]

Borough Announcement

Posts: 10912
17-Apr-2013 11:52 AM
Reply Quote More

Residents have been quick to respond to the Royal Borough's call to become community champions and lead the way with an innovative project that monitors and maps aircraft noise arising from aircraft landing at and taking off from Heathrow Airport.

The Royal Borough sent out a rallying call for residents bothered by aircraft noise to support its 'Raise Your Voice' campaign calling for volunteers to step forward and help implement the roll-out of the WideNoise mobile phone app which allows residents to record, monitor and log aircraft noise under Heathrow flight paths.

Already, 20 residents have expressed an interest in helping demonstrate and coordinate the project for the benefit of other members of the community affected by aircraft noise.

The first step will be to receive training from the council's public protection team and project partners from University College London at 4pm on Tuesday 23 April in Desborough 4, Town Hall, Maidenhead. The training is expected to last no more than an hour and anyone interested in the project is invited to come along and take part.

Cllr Carwyn Cox, cabinet member for environmental services, said: "Once again Royal Borough residents have responded overwhelmingly to a call for help in making this important evidential tool understandable and available to those members of the community who might not be so well versed with such technology.

"I hope the community champions will help demonstrate the WideNoise app purposefully and give a greater voice and credibility to those adversely affected by excessive aircraft noise."

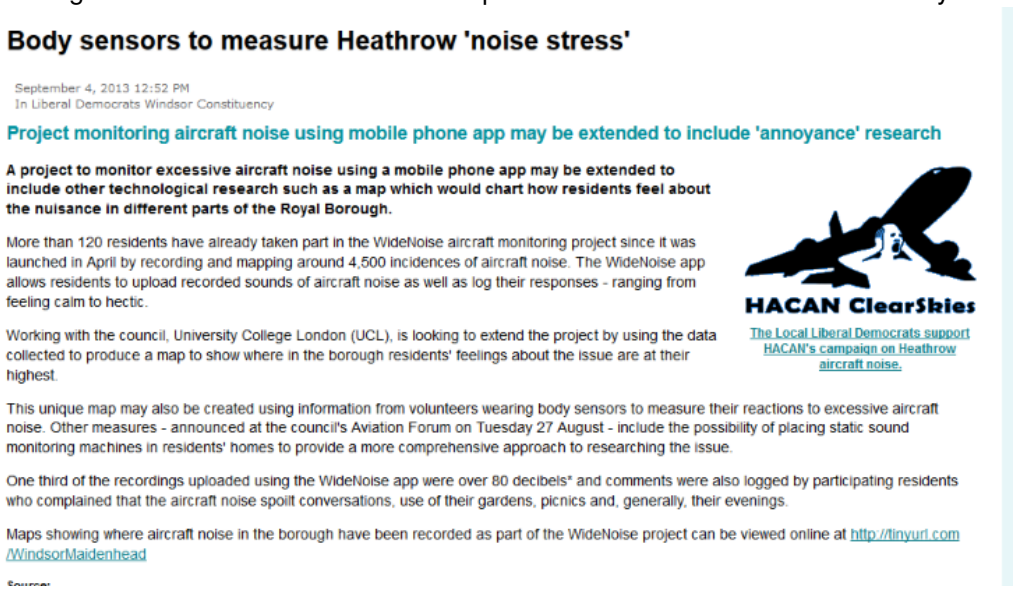
The initial call for community champions came at a meeting of the Aviation Forum on 28 February. This was renewed at a public meeting held at The Windsor Boys' School on 28 March to discuss aviation issues. Also in attendance was Nigel Milton, the director of policy and political relations at Heathrow Airport, who warmly welcomed the community initiative.

It is hoped the WideNoise app will encourage residents and communities to record their views through active participation so that this information can be added to the national and local debates and hopefully help influence government plans to create a new national aviation policy framework, taking fully on board the views of local people.

Cllr John Lenton, chairman of the aviation forum, said: "The application not only enables residents to get involved in dealing with an issue very close to home but also we will be able to see where the incidents and impacts occur and their relative severity, and allow subjective accounts of how aircraft noise is actually affecting borough residents by recording their own experiences."

Anyone who would like to become a community champion and help the local community use this important tool, but cannot attending the training session stated, should contact Chris Nash, environmental protection team leader, at christopher.nash@rbwm.gov.uk

Figure 3.3: Widenoise Call for Participants - Windsor Liberal Democrat Party



Body sensors to measure Heathrow 'noise stress'

September 4, 2013 12:52 PM
In Liberal Democrats Windsor Constituency

Project monitoring aircraft noise using mobile phone app may be extended to include 'annoyance' research

A project to monitor excessive aircraft noise using a mobile phone app may be extended to include other technological research such as a map which would chart how residents feel about the nuisance in different parts of the Royal Borough.

More than 120 residents have already taken part in the WideNoise aircraft monitoring project since it was launched in April by recording and mapping around 4,500 incidences of aircraft noise. The WideNoise app allows residents to upload recorded sounds of aircraft noise as well as log their responses - ranging from feeling calm to hectic.

HACAN ClearSkies

The Local Liberal Democrats support HACAN's campaign on Heathrow aircraft noise.

Working with the council, University College London (UCL), is looking to extend the project by using the data collected to produce a map to show where in the borough residents' feelings about the issue are at their highest.

This unique map may also be created using information from volunteers wearing body sensors to measure their reactions to excessive aircraft noise. Other measures - announced at the council's Aviation Forum on Tuesday 27 August - include the possibility of placing static sound monitoring machines in residents' homes to provide a more comprehensive approach to researching the issue.

One third of the recordings uploaded using the WideNoise app were over 80 decibels* and comments were also logged by participating residents who complained that the aircraft noise spoilt conversations, use of their gardens, picnics and, generally, their evenings.

Maps showing where aircraft noise in the borough have been recorded as part of the WideNoise project can be viewed online at http://tinyurl.com/WindsorMaidenhead

Figure 3.4: Widenoise Call for Participants - BBC Online News

Body sensors to measure Heathrow 'noise stress'

People living under the flight path of Heathrow Airport are being invited to wear body sensors to monitor stress caused by aircraft noise.

Parts of the Royal Borough of Windsor and Maidenhead are affected by the sound of planes taking off.

About 140 residents have already taken part in a study using a mobile phone app to record and chart plane noise.

Residents have complained of the noise being so loud it drowns out conversations

The University College London (UCL) is extending the project to monitor the stress inflicted on people's bodies.

The WideNoise aircraft monitoring app allows residents to upload recorded sounds of aircraft noise and log their responses - ranging from feeling calm to hectic.

Since it was launched in April, it has recorded and mapped around 4,500 incidences of aircraft noise, a spokesman for Windsor and Maidenhead council said.

Volunteers sought

l/27001696 rd of the recordings uploaded so far have been above 80

Related Stories

Heathrow noise trial 'helps 100,000'

Plane vortex rips hole in house roof

Heathrow tests noise relief zones

Figure 3.5: Widenoise Call for Participants - Windsor Conservative Party

Maidenhead Conservatives shared a link.
September 4, 2013 near London

Cllr Carwyn Cox: "Our residents have played an important role in the council's submission as a result of the WideNoise aircraft noise monitoring project. WideNoise is a valuable tool in empowering those directly affected to map and assess the impact of aircraft noise."

http://www.maidenhead-advertiser.co.uk/News/Areas/Maidenhead/Noise-map-of-aircraft-movements-over-Windsor-and-Maidenhead-to-be-made-04092013.htm

'Noise map' of aircraft movements over Windsor and Maidenhead to be made
www.maidenhead-advertiser.co.uk

Residents in Windsor and Maidenhead are to play a key part in the council's response to an Airports Commission consultation calling for evidence and new ways of assessing the impact of excessive aircraft

Like · Comment · Share

Figure 3.6: Widenoise Call for Participants - Maidenhead Advertiser

15:55 Wednesday 04 September 2013 Written by Staff reporter

Like 1 Tweet 4

'Noise map' of aircraft movements over Windsor and Maidenhead to be made

Residents in Windsor and Maidenhead are to play a key part in the council's response to an Airports Commission consultation calling for evidence and new ways of assessing the impact of excessive aircraft noise.

So far 129 residents have uploaded about 4,500 recordings of aircraft noise to the WideNoise monitoring project.

Now a computer-generated 'noise map' of aircraft movements over the borough will be forwarded to the commission with comments from residents who used a mobile phone app to record aircraft noise data from their homes.

Cllr Carwyn Cox, cabinet member for environmental services, said the WideNoise project, a joint initiative between the Royal Borough and University College London, needs to become part of the 'basket of measures' used to assess the impact of aircraft noise.

"Our residents have played an important role in the council's submission as a result of the WideNoise aircraft noise monitoring project. WideNoise is a valuable tool in empowering those directly affected to map and assess the impact of aircraft noise."

Cllr John Lenton, chairman of the aviation forum, added: "An accurate measure of the extent of the noise already suffered by our residents is needed so that it can be fully taken into account by the Davies Commission when it recommends where additional airport capacity should be located in the South East."

< Back

with the concerted attempt to capture information for input into the response by RBWM to the Davies Commission.

Figure 3.7: Average DB Readings for RBWM compared with the rest of the world

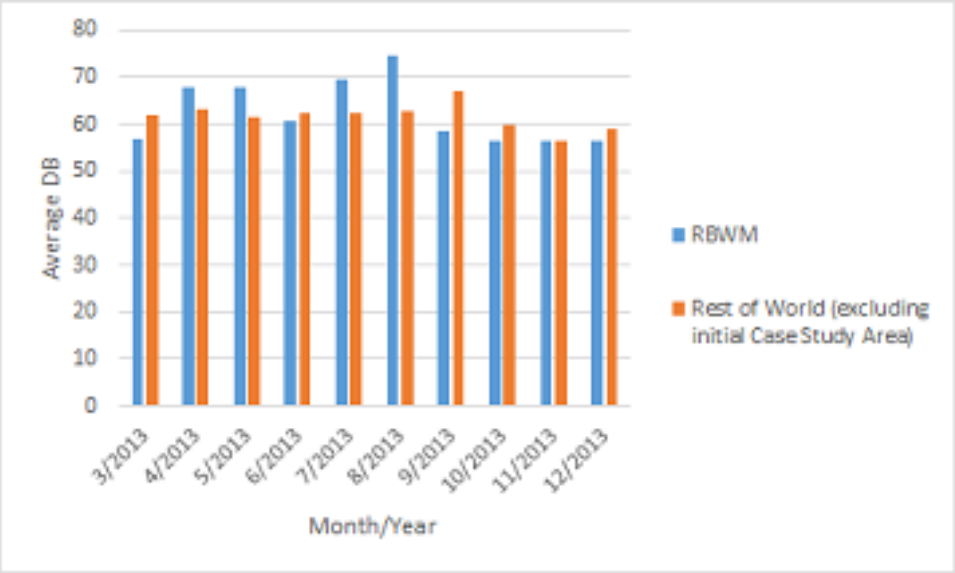


Figure 3.7 shows the average DB readings for the RBWM area when compared to the rest of the world (excluding the initial Heathrow/HACAN campaign area) over the course of the main campaign, which ran from April to December 2013.

Figure 3.8 shows the number of readings taken at each hour of the day for RBWM and for the rest of the world (excluding the original Heathrow area) from April 2013 to December 2013. The numbers of readings taken at each hour are expressed as a percentage of the total number of readings taken during that period. As can be seen in both cases, data capture activity increases during the daytime, but for RBWM a number of peaks occur - 7am and 8am, and in particular in the late afternoon and early evening. This corresponds to the time of day when residents would be in their houses, or on their way to/from work, suggesting that this is data created as purposeful and sustained activity by engaged participants and not just random tests of the software.

3.4 Results - Recruitment, Participation and Engagement - RBWM

A total of 136 residents participated in the RBWM campaign April 2013 - December 2013.

Figure 3.9 shows the cumulative month-by-month readings taken in RBWM. The first peak in August 2012 coincides with the first WideNoise campaign that started in Isleworth and must have been adopted by some participants in RBWM but quickly died off. In contrast in April 2013 we can see the effect of the organised RBWM campaign for these residents. This organised campaign resulted in a steady and continued data capture by local residents. Thus this example allows us to see the effect of a local targeted campaign versus just peripheral participation in a campaign targeting another area.

The results of the activity fed directly into the RBWM response to the Davies Commission, which

Figure 3.8: Hourly Distribution of Readings - RBWM

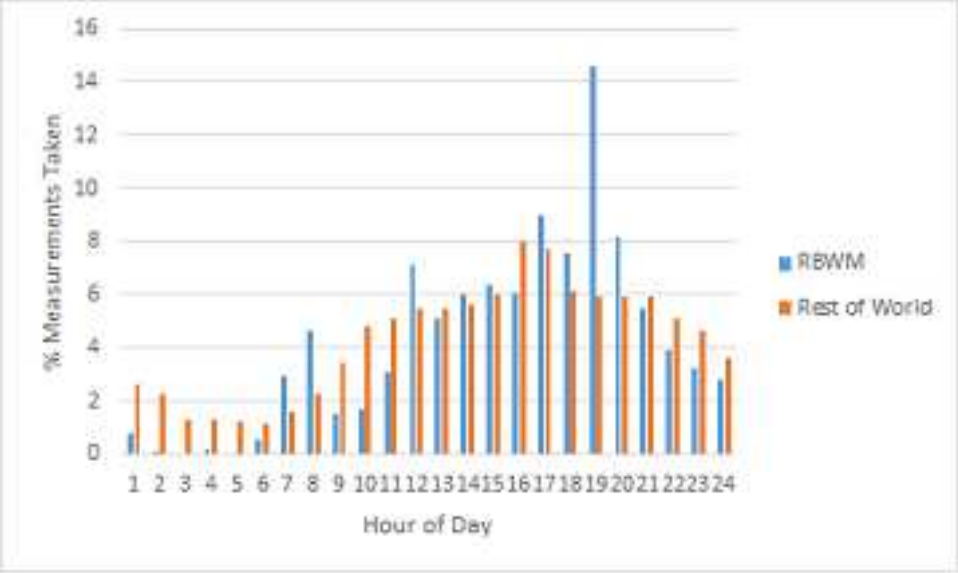


Figure 3.9: Month by Month Readings - RBWM

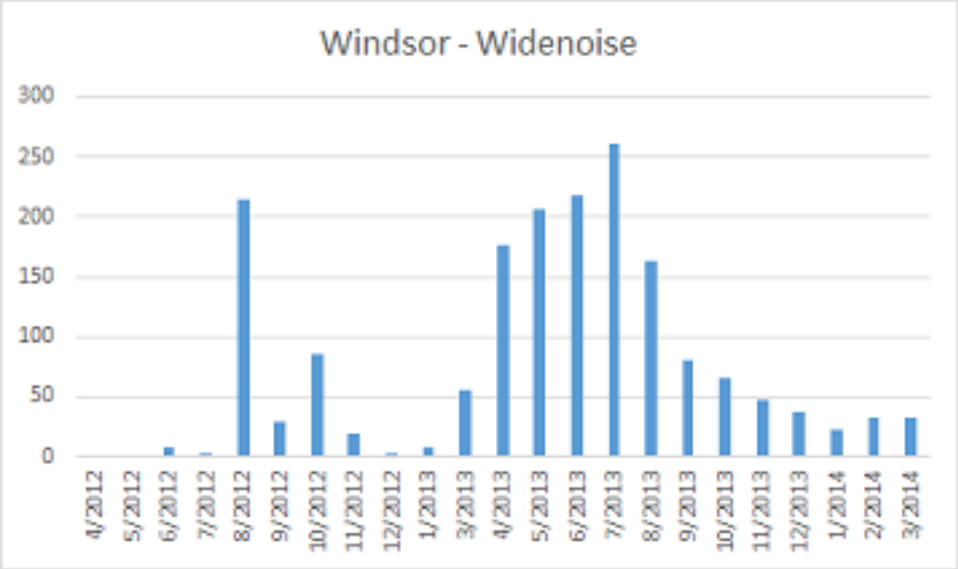
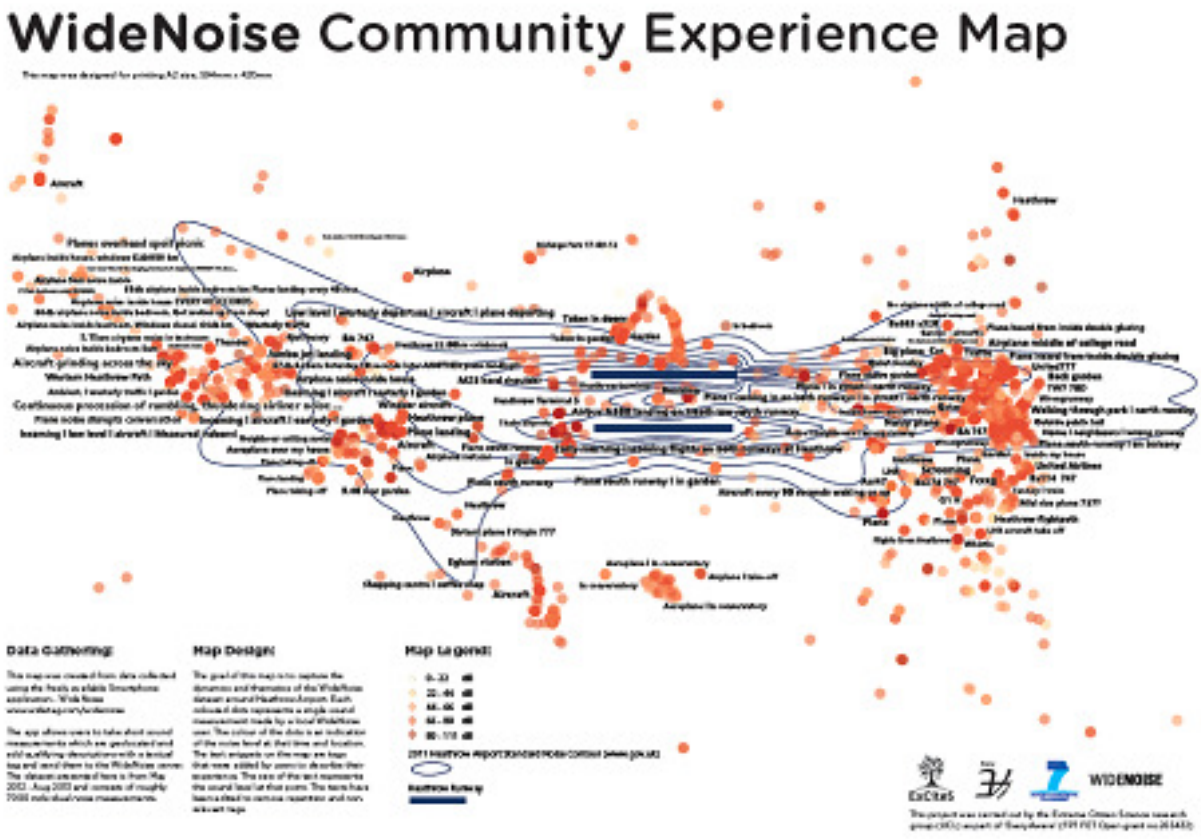
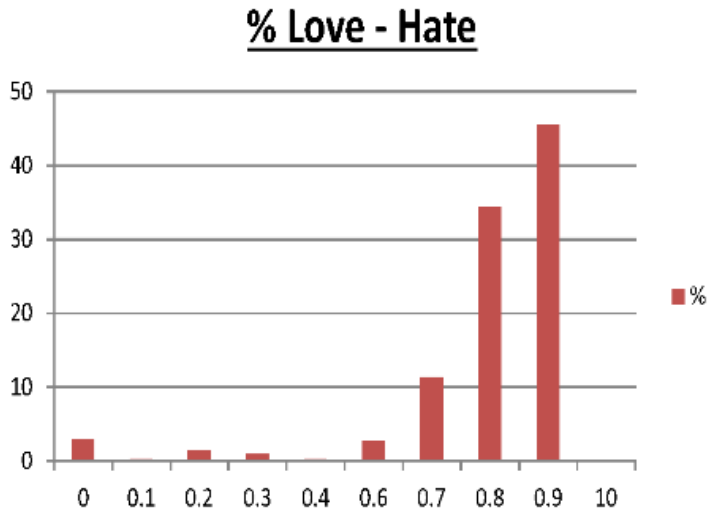


Figure 3.10: Extract from RBWM Report



included an Appendix detailing the study and the responses[10]. The council report also included an analysis of the qualitative slider readings entered by users, eliminating the 0.5 value (which was assumed to mean that users did not submit a value) and highlighting the dominance of 'hate' on the love/hate scale (see Figure 3.11). Figure 3.10 shows an extract from the RBWM report, the "WideNoise Community Experience Map" created by the UCL team, which also forms part of this report. This map was created in close consultation with the RBWM team. It is a custom visualisation of the WideNoise data focused on Heathrow airport. The goal of the map was to represents the participant's experience of noise around the airport. The map highlights the tags used by WideNoise users by visually mapping the geolocated tags and varying the type size in relation to the measured decibel value. This places emphasis on descriptive tags such as "Aircraft grinding across the sky" and "Planes overhead spoil picnic". The decibel data is represented as colour coded dots indicating the measured noise level at that location. The RBWM team requested that the location of the runways be represented in the centre of the map to visually locate the map for viewers. In addition the map shows the governmental '2011 Heathrow Airport Standard Noise Contour'. What is important is that significant number of the WideNoise measurements were outside of the 57 Leq(dBA) airport contour, demonstrating the impact of the airport on a very wide area.

Figure 3.11: Love Hate Scale - RBWM



3.5 Discussion - RBWM

The impact of the project on the Environmental Team at RBWM and on the Davies Commission submission is significant and the project is seen as a success. While other councils in the Heathrow area are submitting responses based on surveys of local participants in relation to the airport, RBWM see the WideNoise pilot as a an exciting departure since it allows the local residents to be directly involved. The following statements were included in the Appendix to the Submission to the Commission:

- "WideNoise, currently being run as a pilot community mapping study involving five other European Universities, appears to have enormous future development potential in relation

[10] http://www.rbwm.gov.uk/public/eh_davies_commission.pdf

to determining aircraft noise and community dose-response relationships. ”

- “It must be highlighted that the response from residents in this pilot study has been remarkable. From the 136 residents that have so far participated in the pilot study, a consistent message has emerged that the noise from aircraft overhead does cause a significant disturbance to the enjoyment of their property.”

- “The results obtained during this pilot can be said to legitimise the concerns of local residents surrounding Heathrow regarding noise. It highlights the importance of taking into account the community experience and impact of aviation noise on local residents in addition to the arguments to be put forward concerning noise levels.”

From the perspective of the RBWM team the key strength of the WideNoise pilot is not so much the data that has been gathered itself but rather the broader benefit of the whole citizen monitoring activity as a way of empowering the local community to voice their opinions. This focus on the experience of noise and enabling local residents to make an active contribution is something that they intend to continue with other emotion mapping processes.

- “The next stage of the project will seek to refine the methodology using static monitors to better assess the subject responses to the noise levels per event/over time but also includes an investigation of the potential for ‘Emotion Mapping’ of peoples reaction to aviation noise thus showing the understanding of the RBWM team of combining both subjective and objective information in such a study.”

As with the previous HACAN study around the Heathrow area, given that users can download and the Widenoise App and measure data without being directly in contact with the RBWM team or the project team at UCL, it is not possible to evaluate the direct impact of a single recruitment method or channel from the range described above. This is perhaps a factor in many similar studies, where once an official Press Release is made or meeting held the information is then disseminated via channels outside the control of the project team, or even via word of mouth. There is perhaps a trade-off to be made between asking users to sign up to the project (and including questions relating to ‘where did you hear about the project’ as part of this sign up process) and facilitating direct access to the task at hand - i.e. measuring noise.

3.6 Cumulative Results - Large Scale Noise Study

A total of 48414 noise measurements were captured worldwide across the 3-year EveryAware project, with an average DB reading of 63.93dB. Of these, 6666 (or 13%) were captured in the Heathrow Area, with another 688 of the points relating to an initial Case Study in Rome and 1013 in the initial London Case Study. Figure 3.13 shows the overall distribution of data for both Heathrow and non-Heathrow activities and Figure 3.14 shows the data points on a map. These results clearly demonstrate the importance of an active campaign in conjunction with a tool kit or App for environmental information gathering. Although users around the world had access to WideNoise, significant usage was only observed in conjunction with a specific campaign activity. The HACAN and RBWM campaigns allow us to see the dramatic effect of a local targeted campaign versus merely peripheral participation in a campaign targeting another area.

3.6.1 The Importance of a Campaign

Figure 3.15 shows the distribution of readings across the entire Widenoise database (including Heathrow), with a peak occurring between around 60-70dB. Figure 3.12 shows the similar figure

for the Heathrow area, where the peak is clearly shifted towards the 70-80dB range. This indicates that, as highlighted in the interim report, those members of the public involved in a noise gathering exercise may be included to make measurements at higher noise levels - i.e. where noise is more problematic. Understanding this behaviour is vital to correctly interpreting the results of the study and highlights the impact of capturing environmental data as part of a campaign.

Figure 3.12: Distribution of Widenoise Readings Across the Heathrow Area

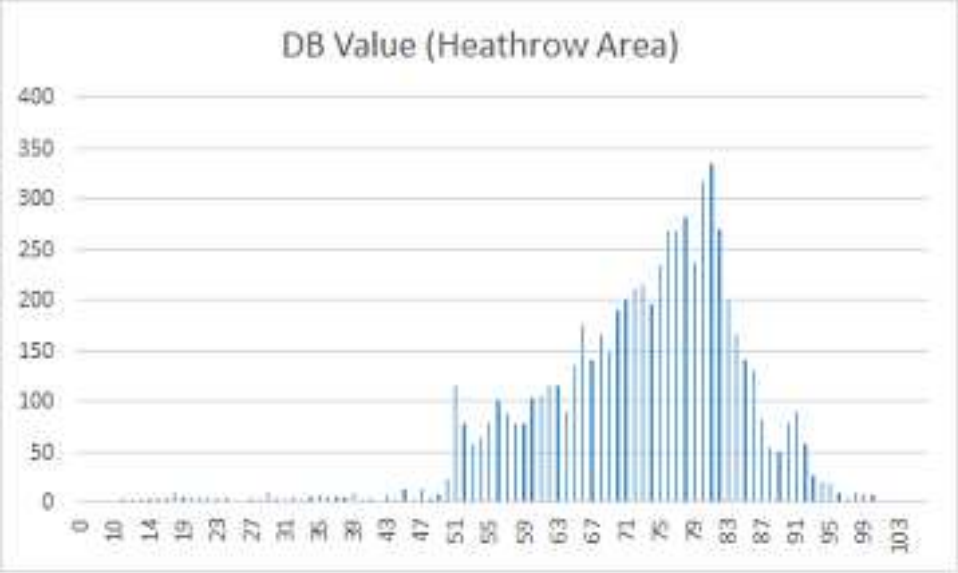
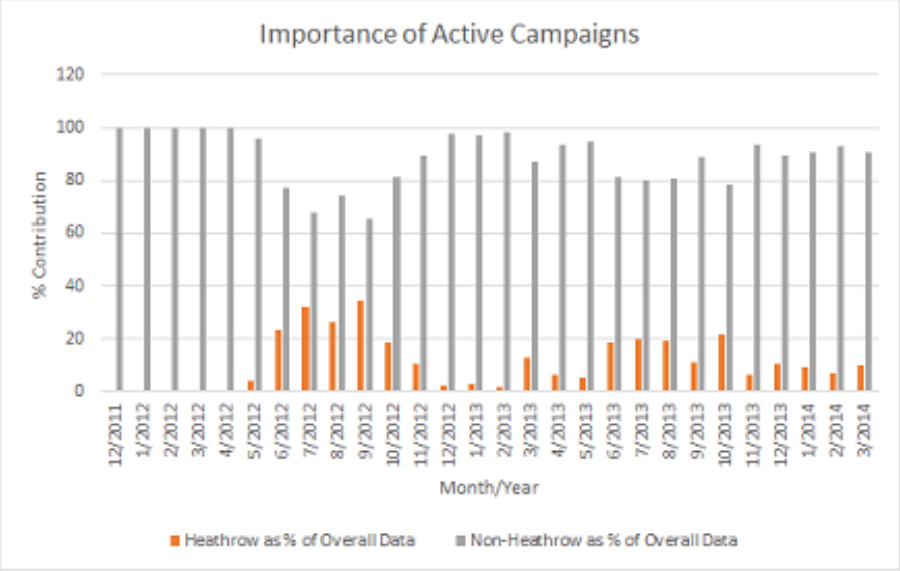
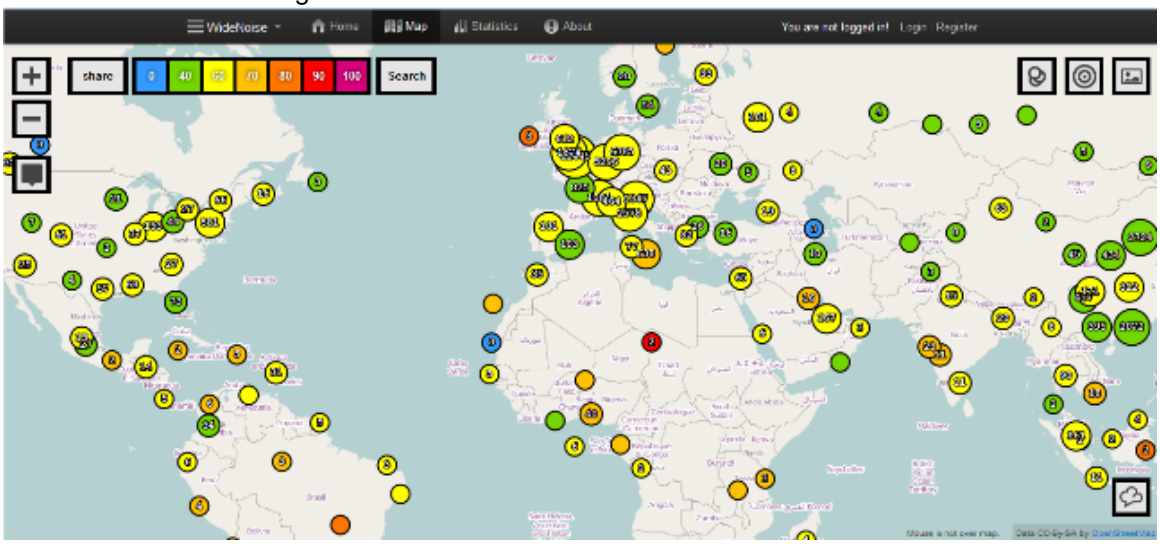


Figure 3.13: Campaign versus Non-Campaign Activity



Examining levels of contribution, the importance of an active campaign emerges further. Figure 3.13 shows that the preliminary conclusions discussed in the interim report D3.1 [UCL, 2012b] have persisted - those users involved in campaign related activity are likely to capture more data points over a longer period of time, and are more likely to use the sliders to provide qualitative

Figure 3.14: Widenoise Worldwide Data Distribution

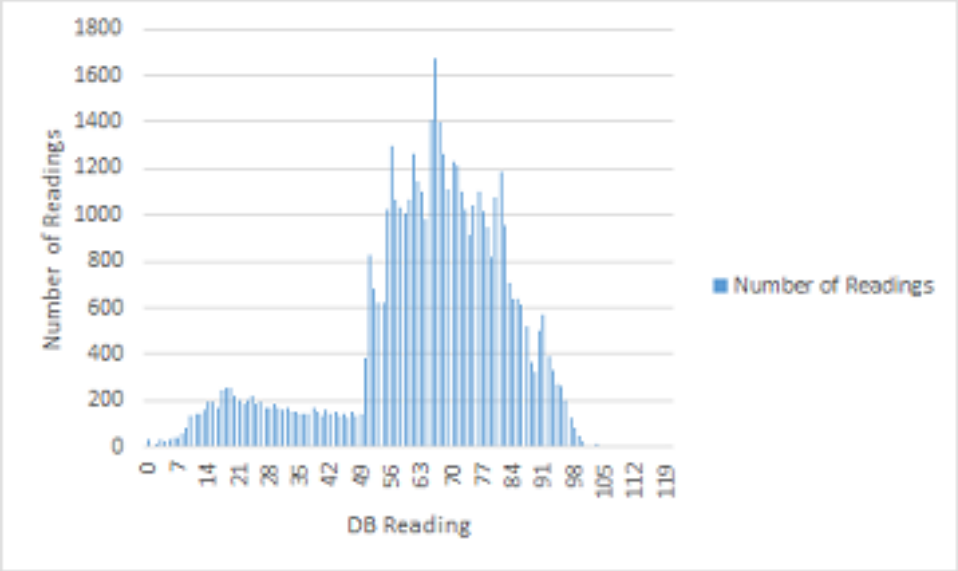


information about their data. The importance of this qualitative information in combination with the quantiative measurement and overall time taken to measure data is illustrated by RBWM's statement in their report to the Davies Commission, which mentions that emotion mapping will be included in the next phase of the study and that:

- "The results obtained during this pilot can be said to legitimise the concerns of local residents surrounding Heathrow regarding noise. It highlights the importance of taking into account the community experience and impact of aviation noise on local residents in addition to the arguments to be put forward concerning noise levels."

Both parts of the case studies in the Heathrow area highlight the fact that although the accuracy of the WideNoise device was not very high (see D2.1 for details of calibration) the device has the potential for involving people in collective action around the issue of noise. The level of involvement from participants around Heathrow (in particular given that each reading can take up to 2-3 minutes to complete and submit to the server) is an indication of the importance of noise for local residents. Yet releasing the app by itself would not have resulted in a concentrated environmental noise mapping activity. The project required the concerted effort by HACAN, UCL and RBWM team to coordinate a campaign and contact local residents, who otherwise would not have been involved in noise monitoring and discussions about local environmental impacts.

Figure 3.15: Distribution of Readings Across Widenoise Database



Chapter 4

Large Scale Case Study - Air Quality - The APIC Challenge (Tasks 3.3 and 3.4)

4.1 Introduction to the Case Study

The aim of the AirProbe International Challenge (APIC) was to permit investigation into recruiting participants for environmental studies via a 'serious gaming'/competition approach, combining online and offline activities, as opposed to the direct campaign approach carried out in the Heathrow Study. Additionally, as the challenge was run across four Case Study areas (London, Antwerp, Kassel and Turin) rather than the one originally planned (Rome) comparison of the various recruitment activities may be possible.

The aim of the APIC competition was to build a map of air pollution for each city. People from each city willing to join could become either Air Ambassadors, whose task was to measure the levels of air pollution with the sensor box developed by the EveryAware Consortium, or Air Guardians, whose task was to report subjective air pollution level estimations in various spots of their city.The challenge was divided in three phases, each of them lasting two weeks, and in each phase the two kinds of volunteers had to perform different tasks, as follows:

1. Phase 1
   (a) Air Ambassadors - recruit Air Guardians and play the online game
   (b) Air Guardians and Air Ambassadors - play the online game
2. Phase 2
   (a) Air Ambassadors - make measurements using the sensor box and play the online game, making sure to cover the given game area as much as possible in both space and time
   (b) Air Guardians - play the online game
3. Phase 3
   (a) Air Ambassadors - make measurements, wherever the ambassador felt appropriate
   (b) Air Guardians - play the online game

Both the Air Ambassadors and the Air Guardians were instructed to play in/map a given area of each city, which was sub-divided into grids. The players were instructed to be active in as many

grids as possible. A full description of the APIC game, including technical details and the online game, can be found in Deliverable D2.2 (“Final version and report on the web-based infrastructure”), with an overview of the elements of design in the APIC game used to encourage longevity of play given in Appendix 3 of this document. The results presented here are initially presented on an area by area basis, followed up by a discussion comparing outcomes across the four cities.

4.2 Area Descriptions

Figure 4.1: Game areas for the Four APIC Challenge Locations (from left to right, top to bottom, Antwerp, Kassel, London, Turin)

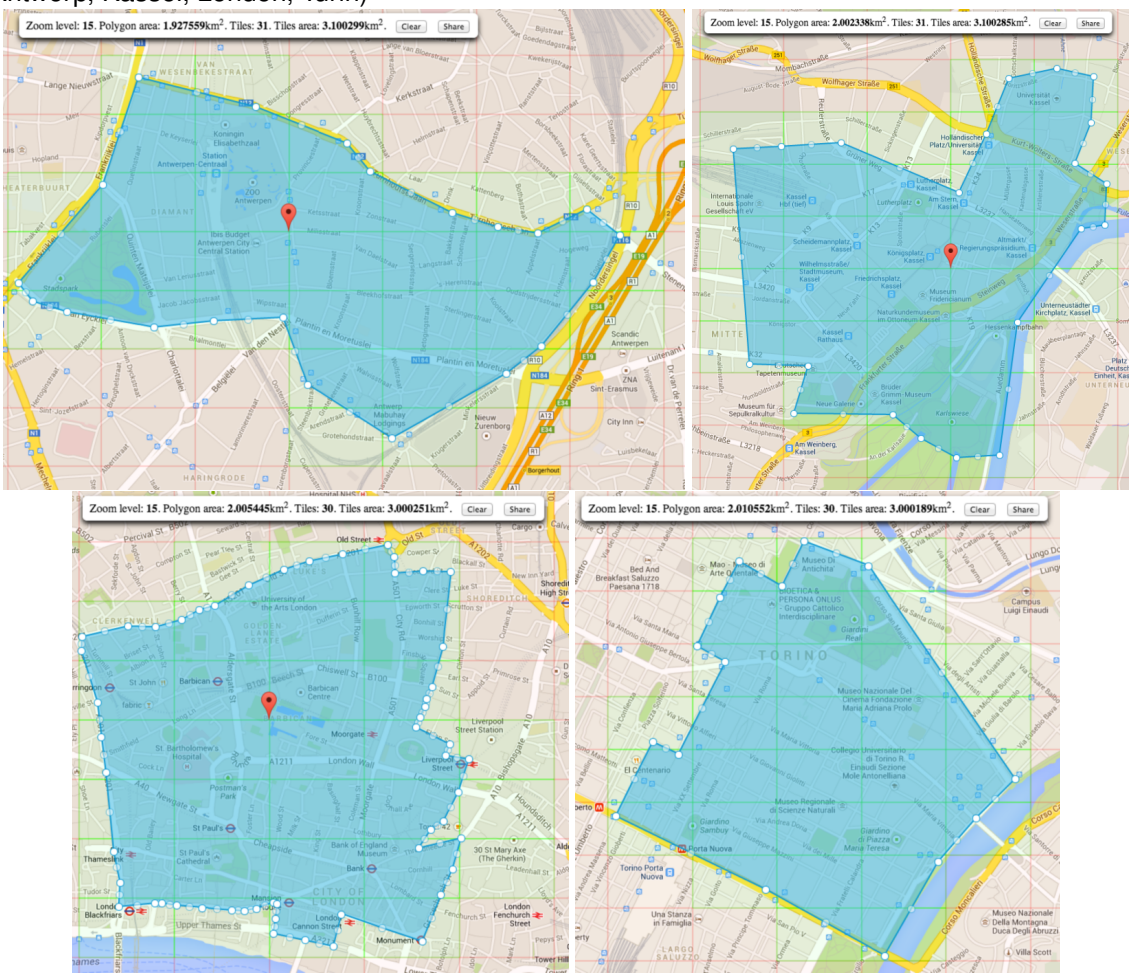


Figure 4.1 shows maps of the game areas in the four selected cities. The areas were selected to be, as far as possible, similar in extent, as shown in Table 4.1.

A brief description of the characteristics of each area is given below.

4.2.1 Antwerp

The area for APIC was set up in the city of Antwerp (51°12’N, 4°26’E), Belgium, which is a medium-sized city (480,000 inhabitants, 985 inhabitants km^{-2}). A core area of about 2 kmÂš was selected to concentrate the monitoring efforts. The area is mainly residential and commercial, but significant differences in traffic density and street configuration are present. An urban green area (Stadspark),

Table 4.1: Extent Details of the APIC Challenge Locations

Location	Area (sq km)	Number of Game Tiles	Area of Game Tiles (sq km)
London	2.005	30	3.000
Antwerp	1.928	31	3.100
Turin	2.010	30	3.000
Kassel	2.002	31	3.100

a low-traffic square (Dageraadplaats), and streets and roads with very different traffic density were included. Also other important features such as the aspect ratio (height-to-width ratio) differed considerably between streets in the area. A station from the air quality monitoring network of the Flemish Environmental Agency (VMM, station 42R801) is located in the centre of the area along one of the main roads (Plantin en Moretuslei).

4.2.2 Kassel

The game area was placed in the inner city of Kassel. It is mainly residential and commercial, but significant differences in traffic density and street configuration are present.An urban green area (parts of the Karlsaue), a pedestrian zone (Obere KÃűnigsstraÃ§e), a high traffic street Frankfurter StraÃ§e / B3), and streets and roads with very different traffic density were included. A station from the air quality monitoring network of the Hessian Agency for the Environment and Geology (HLUG, station “Kassel-FÃijnffensterstraÃ§e”) is located near the center of the area along one of the main roads (FÃijnffensterstraÃ§e).

4.2.3 London

The game area for London was selected as the area around the Barbican within the City of London. This area is characterized by the presence of a large Performing Arts centre and a large estate with multi-level partially covered pedestrian walkways. A number of underground (metro) and rail stations are situated close to the area permitting easy access to APIC participants. The area is traversed by a number of heavily trafficked roads (London Wall, Aldersgate Street) where higher levels of pollution could be expected than on the walkways of the estate. The area was selected due to interest from residents in Air Quality who were also keen to carry out their own air quality survey (see http://www.mappingforchange.org.uk/portfolio/science-in-the-city/). Three roadside stations from the air quality monitoring network of London are located within the area (http://www.londonair.org.uk/london/asp/publicdetails.asp?region=0)

4.2.4 Turin

The game area for Turin was placed in the city centre, to facilitate access for volunteers. In most of this area, traffic is limited to public transportation and residents or cars with a special permit. However a few streets are included where full car access is allowed. Also, several pedestrian streets and squares are included, where pollution is expected to be lower.

4.3 Recruitment, Participation and Engagement - Initial Engagement

For all four participant cities, a general recruitment process, with a focus on recruiting Air Ambassadors (who as described above had the task to recruit Air Guardians) was carried out using a specifically created Facebook page[1] (Figure 4.2), as well as via the EveryAware web site[2]. As part of the recruitment process, issues relating to measurement error were communicated to the participants by communicating the aims of the project as trying to develop low cost sensors and as such they would be experimental and not comparable with official data sources. This was done verbally but also via a short technical specification document available to all participants online[3] which states:

- "[the sensors] perform well in a highly controlled lab environment"
- "[due to weather and other conditions] it is very difficult to give a precise and reliable concentration with individual sensors"
- "[there is an] estimation error of about 2 microgram per cubic meter"

Figure 4.2: APIC Challenge Facebook Recruitment Page

As part of this process, incentive to participate and maintain engagement throughout the study was also given by a set of prizes that were publicised with the initial call to participate, and various strategies designed into the online game to encourage ongoing play (see Appendix 3). Prizes were issued at the end of each Phase, for each City, according to the ranking strategy described in D2.2 (relating to the number of days played and the total 'revenue' gained for each day of play). The top five revenue values on the last day of play awarded t-shirts, while the top ranked player was awarded a backpack, with a second being assigned to the player who had engaged for the longest amount of time. In London the scheme was additionally enriched with some Amazon vouchers for the best teams - each team received Âč100 in Amazon vouchers and the team with the best time/space coverage and the largest number of active Air Guardian players won Âč400 in Amazon

[1] https://www.facebook.com/pages/APIC/455185927931856
[2] http://www.everyaware.eu/APIC/
[3] http://www.everyaware.eu/wp-content/uploads/2013/10/SensorBoxTechnicalSpecs.pdf

Table 4.2: Engagement and Participation - Antwerp

Method	Emails received	Initial Meeting	Final Volunteers
Mailing list	32	19	19
Newspaper	0	0	0
Talks	0	0	0
Posters	0	0	0

Table 4.3: Engagement and Participation - Kassel

Method	Emails received	Initial Meeting	Final Volunteers
Mailing list	7	0	5
Newspaper	3	0	2
Talks	2	0	1
Posters	0	0	0

vouchers. In Antwerp the prize scheme was much more flexible and has been adapted to the low number of players.

In additional to these general recruitment methods, local recruitment methods were utilised, in particular given that much of the text on the main pages is written in English. These are detailed here:

4.3.1 Antwerp

The recruitment strategy for Antwerp was based on the strategy followed in the test case (see Section 2.1.4 in D6.2). An advertisement was prepared and sent around to a selected mailing list. The mailing list included volunteers from earlier monitoring campaigns, traffic organizations environmental agencies and interest groups, communities working on sustainability issues and so forth. The advertisement included a teaser, a comprehensive overview of the AirProbe International Challenge (both the monitoring part and the gaming part) with links to the project website, and a link to a participation form. The participation form included several questions which were used to gain some ideas on the degree of interest of the participants in air quality monitoring and on the temporal coverage that we could expect from the monitoring in Antwerp.

4.3.2 Kassel

Four different recruiting methods were employed in Kassel. Firstly, emails were sent to mailing lists in the University of Kassel, University of WÃijrzburg, University of Hannover, Christian organizations, and several smaller groups asking for volunteers; secondly two newspaper articles were released in press; thirdly one poster was displayed on several screens in the University of Kassel and finally three short talks have been given during classes in the University. All these methods announced the competition and asked interested people to contact us by writing to a given email address.

Table 4.4: Engagement and Participation - London

Method	Emails received	Initial Meeting	Final volunteers
Mailing list	48		34
Newspaper	3	0	2
Talks	2	0	1
Posters	0	0	0

4.3.3 London

Recruitment in London took place via direct and e-mail contact with University Students at University College London. An email advertising the APIC challenge was circulated to all students across the university and interested individuals were asked to respond via email. Posters were distributed across the university to specifically target the recruitment of Air Guardians (Figure 4.3) and the Mapping for Change Twitter account was used to advertise the activity.

Figure 4.3: Poster Advertising APIC in London

4.3.4 Turin

Three different recruiting methods have been employed in Turin. Approximately 50 posters have been put up on public boards within the two largest universities in Turin. Emails have been sent to two mailing lists in the Physics department of the University of Turin, asking for volunteers. Furthermore, five short talks have been given during classes in the Polytechnic University of Turin.

Table 4.5: Engagement and Participation - Turin

Method	Emails received	Initial Meeting	Final volunteers
Posters	0	0	0
Mailing list	8	4	2
Talks	11	8	8

All these methods announced the competition and asked interested students to contact us by writing to an email address.

4.3.5 Ongoing Engagement Through the Challenge

Following on from initial team recruitment, the EveryAware team in all four cities maintained an ongoing level of engagement with participants throughout the challenge. This engagement took the form of email exchanges and various meetings with individual teams. Additional one-off meetings were required to resolve various issues that arose with the technology throughout the game.

4.3.6 Follow-Up Questionnaire

Following on from the conclusion of the Challenge, each team held a debriefing meeting with participants and they were also asked to complete a questionnaire, which investigated motivations for participation, asked for their feedback on the APIC Challenge (in terms of problems encountered and the impact participation had on the players) and examined, in the case of Air Ambassadors, how they recruited team members. A full list of questions can be found in Appendix 1 (Section 6.1).

4.4 Results - Recruitment, Participation and Engagement

4.4.1 Antwerp

Thirty-three people expressed their interest to participate in APIC by making air quality measurements. A meeting was organized for these people to discuss the objectives of the Challenge and the methodology for making measurements with the sensor box in detail and to make practical arrangements. Ten teams of 1 to 3 members were defined (finally 19 people participated in the monitoring), based on home locations. Each team had a coordinator (ambassador) who was responsible for the circulating the sensor box between team members, and to take care of the communication with us on an intermediate (after one week) and final (after two weeks) session.

4.4.2 Kassel

Table 4.3 shows the effectiveness of each of the methods, in terms of initial contacts made, participation at a first introductory meeting and final decision to participate. This shows that mailing lists and newspaper are the most successful, with posters leading to no participants. Mailing lists

were the most successful, due to their more accurate targeting and wider range of recipients. Two additional participants were brought in by one of the volunteers recruited. Amongst all interested people, no one showed up during our initial meeting, which could be due to the fact that most participants coming from mailing lists that already received elaborative information material. In total, 10 people (Air Ambassadors) with 10 sensor boxes participated in Kassel.

4.4.3 London

A total of 49 people responded to the email and from these 48 expressed a willingness to participate in the case study. Subsequently, three individuals withdrew as a result of other commitments. When the date of the initial meeting was circulated eight respondents said that they were unable to make the meeting. Most participants, who responded to the final survey, said that they heard about the challenge via email (80%) with 4 (2 via social media; 2 via a friend) citing alternative channels. The UCL student email list proved to be a successful way in which to recruit participants.

During the initial meeting details of the overall objectives of the challenge were provided including information on the equipment, duration and incentives offered. The attendees were asked to group themselves into teams totalling no more than ten and provide details of their team name and whether the use of project smartphones was needed in order to carry out the activities. In addition, each team was given posters to disseminate across the campus, halls of residence and beyond. Given the incentives, each team was encouraged to get as many Air Guardians to join their team using whichever medium they felt would be most effective.

4.4.4 Turin

Table 4.5 shows the effectiveness of each of the methods, in terms of initial contacts made, participation to a first introductory meeting and final decision to participate. This shows that direct methods of contacting volunteers are the most successful, with posters leading to no participants. Public talks were the most successful, due to their interactive nature and wider range of information that can be conveyed to the audience. While initially, emails and talks resulted in a similar number of interested volunteers, the final participation was much larger from the volunteers who had seen the talks, suggesting that they were already better informed and decided to participate before the initial meeting. Two additional participants were brought in by one of the volunteers recruited. The team also had a participant selected from volunteers that had expressed their interest in the project previously, resulting in 13 total participants, using 11 sensor boxes.

4.5 Engagement During the Challenge

4.5.1 Antwerp

Email correspondence was very limited during the monitoring period, and related primarily to practical problems. One volunteer reported about the incompatibility of his smartphone with the sensor box. Another volunteer reported about the ventilation fan of a sensor box that had come loose, and was fixed by the volunteer himself. Some volunteers had difficulty in uploading the measurement data to the server because they collected quite big datasets that had to be uploaded at once and others were surprised by the fact that the battery had to be charged on a daily basis; they expected a longer autonomy of the system. Finally, the Ambassadors of some of the teams reported when sensor boxes were exchanged between the team members.

4.5.2 Kassel

A number of participants requested meetings during the game via e-mail, with additional participants turning up to the EveryAware team's offices without appointment. Many of the questions asked related to the accuracy of the Black Carbon values provided by the App, which in the opinion of some of the participants were too low. Other questions related to difficulty uploading data to the server (and hence not obtaining the results in the game that were expected). No formal meetings were held during the game. An informal meeting was held in the team's offices where the participants stated that they had enjoyed the study but were disappointed by the App (as four devices that were not able to upload their data for several months). An estimated 5 hours a week was spent communicating with participants through the game period.

4.5.3 London

The initial engagement commenced with a one-on-one meeting with two members from each team. This was used to walk through how the application and sensor box worked during which we gave an outdoor demonstration and provided an opportunity for any questions to be asked. During the challenge there was a considerable amount of email correspondence to all teams and also to individuals. General emails were sent out including one that provided a copy of the briefing presentation and asked all team members to ensure that they had each others' contact details. One of the teams responded and explained that they had set-up a Facebook group to communicate amongst themselves and had organised their own meeting to discuss who would have the sensor box at which times. Further emails were sent reminding Air Ambassadors that the game phase had commenced; we provided updates on the transition through each of the phases and their progress at the City and team level; general words of encouragement were provided and further emails that addressed some of the technical issues.

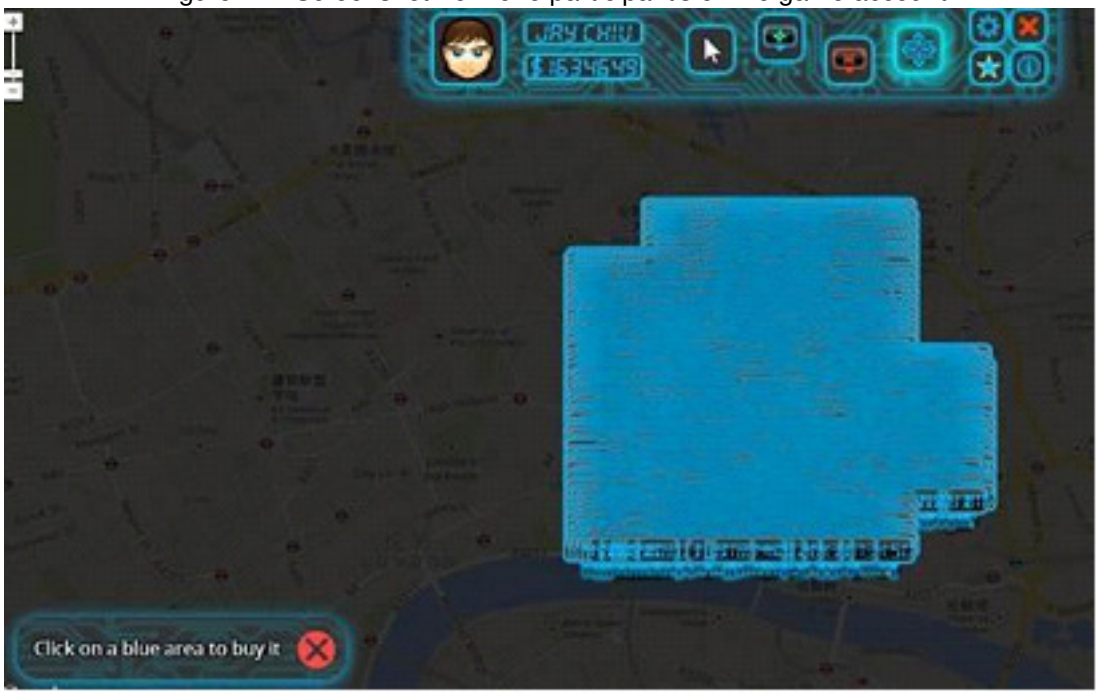
We received various emails that asked for clarification about the game in the first phase (see below for examples); on how the scoring system was calculated; questions about the rankings displayed on both the website and the game, and reports on technical problems, such as in uploading data and a broken fan on one of the sensor boxes, which had to be exchanged. One participant queried why they were getting such high black carbon readings inside their (see below).

- "I played [the] game today. However I am not quite sure about the game. Does the game automatically saved when the gamer exit [s] the game? In addition, does the higher revenue mean the higher accuracy of your assumption in the game?"
- "We Team 9 want to know [how you calculate] the appraisal of the final rank. Whether it is appraised by the [number of] days you play or the credits you get, and what is the proportion the sensor work occupies."
- "When I [get] back home, open the phone and update data in my flat, I find that the BC in my flat upwards to the over 9.00 ug/m3 but then the value decreases slowly. What's the problem? Why there is pretty high value in my flat. Does this black carbon affect health?"

One participant in particular expressed concern about the motivation of London Air Guardians

- "...By the way, as you see the picture above of my account [Figure 4.4], I have nothing to do with my map: one is because I have no place to expand and no place to add pins... I have done enough to support our London [team], you can see more than half of London's credits are from mine and my air guardians' account. But we are still losing."

Figure 4.4: Screenshot from one participant's online game account



4.5.4 Turin

A large amount of email communications have been sent to volunteers during the challenge. Responses, however were limited. Three of the volunteers were very actively involved in the measuring activities, with several emails describing errors and other issues received from them. A few others asked for instructions on the way, although the team had carfeully explained every phase, which indicated that volunteers were not always reading the emails received. This may indicate that the emails sent were too many. A few of the volunteers had issues with the Android application, so they required assistance in uploading data. Some issues were encountered trying to organise meetings where they could upload the data, since their availability to meet was limited and they appeared to have lost from the initial determination for the project. One member of the team in Turin estimated that they spent on average at least 3 hours a day for the entire duration of the APIC challenge, between presentations, posters, and interactions with volunteers, since they also had volunteers coming to upload data with team member's phones (due to technical issues), with a total time spent of around 90 hours.

The most important issue encountered in Turin was the fact that the AirProbe application was not compatible with some older Android models and no iOS version was available. This resulted in four teams needing assistance to upload data, and not being able to get real time information from the sensor box, which in turn resulted in these volunteers losing motivation over time. Secondly, the GPS module on the boxes did not always work as desired, which caused data to be lost since it was not geo-localised. This also caused frustration and might have demotivated some of the volunteers. These issues were identified both during the test case and through the questionnaire. At the same time, however, an increase in activity was seen in those volunteers who did not encounter some of these problems. These continued to perform large amounts of measurements and maintain good communication levels by reporting small issues and showing interest in the scientific project itself.

4.6 Follow-Up Meetings and Questionnaire Responses

4.6.1 Antwerp

A final discussion was held with the Air Ambassadors following the conclusion of the challenge, during which two participants contributed critical but constructive comments about the measurement equipment, noting that they felt that it is way too complicated to handle the sensor box and smartphone. They argued that the monitoring had to be planned carefully too, long before the actual measurements can take place. The smartphone and batteries have to be charged and the sensor box has to be switched on 1 hour before the measurements take place. Furthermore, far too many buttons have to be pushed and connections have to be made carefully at startup. Also regular checks during the measurements are not easy to make, especially not when biking. Both volunteers reported that it is too invasive in their daily activities to keep on monitoring for longer than two weeks. One of them proposed to make the system much more simple, by using just one on/off button for the whole system or even by an automated start based for example on movement. Another volunteer came up with a creative idea to use the EveryAware technology in the handlebars of a bicycle. A docking station for the smartphone could be used to track air quality while moving around. In conclusion, most of the volunteers were creative in planning the monitoring with team members and in finding solutions to small hardware problems. Some volunteers provided very useful comments on the system, which should be taken into account when the usability of the system has to be further optimised.

4.6.2 Kassel

An informal debriefing session was held with a few participants in Kassel, during which some participants informed the team that they liked the study, but were disappointed by the Android App (in Kassel, four devices were not able to upload their data for several months). Three responses were received to the follow-on questionnaire. Having participated in the APIC challenge, two out of three participants were only interested in taking measurements, with the third also expressing interest in the game. One participant noted that he/she had only had a general perception of locations having good and poor air quality in Kassel, but following on from the activity they had a more precise knowledge of where to find good air quality and where not to expect it. In terms of the activity, comments from the Kassel respondents included:

- “Make the box water proof. so you dont have to worry about taking measurements in the rain”
- The Airprobe application had a very changing quality. Sometimes it worked very well, and sometimes almost nothing worked. The online game has been always been, quiet good. But day by day it was going to be a little bit better.
- Airprobe got little bugs

4.6.3 London

Given the UCL team’s specific interest in recruitment, participation and engagement, a much more in-depth range of follow on activities were held with participants, who were both asked to fill in the follow-on questionnaire and were debriefed during in-depth interviews.

In London, there was a 78% (25) response rate to the final questionnaire with a fairly even distribution between genders (14 females; 10 males; 1 no response). Participants were predominantly between 15-24 years old (72%) with most of the remaining group (20%) falling between 25-34. Most respondents had not previously participated in any scientific research projects outside their course of study and only twenty percent had carried out any environmental monitoring, half of

which were specifically related to air quality. However, over half (64%) had previously volunteered. The selected case study area was not familiar to most respondents, who reported to either having not previously visited the site or only on one or two occasions (80%). The primary motivations for participation cited were an interest in air quality (44%), monetary incentives (20%), and wanting to contribute to scientific research (12%); although twenty-four percent would not have participated without a monetary incentive. None of the respondents prioritised the game as an incentive, which they consistently ranked fourth or fifth, accept in two responses, and 92% would have participated without the gaming element. Many of the participants were first year undergraduates who were new to London, which is perhaps why the opportunity to get to know a new part of London was cited as a motivating factor for participation. Just under half of respondents (12) reported difficulty in recruiting Air Guardians to join their team and 28% reported using social media channels such as Facebook and Twitter as a way to recruit team members. Air Ambassadors from the team with the largest number of Air Guardians also reported announcing the challenge and asking people to join their team in class after a lecture on a related topic.

Opinions about playing the online game varied where it was considered difficult by some (28%) and easy by others (36%). None of the respondents reported difficulties in taking measurements with the sensor box and AirProbe and 76% said they found it easy. London air quality was generally perceived as bad or very bad (56%) with the same number of participants reporting having a change of view after participating in the project; some stated that they believed the city to be less polluted, while others expressed their surprise at the impact external factors such as the weather conditions and small location changes had on the measurements taken. A large proportion (84%) said that the project had encouraged them to take part in future environmental monitoring projects.

Further to the online questionnaire circulated to all volunteers across the four cities, interviews were held with some of the volunteers from London. The aim was to explore the participantsÂŠ experience of using both the sensing devices and the online game, their general experience in participating and anything they may have learned from the process. In total 10 interviews were held with representatives from 9 of the 10 teams. Two of the interviews was attended by most of the team members.

Participants were asked about their main motivations for getting involved in the project. Most said that the project sounded interesting with some stating that they were specifically interested in environmental issues, or that the project was linked to their current, or previous course of study. One respondent said that they were keen to learn about the pollution levels since they were an active cyclist around the city. Another of the interviewees stated that the financial incentive was a key motivation and that they would probably not have participated without it. Three others mentioned the financial incentive as one of the motivating factors.

In the questionnaire that was circulated playing the online game was considered difficult by 28% of respondents. However, when interviewees were asked about the game some said that they found it interesting to begin with but many either got bored, found it tedious or found it quite time consuming by the end, with one citing usability as one of the problems. For example, one respondent said:

- “uhmm a nice way of kind of getting to understand [how] people perceive pollution levels in London and, yeah, I quite enjoyed it. I must say that towards the end really of the first two weeks, it started getting a lot because once you acquire a lot of points, you kind of feel you need to spend them as well, and then it just took a lot of time to actually place the flags. And I think at some stage I kind of went from actually thinking about the position where I place the flag and thinking about the actual level I thought was there and just started saying, okay, overall, I think the average in London is something like so and so.”

Another said

- “I thought the game was dreadful, absolutely awful”.

Contrary to this, one response was that the game was really simple and that there were instructions everywhere, so they couldnÂŠt go wrong. Only two participants stated that they had not taken part in the online game aspect at all. Feedback from the questionnaire and interviews suggest that the game could have been made easier, particularly for very active players with a large number of flags, by enabling better functionality to allow users to alter the perceived values for example. Other suggestions were mooted that could have potentially made the game more ÂŚgame likeÂŠ and interactive, such as providing direct interaction with other players, offering the chance to fight for, or steal, squares from other teams, and fortifying or protecting your squares from being stolen, or by providing email notifications with leaderboards, personal points and previous login times.

One of the participants who admitted that they were not someone who is interested in games stated that they constantly checked the rankings of both the game and data collection for teams and individual players and found that aspect interesting. Another of the interviewees who was extremely negative about the game, to the degree whereby they said that they detested it; they also said that they hated online gaming and computer games, admitted to playing the game every day and becoming very competitive. They declared that they would have stopped playing the game if the ranks had not been provided. Someone else reported to being obsessed with the online game and data collection rankings. They said:

- “I looked at all [the rankings]. I am telling you I was really obsessed. I couldnÂŠt understand why I wasnÂŠt earning more points, really. And I was trying to understand what was the strategy of the other players.

  And I was really ÂŰ really interested in knowing who was playing the game online as well and I was trying to understand the psychology of these players and how do they do this because some of them were crazy, I mean. They went ÂŰ I donÂŠt know how they could do that really. You must spend like hours every day to do this.”

Based on feedback from the interviews it appears that there was some confusion about the game with respect to selecting the values, what the values were representing, and how the scoring was calculated. One participant stated that in the first phase of the game he thought he was putting in values as a relative scale from 1-10 as opposed to actual pollution levels and as such gave roads a high value and parks a lower one. The same interviewee said that they did not realise that the revenue raised was based on other playersÂŠ guesses, although this was in fact articulated in emails that were circulated. This was echoed by others, one of whom said:

- “I was just guessing estimating, the level of pollution [...] in London. So at some point I would receive these bonuses for good accuracy and I knew that [the] actual measurement [phase] hadn’t started yet, so I was wondering how do they know, why are they saying that my measurements are accurate? ”

Another added that he was not sure how he could get points based on accuracy given that they had just guessed the values.

Overall there was generally more interest in the data collection with the sensorbox than in other aspects of the challenge. Feedback from the interviewees ranged from enjoying the opportunity to walk around the city whilst contributing to something useful to getting the opportunity to sight-see. One interviewee commented on the fact that they would have taken the sensorbox out more frequently had the device been smaller. They also said that they were concerned about taking the device out on a packed train or in the street because of the wires and “black box” and that they didnÂŠt want to scare people. They suggested changing the colour of the box and putting labels on it. In one case one of the participants said that they turned the data collection into a game to amuse themselves. They noticed that covering a greater area generated more points for their team so they spent time trying to cover untrodden territory and in some cases walking on one side of

the street and then coming back half an hour later to cover the other side of the street, which they found more fun than the game itself. They said they also thought that other teams had noticed when they had been out data collecting and were trying to send people out after them in order to compete. Another participant from a different team also spoke about their focus on trying to cover the whole area. They printed maps and took them with them when cycling around. They shared the paper maps with their two team members so that they knew which areas had been covered and which areas still needed to be done. They said that towards the end of phase two they noticed the rankings were getting very tight at the top so they decided to focus their weekend on collecting data - they didnÂŠt think that they would win because they thought the other teams would be out collecting late at night. Another interviewee reported starting their data collection on foot but after studying the ranks and the maps daily they revised their strategy and began cycling around the area to increase their coverage and points.

There were different views about the data that was gathered during phase two and three of the challenge. For the most part participants were surprised at the levels of pollution that were recorded. One interviewee said that they were quite surprised at how consistently low their readings were, which they were positively surprised about. They also realised, through their participation in phase one of the the game, that other participants, like themselves, perceived the pollution levels in London to be quite high. Despite commenting on the lack of variation in their readings the interviewee said that they trusted the numbers displayed by the device. Another stated that although they trusted the device they did not fully know what the device told them, so they trusted that the measurement was at level 2 but did not have a clear context for how safe level 2 was for them. Some suggestions were made to address this point such as providing additional information as to why measurements might be low or high, or by communicating the error margins to the user.

Not all of the respondents expressed this level of trust with some explicitly reporting a lack of trust in the sensorbox readings. One interviewee said that this was because there was either little variation in the numbers, or areas where they had expected readings to be low, such as in parks or at night, had shown high readings, and conversely, next to busy roads during the rush hour they had obtained low readings. This skepticism was reported by several other people interviewed who also spoke about the lack of variation in the measurements collected from different locations. Participants reported experimenting with the sensor box by moving it closer to the road, placing it behind buses, going out at different times of the day etc. One said that they didnÂŠt know how accurate the sensor box was but thought it was okay relative to other sensor boxes. This respondent noted that after playing with the sensorbox for a little while they started to notice that there was a change in different situations, although they reported that there was a ten second time lag before seeing any obvious reactions. The lagging issue was also mentioned by another interviewee. In one case, the participant was concerned about safety and as such did not look at the smartphone to see the measurements during their walk accept for on one occasion where they were on an elevated pathway next to the museum.

When interviewees were asked about what was learnt, or about changes in their perception the predominant response was that pollution appeared to be a lot lower than had initially been perceived. Below are some of the responses that were given:

- “Well, so, I guess I am a runner and so [...] I am very conscious of when I am like running on a big street, itÂŠs like you can smell that itÂŠs bad and so I always think, like, this isnÂŠt good for me. So thatÂŠs why I was kind of interested in how quickly moving from the street to a smaller street or a park area would actually protect you from the supposedly evil big streets. But I was surprised and kind of low then maybe false comfort that even the big streets were not as evil as I kind of had thought prior to participating. I was like, London really isnÂŠt that bad. I donÂŠt know why everybody is so stressed out about pollution. So I donÂŠt ÂŰ you know it seemed a bit rather than shocking me into outrage and advocacy pretty much evolved into complacency.”

- “Awareness ÂŰ yes I think I became more aware of the hotspots ÂŰ around St Pauls, which was quite surprising. IÂŠm not going to say that I would avoid an area but it made me think [about] riding behind a bus so it increased my awareness and sometimes I wish I had the box to check readings when I want.”

- “After the game I now know more about where is higher and where is lower; I know about the true value in certain areas...ÂŤ Awareness for me ÂŰ not so much ÂŰ because I was always aware of the fact that there is pollution and assumed that in bigger cities itÂŠs higher; the learning aspect was understanding that itÂŠs not quite as high as it was.”

4.6.4 Turin

11 participants responded to the final questionnaire, which gave some insight in the background of volunteers. These were young (between 20 and 35 years old), new to both scientific projects and environmental monitoring (90%), but most of them had done previous volunteer work (63%). The reasons they declared for participation were mainly interest for air quality (45%) and the scientific contribution (45%). Most volunteers also declared that they would have preferred to perform only field measurements (63%), since they found difficult the recruiting activity for the game. Volunteers declared to have known the mapping area very well, and most of them maintained that their perception of pollution in Turin did change through participation to our project (72%). Specifically, many declared that they had previously overestimated pollution in Turin, and the project gave them the impression that the situation is not so bad, especially in the city centre where traffic is limited. Approximately 81% of the interviewed volunteers declared that the project encouraged them to participate again in environmental monitoring.

4.7 Comparative Outcomes

A total of 23835095 air quality data points were captured through the EveryAware project, with 7.6 million of these captured during the APIC challenge. The London teams captured 1.5 million points, the Kassel teams 3.8 million, the Turin teams 1.9 million and the Antwerp teams 0.3 million data points, and as shown in Figures 4.5,4.6,4.7,4.8, good coverage was obtained in all four cities.

Figure 4.5: Antwerp Heatmap

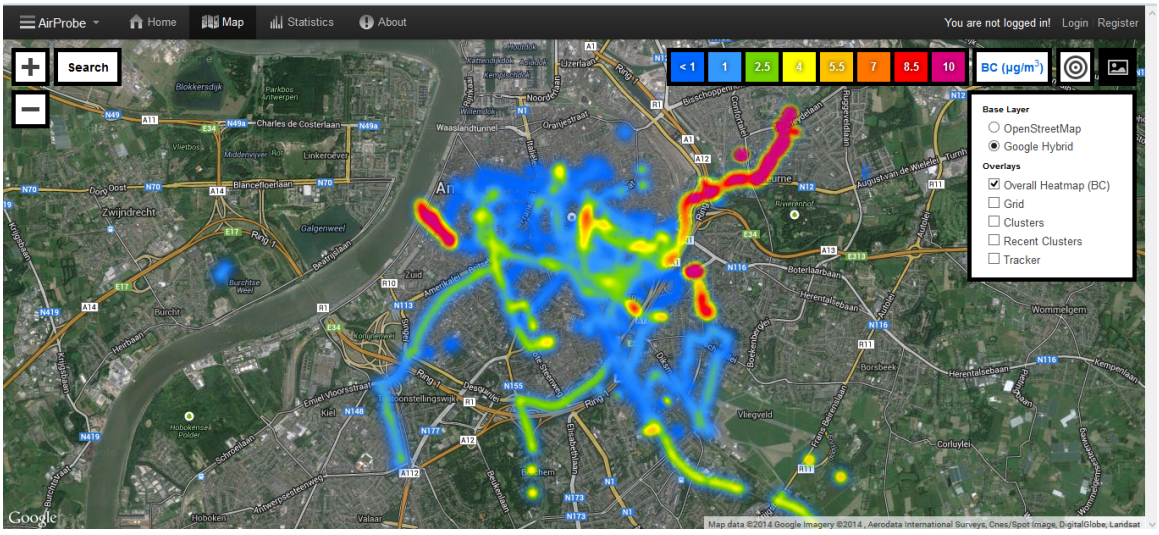


Figure 4.6: Kassel Heatmap

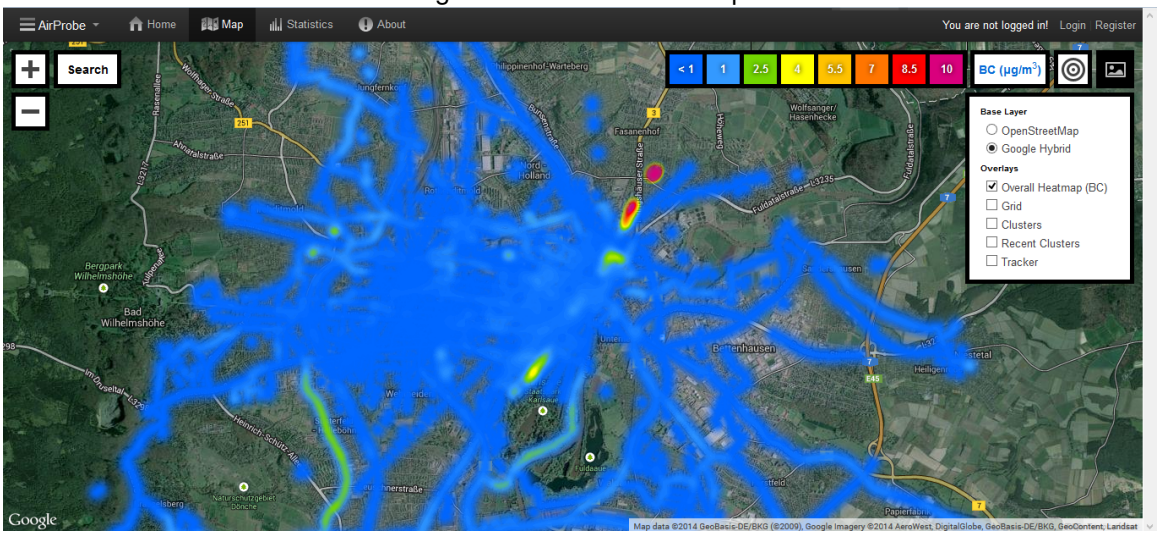
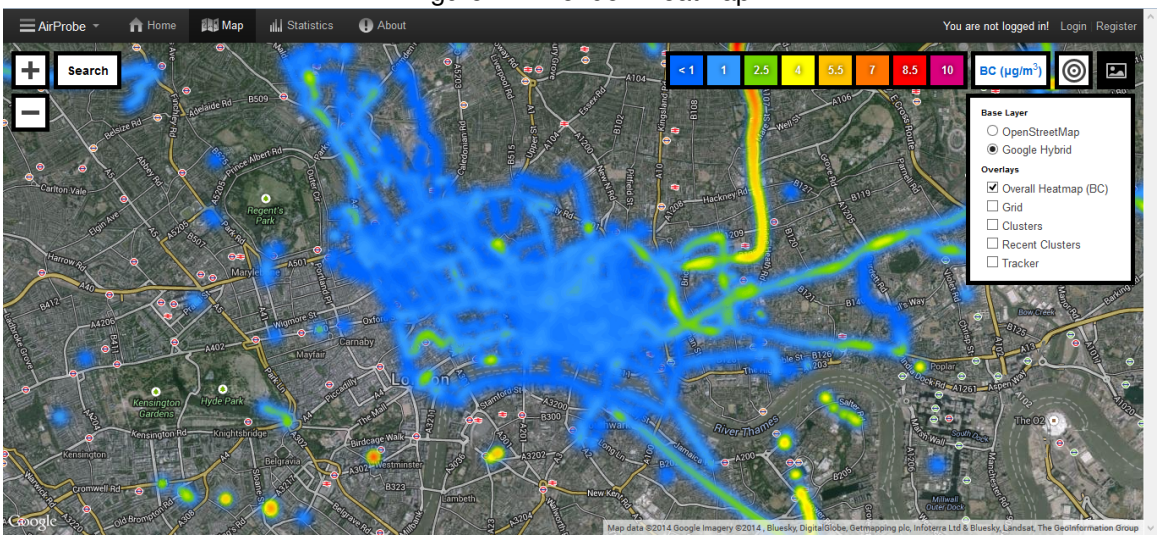


Figure 4.7: London Heatmap



4.7.1 Recruitment, Engagement and Participation

As can be seen from Table 4.6, all teams primarily relied on e-mails to appropriate lists to engage participants in the APIC challenge, with this proving particularly successful for London and Antwerp in terms of recruiting final volunteers. However, as the previous large-scale project with WideNoise demonstrated it is ideal to make use of more than one stream of recruitment - this was particularly successful in the Turin case, where the opportunity was taken to pitch the challenge to students during lectures, although this met with less success in Kassel. For all three cases where it was tried, posters did not result in any recruitment, perhaps suggesting that a more personal touch is important.

Figure 4.8: Turin Heatmap

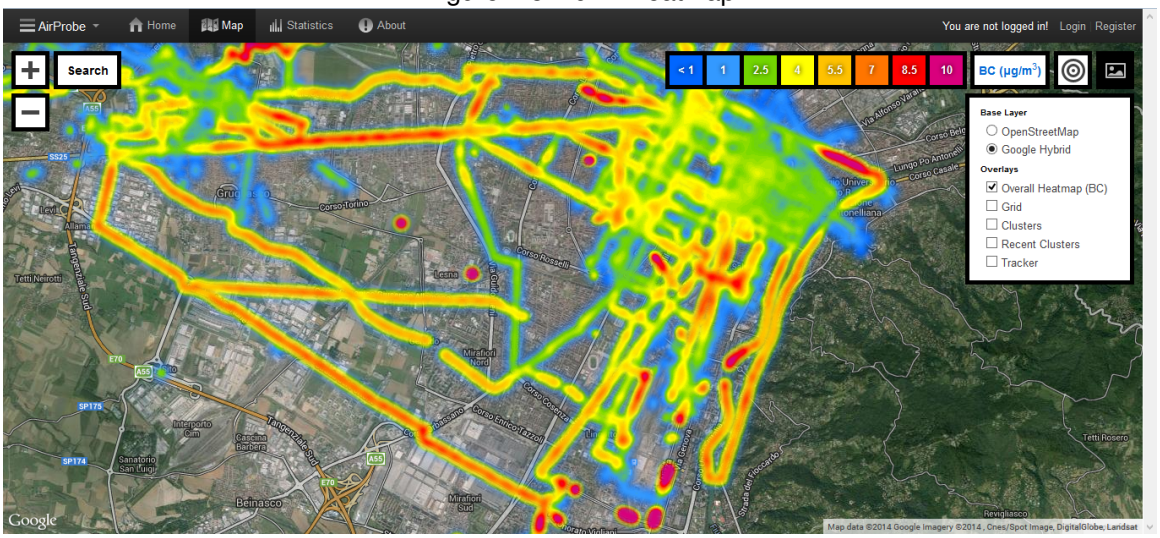
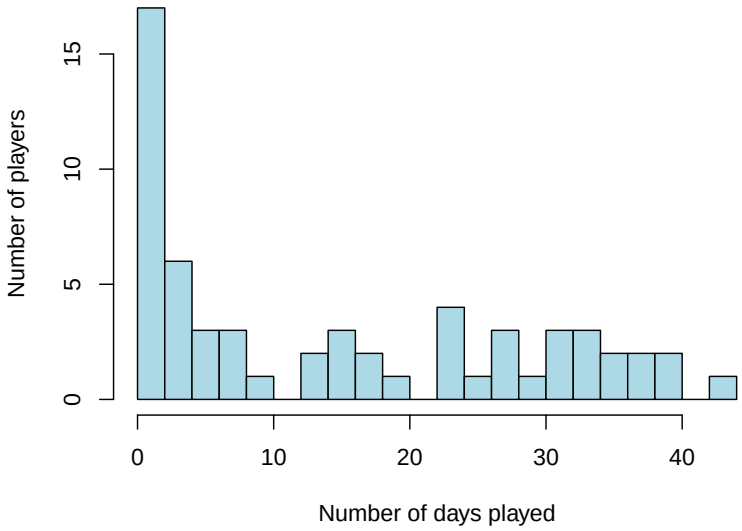


Table 4.6: Engagement and Participation - All Cities

	Method	Emails received	Initial Meeting	Final Volunteers
Kassel	Mailing list	7	0	5
Antwerp	Mailing List	32	19	19
Turin	Mailing list	8	4	2
London	Mailing list	48		34
Kassel	Newspaper	3	0	2
Kassel	Posters	0	0	0
Turin	Posters	0	0	0
London	Posters	0	0	0
Kassel	Talks	2	0	1
Turin	Talks	11	8	8

Figure 4.9: Number of Days Played versus Number of Players - Kassel



As can be seen from Figures 4.9,4.10, 4.11 and 4.12, the initial recruitment campaign in London led to the highest numbers of people initially joining the game. In all four cases, the typical attrition curve of participation can also be seen as the days of the game progress, with only a few participants remaining engaged for entire length of the activity. In terms of overall teams, the initial recruitment methods employed by London and Turin appear to yield the most successful results, and this is reflected in the overall number of users registered by these teams. However, these initial results do not necessarily translate into longer term engagement with the APIC challenge, with the Kassel team retaining more consistent player numbers through the game. All four teams lost players, however, with all teams except Kassel reducing to less than 50% of the original player numbers (London 30%, Turin 44% and Antwerp 23%). Additionally, higher user numbers do not necessarily correspond to increased activity - the London group capturing a total of 23433 'revenue' points versus the Kassel group's 31022.

Similarly, Figure 4.13 shows the number of registered users for each phase of the game, split by country, with Figure 4.14 showing the cumulative number of game air points ("revenue" points) created by each City and for each Phase. The number of points created in the Antwerp case reflects the lower number of users engaged in this study (see Section 4.8 for further discussion related to this issue). Overall, there is no direct correspondence between numbers of users and overall outcome at each phase of the game - indeed, in Phase 2 while London has the greater number of users, Kassel has generated the greatest amount of revenue, and a similar pattern is noted in Phase 3.

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Figure 4.10: Number of Days Played versus Number of Players - Antwerp

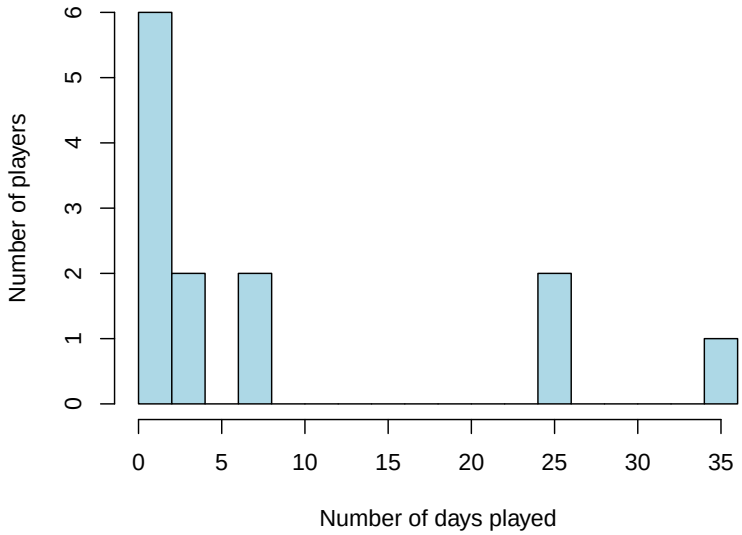


Figure 4.11: Number of Days Played versus Number of Players - Turin

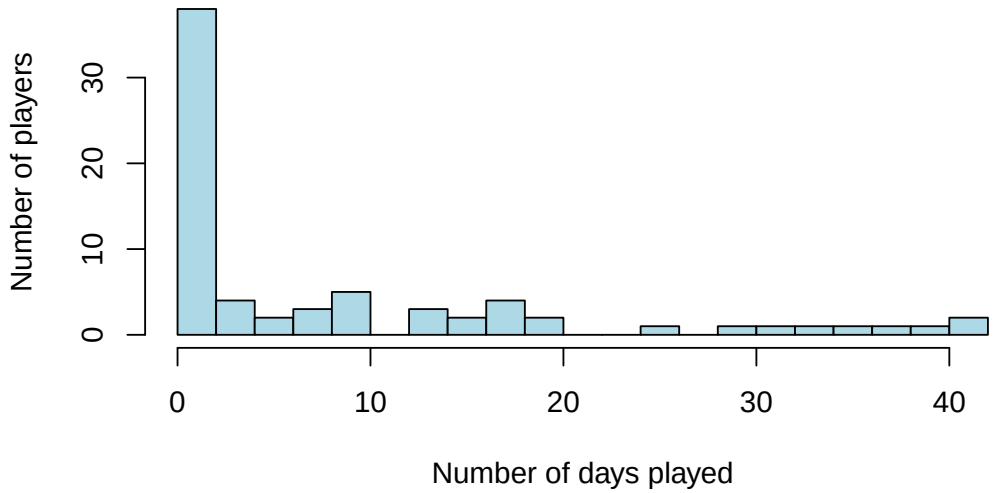


Figure 4.12: Number of Days Played versus Number of Players - London

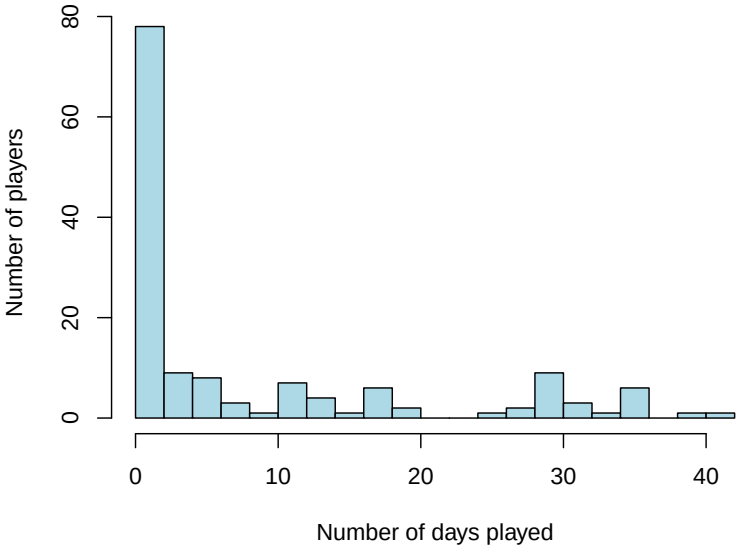


Figure 4.13: Number of Players for each Phase of the Game

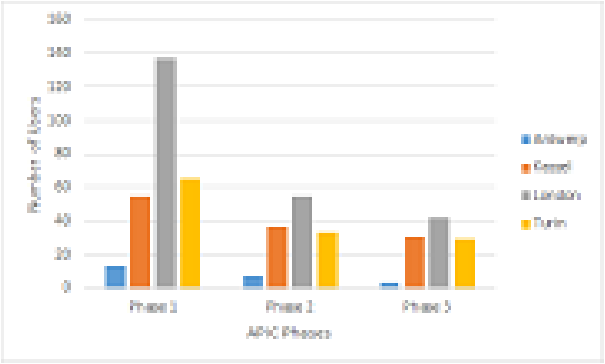


Figure 4.14: Cumulative Number of Game Points

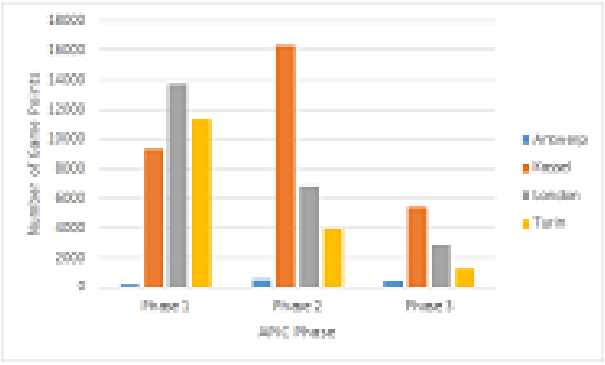


Figure 4.15: Measurements per Day - Antwerp

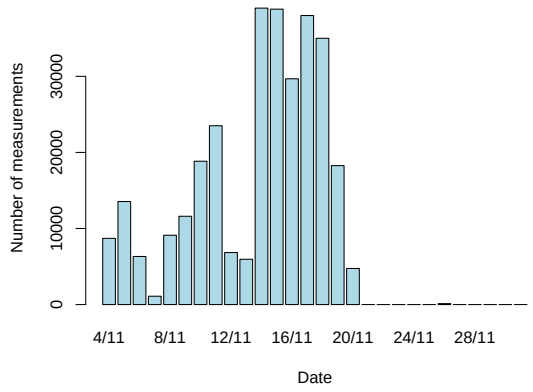
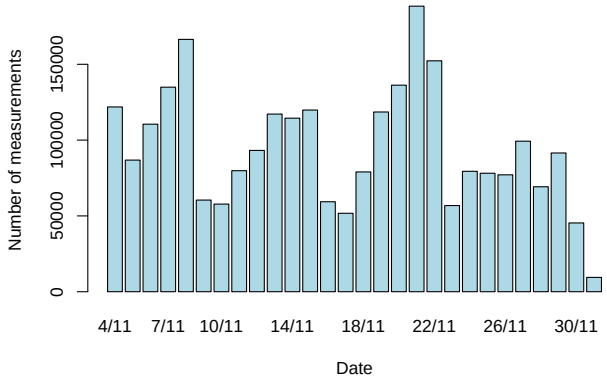


Figure 4.16: Measurements per Day - Kassel



As can be seen from Figures 4.15, 4.16,4.17 and 4.18 the recruitment and engagement activities utilized by each of the four groups different also cannot be correlated directly to daily activity patterns in terms of air quality measurements made by the sensor boxes (operated by the Air Ambassadors), in particular resulting in a spike of activity for the Turin case study in the third phase of the project, when the Ambassadors were free to measure at will.

Finally, Figure 4.19, 4.20,4.21 and 4.22 shows the variation in the time of day measurements were taken for each of the four cities. As can be seen, for both London and Antwerp relatively few measurements were taken between the hours of 10pm and 8am. However, for both Turin and

Figure 4.17: Measurements per Day - London

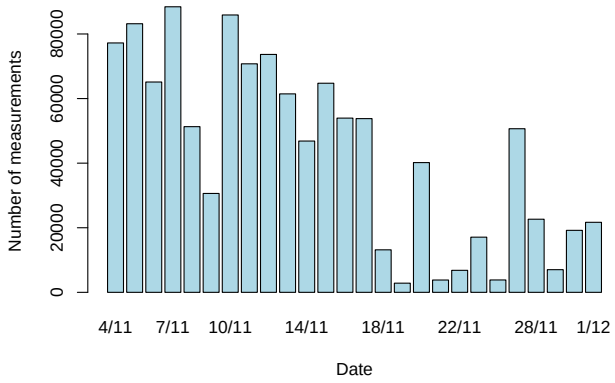


Figure 4.18: Measurements per Day - Turin

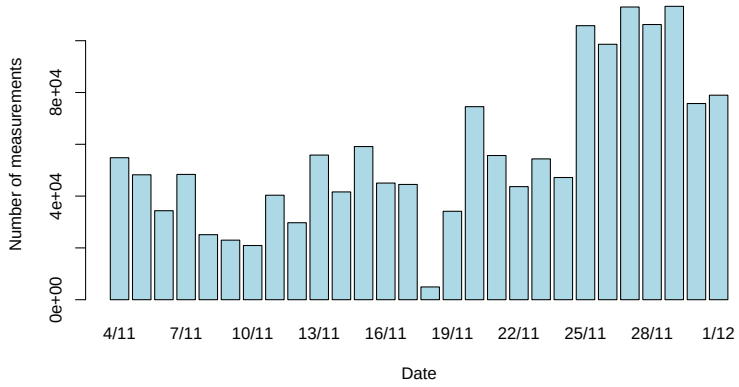


Figure 4.19: Measurements per Hour - Antwerp

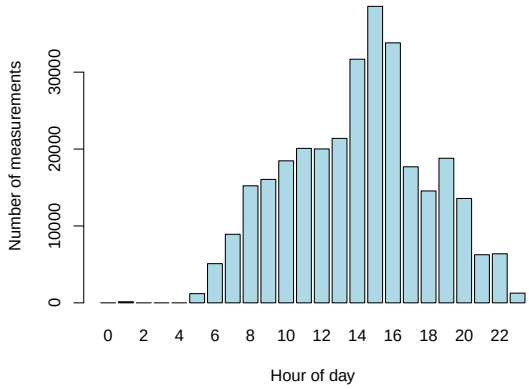


Figure 4.20: Measurements per Hour - Kassel

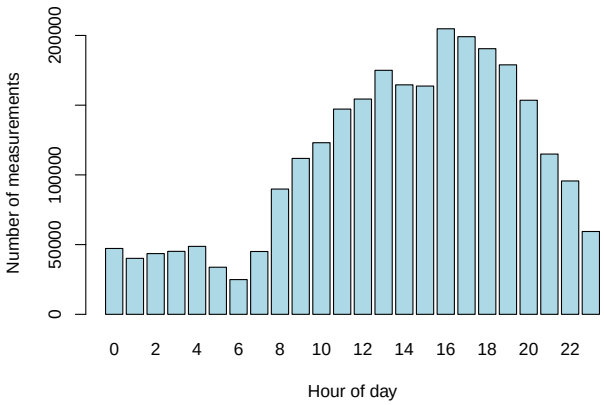


Figure 4.21: Measurements per Hour - London

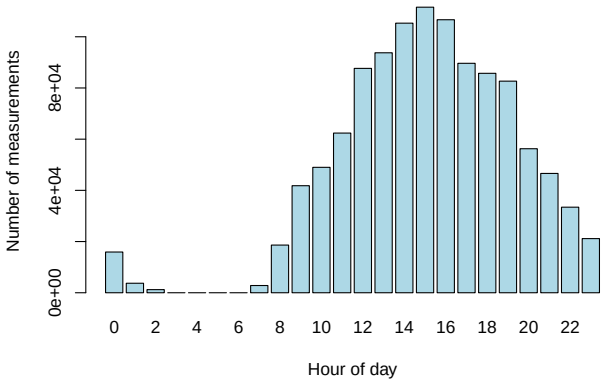


Figure 4.22: Measurements per Hour - Turin

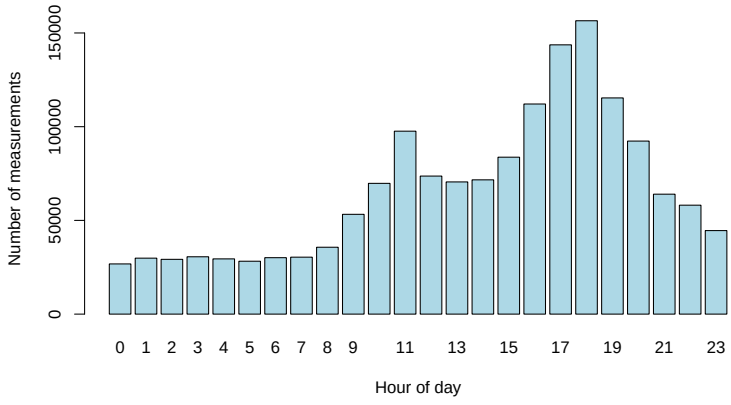


Table 4.7: Participation Motivations

	Online game	Interest in air quality	Competing with other cities	Monetary incentive	Contribution to scientific research
First	0	26	4	11	9
Second	3	12	5	7	20
Third	6	5	11	9	5
Fourth	13	3	16	9	2
Fifth	23	1	8	10	2

Kassel this is not the case, with many thousands of points being recorded. This may relate to a strategy outlined by one of the Antwerp questionnaire respondents (see below for questionnaire details) who noted that: “The fact that the sensorbox needed a warming up period of an hour was inconvenient. We let it run all the time, even when not measuring”.

4.7.2 Follow-Up Questionnaire

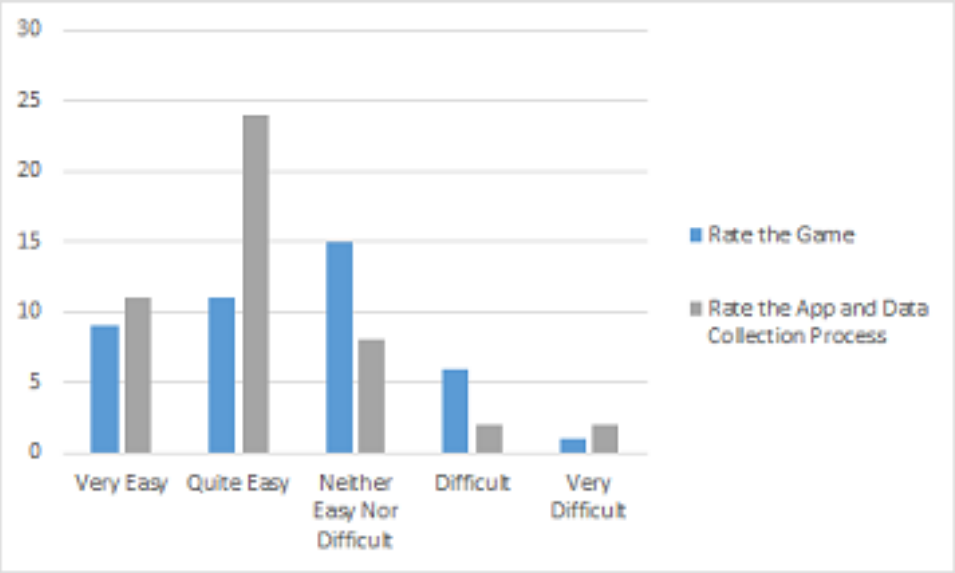
A total of 47 respondents (11 from Turin, 3 from Kassel, 8 from Antwerp and 25 from the UK) filled in the questionnaire. Participants were asked how they heard about the project, with E-mail proving by far the most successful method of contact (28 respondents) followed by ‘Other’ (9 in total, which included 7 respondents who heard about the project at a University presentation by one of the team members, one via work and another via the “ademloos” organisation), and 5 each for friends and website/social media.

Participants were also asked if they had undertaken some volunteering activity beforehand (30 responded yes, with activities ranging from volunteering at a dog kennel to charity volunteering, peer mentoring and museum volunteering). Of the 47 respondents, only 7 had been involved in environmental monitoring prior to the APIC challenge.

Table 4.7 outlines the given motivations for participation from all the respondents. As can be seen, the majority of respondents rated an interest in air quality as their most important motivation, with a second interest in scientific research. The monetary incentive did provide primary motivation for 11 participants, however. Interestingly, 23 participants rated the online gaming aspect of the APIC challenge as the least important motivating factor, and no-one ranked it first. 31 people noted that they would participate even if the task involved only taking measurements, 3 were interested in recruiting others and 11 in both gaming and measurement taking. 25 people noted that their perception of local air quality had changed since participating in the project, with 22 maintaining that it was unchanged. For the former group, one participant commented on the impact of weather on air quality, with 5 noting that the values seemed lower than they expected and 4 noting that pollution was greater than expected (although in both cases comments on the reliability of the measurements were made by some respondents). One other participant noted the variability around the measurement area, and another the green spaces.

In terms of the game itself, Figure 4.23 shows the overall difficulty ratings given to the online game and the Air Probe data collection process. As can be seen, very few users found the process difficult or very difficult. However, in contrast to this reply, a significant number of users did comment about the problems encountered, including:

Figure 4.23: Difficulty Ratings for the APIC Game



- "The game got increasingly more demanding in time, I lost the point of the game after a while not knowing what would really be the goal: make more revenue? Or make more accurate estimations? Difficult to get other people involved as They wouldn't find it fun to play and abandoned the game after the first day or two"
- "My GPS wasn't accurate which meant we lost a lot of squares along fringes of the game area"
- "The usability was quite poor. Among other things, it was necessary to click each time on the green pin button before being able to add a new pin on the map, which made the game even more boring. There is no engagement in the game. Recommendations among team members were to add pins as quickly as possible until finishing up the available budget, because the game itself was boring; there is no change or challenge during the game and no immediate feedback as to whether the pollution levels are correct or not and why."
- "The online game was tedious. As more pins were added it took longer to load. I guess there wasn't a budget to make it fun or entertaining but the avatar just sat at the top. It would have been more fun if she (BarbAIRa) could have hovered over the map and perhaps developed breathing problems whilst over more dirty areas and looked more radiant over cleaner areas to give me air quality clues."
- "The online game is conceived in a bit confusing way. As much as I tried to play, I couldn't get what strategy was the best. I'm not too sure it made much sense at the end of stage 3. . . "
- "After actual results had been included into the game, many of my previous results were now inaccurate - this was very discouraging"
- "The AirProbe application had a very changing quality. Sometimes it worked very well, and sometimes almost nothing worked."
- "It's not at all user friendly! Or it was raining, so I couldn't take it out; or the batteries were empty again; or there was no time to wait for half an hour (which we were asked to); or I forgot to take it along,... It was always something."

- “The fact that the sensorbox needed a warming up period of an hour was inconvenient. We let it run all the time, even when not measuring. But if we had to charge the battery ”

These comments reflect feedback obtained during the activity itself, when a number of participants approach EveryAware team members on multiple occasions to resolve issues with the sensor box, mobile phone App, game and data upload. Other comments related to battery life, lack of waterproofing and GPS accuracy, which was perceived as poor. However, some more positive comments were also made:

- “The AirProbe application is quite cool and I think it is a very good way to raise the awareness of environmental protection.”
- “L’applicazione e’ interessante, specialmente perche’ permette di visionare in diretta i dati dell’aria, forse e’ un po’ troppo "pesante" per certi smartphone.... (the application is interesting, in particular because it permits real-time visualisation of the air quality data, however it may be too resource-hungry for certain smartphones)”
- “increased learning about citizen science: I really enjoyed participating in this type of citizen science project. I recognized how difficult it must be to engage any citizen to participate in a project that requires any daily action.”

Additional positive comments related to the opportunity of getting to know a different part of the local area and having a better perception of air quality (10 responses in total), with 7 responses citing teamwork and meeting new people as an important outcome of the process. Importantly, despite the negative comments, 39 respondents also noted that the project has encouraged them to take part in additional monitoring activities.

4.8 Discussion

The over 28 million air quality points captured by the AirProbe App and EveryAware sensor box, along with the distribution of these points over the gaming area, highlight the potential of the gaming approach to more systematically capture large quantities of data while addressing, at least in part, the sampling bias evident in the WideNoise data capture processes (where users captured data according to their daily activities [4]). This intensive data capture activity was accompanied by a total of 80,000 air quality “annotations” placed on the game during the APIC activity. A total of 300 participants were engaged across the four Case Study sites. Given these numbers, it can be said that the APIC challenge itself was successful in motivating interest in environmental data and encouraging data capture and online play. The exception to this case could be said to be Antwerp, where teams were not very active in the AirProbe game. Antwerp had fewer gamers in comparison to the other cities and also collected fewer data points. The team in Antwerp feel that two factors contributed to this issue. Firstly, the volunteer community in Antwerp was perhaps different compared to the volunteers in other cities, as they were recruited via e-mails to mailing lists of organisations specifically interested in air quality and noise issues, rather than the more general student and contact mailing lists targeted by the other teams. Thus, it could be suggested that the volunteers were keen on collecting data and acquiring air quality data in their neighbourhoods, but they were much less interested in the game. Additionally, it could perhaps be assumed that participants were better informed about Air Quality issues prior to the activity, and perhaps felt that the relatively inaccurate readings provided by the sensor boxes were not adequate for their level of interest. Secondly, the Antwerp team’s communication with the volunteers focussed primarily on the monitoring issues. The game was introduced on the first meeting, indicating the objectives and

[4] The issue of sample coverage is discussed further in Secton 5.4

showing how to access the game but the participants were not given a demo on how to play the game. The APIC challenge provided an in-depth study into the importance of factors such as ease of operation and usability in participatory sensing projects. Extensive feedback on the EveryAware tools was obtained initially through preliminary case studies and then from the APIC challenge itself. Some issues were addressed as the challenge progressed (in particular those relating to the mobile App, to online reporting and to coupling the App and the sensor box) resulting in a full participatory design process for the users (although this was not possible with the sensor box itself due to the extended manufacturing process). It is perhaps the responsiveness of the EveryAware team that meant that, despite the technical challenges encountered the overall difficulty rating of the task was not very high (Figure 4.23).

In addition to overcoming usability issues, to achieve the high number of data points and game points captured and provide the detailed feedback, users have had to dedicate relatively large amounts of time each day to the game and data capture activities, with the result that such activity is sustainable over the short term only. This, along with the willingness of the participants to persist with the AirProbe App and Sensor Box despite the technical issues and the requirement to warm up the sensor box for 1 hour prior to the start of any data capture activity and the specific target area where measurements were to be taken (which was often not close to the participants residence or place of work) meant that significant, specific time had to be allocated to the APIC challenge task and it could not naturally be fitted into daily activities. This in turn implies that, if this tool is to be used in its current form in future activities (perhaps without gaming or financial motivation), ongoing use would indicate a high level of interest in air quality issues. Encouragingly, 83% of the respondents to the questionnaire indicated that the project has encouraged them to take part in future environmental monitoring projects although only 6 of the 48 respondents had been involved in such activities before. Indeed, the follow-up questionnaires and meetings indicate that the majority of participants became involved primarily due to an interest in air quality - this may, however, be a factor of the recruitment methods which targeted interested groups. Participation in the gaming aspect of the APIC challenge was considered to be the least important factor, and competing with other cities also falls at the lower end of the motivational scale.

Chapter 5

Summarising Lessons Learned from the Case Studies

A number of common factors can be identified across the Large Scale Case Studies undertaken by the EveryAware project. These are examined in more detail here, and in turn contribute to a wider framework for Citizen-Science based environmental monitoring activities.

5.1 Motivating and Incentivising Participants

As can be seen from the above and from the interim report D6.2 [UCL, 2012c], various techniques to motivate participants were used throughout the EveryAware project. However, as feedback from participants shows, it is not possible to identify one clear activity or incentive that will inevitably motivate all participants - indeed, the work above demonstrates that a wide variety of incentives should be considered and built in to any project, ranging from simple financial rewards to the knowledge of undertaking a project for personal or societal reasons. Identifying a direct link between engagement methods and both initial participation and longer-term participation is additionally complicated by the fact that any engagement method is likely to be replicated by persons outside the project team - a link can be tweeted, a press release can be repeated on another website (as was the case with the RBWM project, which was shared by local political websites), people mention projects to friends and so forth. A trade-off is required between complicating the process of participation by asking volunteers how they heard about the project and what motivates them (this is particularly difficult for larger projects) versus simplifying the task by letting them access the project without too many barriers to entry.

The above case studies, and feedback from participants, have also demonstrated that the methodology to collect environmental monitoring information should fit specific purpose and context, as well as, ideally, the daily activities of the participants if long-term engagement is to be maintained. While projects such as OpenStreetMap have challenges that are due to the unstructured way in which data is captured and managed, this is not the case for the citizen science activities undertaken by EveryAware. However, as with other crowdsourcing projects it has been fundamental to consider the engagement with the “crowd” as an integral part of the work methodology, and the Case Studies highlighted the need to not only recruit participants but also support and maintain the relationships throughout the activity and beyond. As highlighted in particular by the APIC challenge, relationship building takes up considerable amounts of time, but is fundamental to the success of such citizen science projects, in particular where experimental technology is in use or new methods or tools are being trialled. Similarly, as can be seen particularly with WideNoise (an App which is freely available world wide) greatest success has been achieved when the App was deployed in the context of a wider activity or campaign.

Again, it is important to find the balance between the recognition that employing additional effort

to capture data - in particular changing daily behaviour to do this - indicates the importance of the issue to participants and the importance of inconveniencing participants as little as possible to maintain engagement over time. This issue is further complicated when both objective data (which could be perhaps captured automatically by monitoring stations) and subjective data (which requires manual capture) is required. However it is the latter that adds context to the former and, in particular in the case of lower-accuracy sensors, empowers the users to influence policy makers.

5.2 The Importance and Impact of Technology

Hardware and software technology (specifically the WideNoise App, the Air Probe App, the sensor box and the noise and air quality website) formed a fundamental part of the EveryAware project. The effort required to develop, calibrate and maintain the tools used for this and other citizen sciences projects is considerable, and as with many research projects the importance of a flexible development process, with developers willing to respond to feedback from other team members (initially) and from participants (during pilot and full scale Case Studies) is fundamental to the success of the project. The selection of participants who have, in turn, full understanding of the nature of prototypes and early stage technical projects is also important, as is the importance of making participants aware of the relative maturity of the tools. While early stage projects may encounter technical issues, the presence of a responsive development team also offers participants to make a clear statement about the direction or functionality of a specific piece of software (or hardware if rapid prototyping is possible). Where possible, therefore, end users should be involved as in the technical development of a project as early as possible, in a similar way to that where they are consulted at an early stage of developing measurement protocols and other data capture tasks. While the APIC challenge showed that with willing participants and face to face engagement end users are tolerant of usability and technical issues, and indeed understand these to be a part of a research project, technical solidity is a must if a project is to be scaled up beyond the initial team. Further consideration should also be given to the maintenance and improvement of tools and software beyond initial funding.

5.3 Data Accuracy and Measurement Error

An important factor to consider when examining the outcomes of the EveryAware project is the relevance of data quality to the process of citizen science, and the importance of explaining the quality of the captured data in a clear way to participants. EveryAware is unique in that it has provided calibration for both noise and air quality sensors and in both cases the results have demonstrated that, as expected, the low-cost sensors are less accurate than high-end devices. This fact has been communicated to participants, and in turn resulted in an identification of the importance of a data capture device not only in providing quantitative information but also in providing qualitative information and an indication of the levels of engagement of participants in a project, the time spent and disruption incurred by participants and hence the importance of an activity to participants. As noted by the Royal Borough of Windsor and Maidenhead (alongside a detailed explanation of the calibration accuracy of the WideNoise devices):

- “It must be highlighted that the response from residents in this pilot study has been remarkable. From the 136 residents that have so far participated in the pilot study, a consistent message has emerged that the noise from aircraft overhead does cause a significant disturbance to the enjoyment of their property.”

In order to improve data quality, the results from the AirProbe tools in the EveryAware project were calibrated against data captured by the sensor boxes against higher quality data captured

by professional devices with a similar exercise for WideNoise carred out during Phase 1 of the project. The importance of this task, and the need for specialist knowledge to undertake such activities, should be considered as a core part of all citizen science projects and helps distinguish EveryAware from other projects.

Examining the data capture issue in more detail, several aspects that will influence the methodology and approach to collect the information. The first differentiation is between data collection that is *passive*, where sensors and automatic logging of the data from them is used to record geographical information, and *active*, which requires the participants to actively notice something in their environment and record it. For EveryAware, this different experience was given by the active noise measurement and the relatively passive air quality measurement processes (once the process was initiated). The contrasting activities have shown that in passive data collection, there is a need to consider which sensors can record the needed information, the areas that will be covered and the type of participants that are most suitable to record the information.The methodology for such data collection is to start recording the information from the sensor at a given time, and when the process is completed, or at suitable time intervals, upload the information to a main server to allow further analysis and use. The considerations that should therefore be taken into account include the capacity of the storage on the device, the way in which the passive sensing will start and stop, and also power consumption of the sensing and logging process, and therefore the rate of sensing.

In active engagement, there are multiple challenges that need to be taken into account when designing data collection activities and the way in which people are involved in carrying it out. While technical issues remain a challenge (for example, battery life on a phone running WideNoise and GPS), issues such as personal safety when capturing measurements, time and place at which measurements are made (and hence bias and coverage) also come to the fore.

In both cases, there is need to consider how much training the participants will need to collect data accurately and successfully and how to deliver such training in a distributed manner, how to ensure that the participants will remember to collect and share the information, and other factors that are explored below in more detail. Similarly, for both cases positional information is a fundamental part of the process and the methodology can be extended to include useful contextual information as metadata (in the EveryAware project, this takes the form of tagging).

5.4 Coverage and Sampling Bias

A fundamental consideration important to the EveryAware project and similar activities is the conflict between obtaining maximum spatial and temporal coverage required to produce a reasonable map of noise or air quality in a given geographical area, versus the daily activities of the end users of each device - the devices developed by this project are, in fact, are more suited to recording personal exposure and a coordinated effort such as that exemplified in the APIC challenge is required to build up useful information about an area. This understanding is important in terms of making such information available to, and relevant to, those not directly involved in a citizen science project, or perhaps not having access to the required tools or the skills to operate such devices. In general, the higher the number of people that use or visit the study area on a regular basis, the better the likelihood that among these people there will be a person that can collect and share environmental data. However, questions still remain as to the quantity of such data required to give complete spatial and temporal coverage to a quality acceptable by noise or air quality professionals, and whether this should in fact be the aim of a citizen science project.

To illustrate this issue, and highlight the success and limitations of passive and active sampling in

Figure 5.1: Noise Measurement Coverage - Heathrow Villages (HACAN). Empty cells are shown in grey

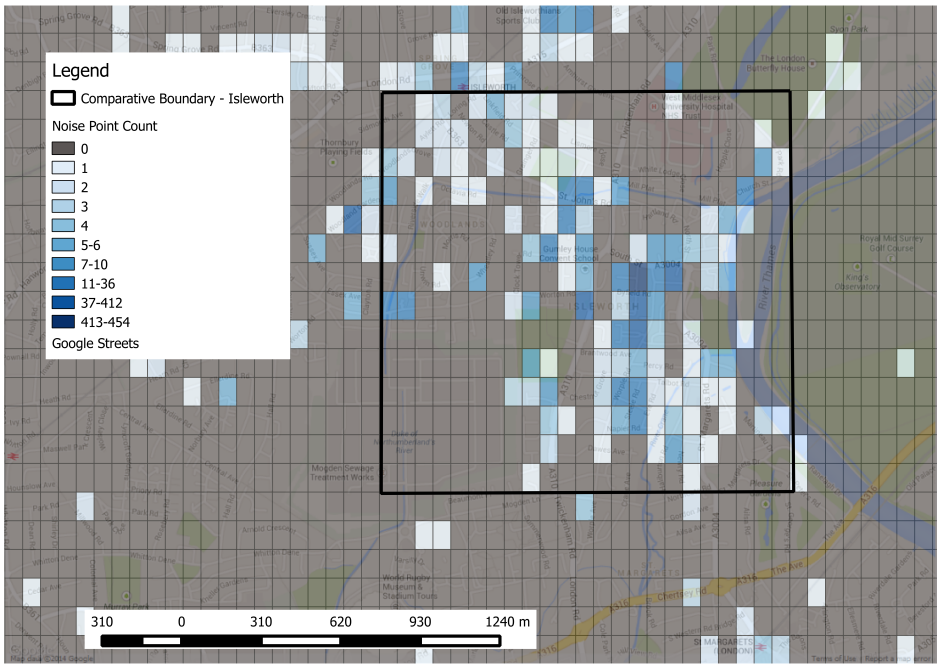
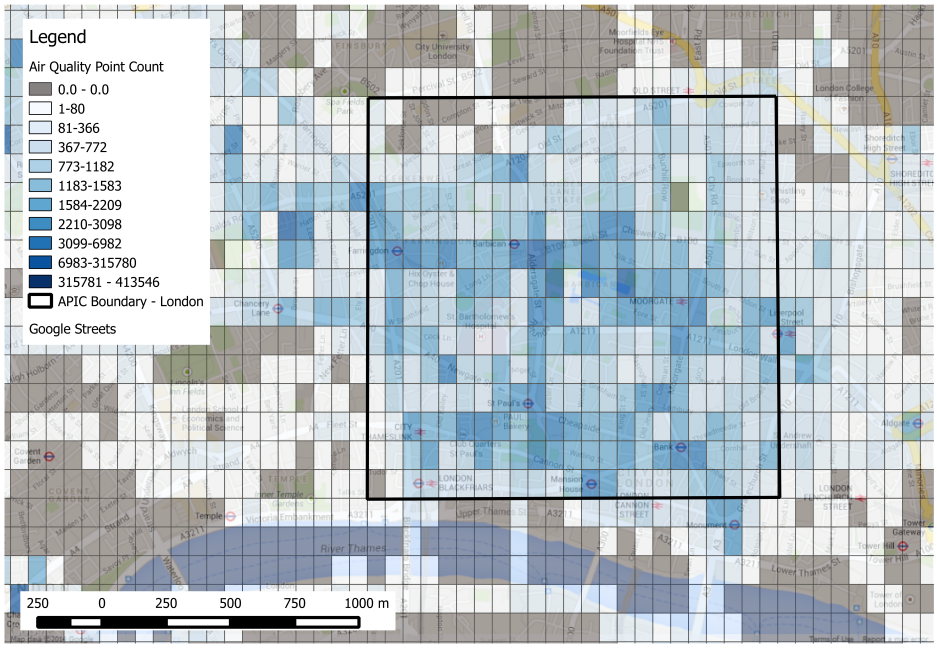


Figure 5.2: Air Quality Measurement Coverage - Barbican. Empty cells are shown in grey



addressing the problem, Figure 5.1 and Figure 5.2 above show an identical area of grid cells (of 0.001 degree each in dimension) for the two London case studies (noise and air quality). Empty cells are shown in grey. As can be seen, data has been captured for all the cells in the air quality Case Study with the exception of a few cells at the border of the area which correspond to locations around the London APIC zone. In contrast, for the noise data, much more sporadic coverage is observed.

From the point of view of the EveryAware team involved in the project, having the systematic sampling required by the APIC game required a significant level of involvement and reporting beyond that provided for WideNoise. For example, software was developed to allow users to see their own, their team's and other teams coverage on a daily basis and thus to guide them as to where coverage was lacking. Reporting was both map based and chart/graph based. Although, not stated to be primary motivating factor by participants, the financial incentives offered by the team meant that it was also possible to direct the players far more than in a true volunteer situation. Participants themselves, however, were required to fairly significantly disrupt their daily activity in order to meet the data capture targets. In contrast, for WideNoise, a map showing all the data collected in an area was sufficient in terms of the technical support required, with no additional funding required for advanced mapping or gaming options. Participants incorporated noise measurement into their daily activities, and required little support from the EveryAware team.

Another important observation that could be made is that the pre-defined sampling grids could be considered a factor in reducing understanding of the aims of the APIC Challenge. As the players were not capturing data in their own neighbourhoods or in locations of interest to themselves - i.e. defining their sampling pattern autonomously in accordance with their daily activities - perhaps it could be said that some of the relevance and meaning of the game, in terms of environmental information, was lost. This could be reflected in some of the feedback which included statements such as those shown below.

- "The game got increasingly more demanding in time, I lost the point of the game after a while not knowing what would really be the goal: make more revenue? Or make more accurate estimations?"
- "There is no engagement in the game. Recommendations among team members were to add pins as quickly as possible until finishing up the available budget, because the game itself was boring; there is no change or challenge during the game and no immediate feedback as to whether the pollution levels are correct or not and why."
- "The online game was tedious. As more pins were added it took longer to load. I guess there wasn't a budget to make it fun or entertaining but the avatar just sat at the top. It would have been more fun if she (BarbAIRa) could have hovered over the map and perhaps developed breathing problems whilst over more dirty areas and looked more radiant over cleaner areas to give me air quality clues."
- "The online game is conceived in a bit confusing way. As much as I tried to play, I couldn't get what strategy was the best. I'm not too sure it made much sense at the end of stage 3. . . "

In addition, having a fixed area of measurement limited the freedom of participants to measure areas of particular significance or importance to their daily routine or activities, or to highlight areas where they felt the environmental situation is particularly poor. The latter approach, however, resulted in the sampling bias seen in the WideNoise case study, where participants tended to capture louder noises rather than providing an overall view of the study area.

The overall results of the EveryAware project also highlight the importance of scale and activity duration in obtaining useful data coverage. For small scale operations (and in particular those

where it is feasible for one user to capture data in a short amount of time), while the time that is dedicated to covering such an area can be fairly short, as in collecting the names of shops in a local shopping centre. However, targeted recruitment and direction of the participants will be required to get such information, again as was undertaken for APIC. Following such an activity, it may then be possible to create an interpolated map of the resulting data (assuming that the resulting sample is sufficient). This is shown for APIC in Figure 5.3. Given the fact that WideNoise data capture depended primarily on an individual user's daily activity, the noise dataset is presented as points or clusters of points. In both cases, further work remains to determine an appropriate method to present the time-variability factors of the datasets.

At a medium scale, such as a neighbourhood or a town, there is the potential that with suitable planning and engagement plans, participants will be willing not only to cover their locality, but also adjacent locations, and therefore complete the gaps that will arise from the uneven distribution of participants. However, at the regional or national scale, problem arise again as, by necessity, this will include places that are less populated as noted above. Again, the gaming approach undertaken by the APIC challenge can help to overcome these coverage issues, with the possibility for repeated measurements from different sources to "validate" the data collected. However, as shown by the general activity curves (e.g Figure 4.9 above), it is frequently the case that a few very keen participants will be responsible for the large majority of the data capture. Work carried out by [Haklay et al., 2010] also shows that when considering larger areas of coverage (e.g. city, county or country) data capture may be concentrated on more affluent and more populated areas.

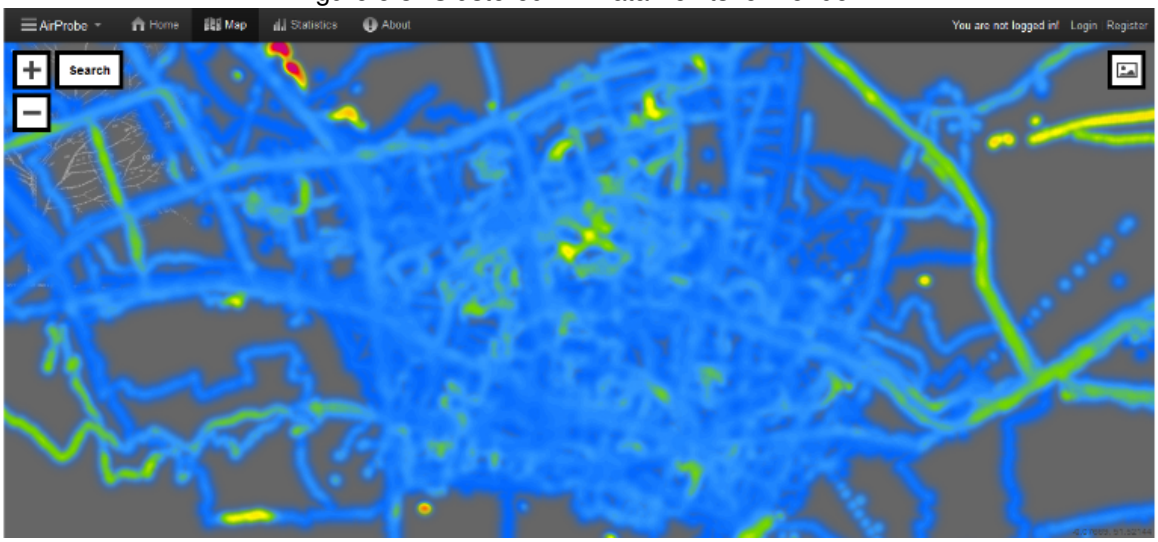
The temporal aspect of data capture is also influenced by scale, and can be generalised by a rephrasing Lincoln that 'you can be supported by a huge crowd for a very short time, or by few for a long time, but you can't have a huge crowd all the time (unless data collection is passive)'. In more details, a specific, targeted task that takes a relatively short time to accomplish can include a relatively large crowd. The exception to the rule is the special potential that is encapsulated in passive data collection, such as leaving a number of AirProbe boxes in a specific single location for an extended length of time. Sufficient quantities of these boxes, with appropriate calibration, may also help to overcome the spatial coverage issue although participation is still required to place and monitor the devices and this approach effectively decouples the subjective information found to be of particular importance in EveryAware work.

As [Goodchild, 2008] observed, the conceptualisation of geographic data collection before the emergence of VGI was one of scarcity where data is expensive and complex to collect. Therefore every part of the process was design to carefully collect the data on the ground by well trained professionals who follow a strict process that integrates quality assurance steps within it. With citizen science, however, the potential for data abundance exists (as evidenced by the over 28 million Air Quality data points captured during the relatively short APIC challenge and other EveryAware activities). This is particularly the case if the 'fixed sensor' approach described above is adopted, although as can be seen from the WideNoise challenges this is much less the case where the users are required to actively participate in capturing individual measurements.

While in previous eras, there was perhaps inherently one application that was used for data capture and editing, in modern citizen science activities there is a need to consider of multiple applications as different designs and workflows can appeal and be suitable for different groups of participants. The problem of overcoming spatial coverage bias therefore still remains one of the challenges of citizen science activities such as those undertaken by this project and sampling bias is a difficult issue to address in that a compromise must be reached between the effort required to participate by the users in order to achieve sufficient coverage and their requirement to go about their daily activities. One solution to this problem (which is being proposed by RBWM) is to have fixed sensors but this then removes the direct information of the user's exposure and hence the potential increasing awareness and behaviour change of the end users, as well as gaining the understanding of how residents and participants feel and perceive environmental issues that is so important

to making a case for change with policy makers.

Figure 5.3: Clustered Air Data Points for London



In summary, therefore, in the framing of crowdsourcing activities for citizen science, considerations of the participants' characteristics, spatial and temporal aspects of the tasks and the participants are all emphasising that such activities require the capture process to be tailored to each specific task. Given this, and the ongoing engagement required for each activity, the time required from the 'scientists' involved in such projects is not insignificant.

5.5 Positional Error

An additional factor, relating to both sampling bias and data quality, is positioning error of the GPS device used to locate the data captured in the EveryAware project (and indeed much of the citizen science data captured by similar devices). Positional inaccuracy can be up to 100m, in particular in urban areas such as those covered by EveryAware. Indoor measurements (e.g. those captured when the device is warming up or if the participant moves into a building or underground / metro system) are subject to further measurement errors. Work is currently being carried out (e.g. Shadow Matching [Groves, 2011], combining Wi-Fi and Inertial Positioning [Evennou and Marx, 2006]) on improving positional accuracy. However, this issue should be taken into account both in any interpolation activities and in any visualisation of the resulting data, whether as points or interpolated. Again, this issue may be overcome through the use of fixed sensors which either have a longer time to acquire positional information from GPS satellites or other sources, or can be manually associated with an accurate position.

5.6 Citizen Science, Data Quality and Spatial Information Management (SIM)

The EveryAware project has confirmed the need to engage a wide range of participants with varying levels of experience and knowledge, using different methodologies that take into account the specific spatial, temporal and domain of the data collection activities and citizen science activities. This in turn has implications for the management of the resulting information. Data interoperability is an important aspect of citizen science - the data collected by both WideNoise and AirProbe is

very highly structured with the exception of the tagging options, where users are free to contribute any additional text. While tagging is fundamental to understand the semantic meaning of the data, it raises challenges in terms of data integration.

Another aspect of the management of the data is the consideration of the length of the crowd-sourcing activity. A short term activity can be managed separately from other sources, and after its completion go through quality assurance steps before archiving and integrating it with other sources. The more continuous the engagement with the participants it is, the more likely it is the investment in a process to integrate the information with existing information is worthwhile, although the technical challenge should not be underestimated.

In terms of metadata, used to describe data quality factors that include both sampling bias and measurement issues, because quality matrices of captured data are related to the participants, the time of data capture, the equipment that was used and other factors that are inherent in the heterogeneity of the information, metadata is best captured at feature level (as indeed every measurement taken by the EveryAware project is tagged to a specific device and hence to a user and a set of calibration processes). This adds significantly to data volumes and management efforts, but it can be critical for fitness-for-use testing at later stages and should be managed as well as the geographic information itself.

5.7 Towards a Framework for Citizen Science Activities

Although the term citizen science is relatively new, emerging less than a decade ago, the commercial and academic research that focused on around this term (along with related work in fields such as Crowdsourcing and Volunteered Geographical Information) has already yielded substantive and useful outcomes. EveryAware has contributed to the significant body of knowledge of the operation of systems with and without financial compensation to participants, and some understanding of motivations of participants - which are more complex than might seem at first glance. There are growing examples of systems that explicitly focused on geographic information and those that are implicit and some understanding of their characteristics. There are also several methods to assess information quality and reliability, which have been recently grouped to crowd-sourcing, social, and geographic approaches (see Goodchild and Li 2012 for details). The social, economic and cultural disparities within projects and among projects is also receiving attention (e.g. Stephens 2013).

While some patterns are likely to be general and relevant to all citizen science projects, for example the disparity in contribution between participants, with few contributing the most and a very long tail of those that contribute a little, the questions relating to how to recruit and retain high contributors and how to encourage contribution remain open. It is likely that the factors that influence the success of a specific project will be a mix between aspects that are under control by the project coordinators, and those that are a mix of luck and circumstances which are beyond their control and as the Large Scale studies above show it is not necessarily possible to predict the success of one method over another, or where an initial recruitment campaign will lead. What does seem to be perhaps more clear, however, is that campaign-based, bottom-up, environmental monitoring activities are important in this context.

As a framework for citizen science activities emerges from an intensive and multi-disciplinary research effort of which EveryAware forms a part, it is likely to address multiple facets that relate to:

1. the human and societal part – from recruitment to engagement, identification of participants characteristics and methods to evaluate them and encourage them to contribute
2. the construction of the socio-technical systems for data collection and organisation, including the tools that are relevant for participants as well as integrating methods to ensure data

quality

3. the understanding of biases and patterns in data collection practices, and development of methods to address them or mitigate them.
4. the importance of technology to citizen science activities, as well as co-design of such technology with end users
5. the impact of positioning issues on any results obtained
6. the integration of such data sources with traditional data sources, including the propagation of data quality descriptors (metadata).
7. a legal and ethical framework for such activities.

The EveryAware project has made significant contributions to many of these questions, highlighting and articulating the trade-offs that are required to address these issues in practice. As the routine use of environmentally-related citizen science data capture increases the experience from this project will thus contribute towards the outlines of a framework for citizen science.

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Chapter 6

Appendices

6.1 Appendix 1 - Questions for Follow-Up Questionnaire

- Country
- Gender
- Which age group do you belong to?
- Can you tell me the highest educational or school qualification you have obtained?
- How well did you know the area around the Barbican before participating in this project?
- How did you hear about this project?
- Outside of any academic course of study, have you ever participated in a scientific research project? If yes, please provide details
- Have you previously done any volunteer work? If yes, please provide details
- Have you been involved in any environmental monitoring before? If yes, please provide details
- Please rank the following factors in terms of what motivated you to participate:
  - Online game
  - Interest in air quality
  - Competing with other cities
  - Monetary incentive
  - Contribution to scientific research
- Are there any other things that motivated you to participate in this project?
- Would you have participated in an air quality monitoring exercise without the gaming aspect?
- Would you have participated in an air quality monitoring exercise without a financial incentive?
- If you were given the choice would you have selected to participate in:
- How would you rate the ease with which you were able to recruit Air Guardians to join your team?

- Which do you feel was the most successful way in which you recruited Air Guardians to join your team?
- Which team did you belong to?
- How many team members joined your team overall?
- What was your perception of air quality in London before playing the APIC online game?
- Has your perception of local air quality changed since participating in this research project? If yes, how or why has it changed?
- How would you rate the ease with which you were able to play the APIC online game?
- How would you rate the ease with which you were able to take measurements using the sensor box and Airprobe phone application?
- Do you have any other comments about the usability of the Airprobe application or the online game?
- Did you personally gain anything by participating in this project?
- Has this project encouraged you to take part in future environmental monitoring projects?

6.2 Appendix 2- London Email Recruitment text

We are currently recruiting participants for an experiment investigating local air quality in and around the Barbican in the City of London. http://www.everyaware.eu/category/apic/apic-london/

APIC (AirProbe International Challenge) is a competition between citizens of 4 European cities who will compete to create the most complete (in time and space) map of air pollution for their city. The cities are London (UK), Antwerp (Belgium), Kassel (Germany), and Turin (Italy).

The challenge starts on the **21**st **October** and involves volunteers who will carry out two activities: **Air Guardians** will be asked to play an online game; **Air Ambassadors** will measure air pollution using sensor-boxes that we have developed especially for the research project. Air Ambassadors will also need to get others actively involved in the online game by recruiting Air Guardians to join their team of online players.

Payment for Air Ambassadors who volunteer over the two weeks will be Âč50 (Amazon vouchers). If your team get the best time and space coverage, of measurements in the field, you will win a bonus of Âč400 (Amazon vouchers). In addition, you will also get t-shirts and a solar backpack especially tailored to power electronic devices. Any travel expenses will be reimbursed.

Your role as an Air Ambassador:

Âů Take outdoor measurements using the sensor box, by walking in the area around the Barbican as much as you can over the course of two weeks.

Âů Get as many people (Air Guardians) as you can to play the online game by joining your team.

After the competition we would like to debrief Air Ambassadors to find out how they got on in recruiting the online players (Air Guardians).

Please get in touch by the **10**th **October** if you would like to become an Air Ambassador or you would like any further information

Email Louise Francis at louise.francis@ucl.ac.uk

Tel: 020 7679 2296

See here for more details:

http://www.everyaware.eu/category/apic/apic-london/

All those gamers out there, ensure that London wins the 4 cities challenge by playing the new mixed reality game that teaches you about air pollution in the streets of London while contributing to science.

http://www.everyaware.eu/category/apic/apic-london/).

6.3 Appendix 3 - Web-game recruiting and engagement strategy

Web-games implemented exploit several kind of recruiting strategies. In particular, beside classic ones (posters, flyers, newspapers, radio, etc) we adopted web advertisement on social networks, also through exploiting the social network integration offered by XTribe platform. Furthermore we manage to gather users also thanks to the Amazon Mechanical Turk platform (`www.mturk.com`, a virtual marketplace for small online jobs such as image annotation, polls, translations, etc; will be referred to as AMT in the following) in order to exploit its ability to recruit users with a modest monetary investment. AMT can be used to enhance participation and possibly in the initial phase of an experiment, to provide the necessary pool of data to begin with. In particular, we used AMT users in the City Race experiment described in the Deliverable 2.1. So, by discriminating between AMT users and normal XTribe users, we observe some performance differences between the two experimental settings with different stress levels and goals. One group was composed mostly by players taking part in a special event organized in a bookstore in Rome already described in Deliverable 6.2, while the other was set up by recruiting players in the virtual labour market of AMT. Through these experience we proved that XTribe can be successfully used as a host for complex AMT tasks and that researcher can safely recruit users on the Amazon platform when needed. Once that user have been attracted to our web-games, we need to keep them engaged. We developed the AirProbe web-game interaction design on this purpose. We needed to keep players engaged in the game for the longest time possible, in order to monitor the opinion shift of each player. The most suitable kind of game seems thus to be a management simulation, like the famous FarmVille or Harvest Moon. In this kind of game the user have the task to take care of a given territory. By improving his management performances, the user increase the income in the game virtual currency. Thus he may access a wider set of interaction, for example he can expand his territory or buy more stuff, trying to get a further improvement. The periodic rhythm of this vicious, or virtuous circle, is marked (in FarmVille-like game) by the ripening time of the income: in order to generate a revenue, each action required a given time, spanning from few seconds to several hours. This mechanism is an incentive to return to the game, in order to gather the results of the efforts. The AirProbe web game is a simplified kind of map management game. Players are called to fulfill their role of Air Guardians by annotating the map with AirPins, geolocated flags with an estimation of the pollution level identified as the level of Black Carbon in $\mu g/m^3$ within a scale from 0 to 10. At the beginning of the game, users are asked to create a profile (by choosing an avatar and a name) and to choose a city and a team. Teams were linked to Air Ambassadors, and were an important part of the competition. Then the volunteer starts from a given Tile of the map of the chosen city. The user can interact by placing (or editing or removing) AirPins or by expanding his territory by buying more Tiles. Each day the AirPins placed generate a revenue calculated on the precision of the annotation (more details in the following). In order to collect the revenue generated every day by each AirPin, the user has to access daily, otherwise the revenue will be wasted. The revenue collected will be added to the user balance, and can be used to buy more AirPins and more Tiles, and so on. In order to improve motivation and fidelity, there are bonus for day-in-a-row accesses and a great set of achievements. These achievements consisted in prizes at given milestone in the game story: a certain numbers of AirPins, or of Tiles, or for the precision in the annotation, and so on.