Hush City –
A Novel Mobile Application to Crowdsource and Access "Everyday Quiet Areas" in Cities.

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ABSTRACT: This paper presents the Hush City app: a novel mobile application to crowdsource and evaluate quietness in cities. Hush City app has been developed in the framework of the "Beyond the Noise: Open Source Soundscapes" project, grounded on the soundscape approach and citizen science. This paper firstly outlines the project's theoretical framework; secondly it describes the Hush City app's concept, its technology and advancement on the state of the art; lastly it discusses initial results and introduces future work.

> The soundscape is a huge musical composition, unfolding around us ceaselessly [where] we are simultaneously its audience, its performers and its composers. (Schafer, 1977)

KEYWORDS: END 49/2002, quiet areas, soundscape research, noise pollution, citizen science, open source, mobile applications, mapping, planning.

1. Introduction

Today, cities are becoming increasingly noisier: only in Europe, according to the European Environment Agency, over 125 million people are affected by noise pollution from traffic every year (EEA 2014), which represents the second environmental stressor in Europe, behind air pollution (WHO 2011). The harmful effects of noise arise mainly from the stress reaction it causes in the human body, which can also occur during sleep. These can potentially lead to premature death, cardiovascular disease, cognitive impairment, sleep disturbance, hypertension and annoyance (EEA 2017). To take action against noise pollution is therefore imperative. At the European policy level, in 2002 the *Environmental Noise Directive* 2002/49/EC [hereafter indicated as END] was adopted with the aim of establishing a common approach to avoid, prevent, and reduce the harmful effects of noise pollution among the Member States. The END provides a quantitative methodology based upon acoustical indicators (e.g. "L_{aeq}" and "L_{den}") to calculate noise pollution from major noise sources (e.g. roads with more than 3 million car passages per year), "noise maps" to represent it, and action plans based upon noise-mapping results to reduce it.

The END also stresses the importance of protecting and planning urban quiet areas as a valid measure to reduce noise pollution; and it provides a definition of a "quiet area in agglomeration" as "an area, delimited by the competent authority, for instance, which is not exposed to a value of L_{den} or of another appropriate noise indicator greater than a certain value set by the Member States, from any noise source" (END, art. 3). However, the Directive does not provide any common methodology for protecting and planning urban quiet areas.

As a result, in recent years different criteria for identifying quiet areas have been developed by the Member States and by means of European funded research projects as reported in (Alves et al. 2016; EEA 2014; Licitra et al. 2011). Main criteria so far applied are: 1) acoustical criteria; 2) distance-based criteria; 3) mixed criteria, such as the combination of acoustical, size-based and land use-based criteria (Berlin Senate 2008), the adoption of acoustical criteria combined with accessibility-based criteria (Licitra et al. 2011) – to name only a few.

Despite numerous projects have been conducted, the European Environment Agency has encouraged scholars to do in-depth research in the field and to experiment with mixed methodologies, integrating qualitative approaches such as the soundscape one (EEA 2014).

The "Beyond the Noise: Open Source Soundscapes" project aims to contribute to filling this gap of knowledge: it experiments with a novel mixed methodology for to identifying, assessing and planning "everyday quiet areas" in cities, by implementing the soundscape approach, the citizen science paradigm and a novel mobile application: the Hush City app.

1.1. The soundscape approach: "quietness as a commons"

From the early definition of soundscapes provided by Murray Schafer (Schafer 1977) to the latest one released by the ISO norm, a soundscape can be defined as the "acoustic environment as perceived, experienced, and/or understood by people, in context" (ISO 2014). Accordingly, the soundscape approach is grounded on three main assumptions:

1. the soundscape can be understood as a "pool of resources" (Schulte-Fortkamp 2013) than merely noise;
2. soundscape analyses and evaluation processes are placed in context (Kang et al. 2016);
3. people's preferences as well as their perceptual and physical evaluations are combined towards a holistic study of the (sonic) environment (Brooks and Schulte-Fortkamp 2016).

Inspecting the issue of urban quiet areas through the lens of soundscape allows for the formulation of the research's hypothesis: accordingly, quietness is considered as a commons: as "the cultural and natural resources accessible to all members of a society [...]" (Wikipedia[1]) which "[should be] co-governed by its user community, according to the rules and norms of that community." (Bauwens et al. 2017).

Departing from this theoretical assumption, a novel operative definition of "everyday quiet area" is proposed as "a small, public, quiet spot embedded in the city fabric, at a walking distance from the places we work and live, where social interaction and spoken communication are not only undisturbed, but even favored" (Radicchi 2017). Following this definition, a set of criteria are proposed for the identification and evaluation of small, quiet areas in cities. They are: people's preferences, accessibility, small size (< 1ha), neighbourhood scale (< 30 ha, in the case of Berlin), the walking distance paradigm (Welle et al. 2015), and the "human voice scale" concept (Radicchi 2017). These hypotheses have to be validated through the citizen-driven pilot study, implemented in Berlin in the framework of the "Beyond the Noise: Open Source Soundscapes" project.

1.2. Citizen science applied to research in urban quiet areas

In its formulation, the END also calls for informing and involving the public in preparing noise maps and action plans (END 2002, art. 8, 9), however it does not suggest any strategy to achieve this goal. On the other hand, the soundscape paradigm has become an important tool in facilitating people's involvement in soundscape evaluations and decision processes about the sonic environment (Brooks and Schulte-Fortkamp 2016). However, in the framework of research in quiet areas, public participation is still at the very beginning, with few examples available (Matsinos et al. 2017).

Taking inspiration from citizen science trends towards the use of GPS-equipped smartphones as sensors in data collection and evaluations in the field of environmental noise

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[1]. https://en.wikipedia.org/wiki/Commons (accessed on May 20, 2017).

(e.g. WideNoise, NoiseWatch, see 2.1.), the idea of using a mobile app seemed to be the most appropriate one[2], as it can be used by people in their everyday life, independently by the researchers.

2. The Hush City app

The Hush City app has been therefore developed in order to achieve a set of ambitious goals and, actually, to positively impact on science, environment, society, policy and economic.

1. To increase civic awareness towards the importance of safeguarding urban quiet areas in cities.

2. To facilitate access to existing quiet areas, by allowing people to identify quiets areas shared by the community, where they can find relief from the hectic life experienced in big cities.

3. To boost public participation in quiet areas evaluation, protection and planning processes, by providing people with a free and participative tool to crowdsource mixed data related to their favourite quiet spots.

4. To exploit data collected through he Hush City app in integrated city planning processes, in order to develop policies and planning guidelines grounded on people preferences, and therefore filling a gap in literature (Heinrichs et al. 2015; Hintzsche and Heinrichs 2017).

5. To favour the building of a bridge between the noise level-oriented approach practiced by acoustic planning and a qualitative and people-oriented one, applied in soundscape research. The Hush City app indeed allows for the collection of mixed data – such as field recordings, noise level measurements, pictures and user feedback – which can be used to develop interdisciplinary and more proper evaluations of the sonic environment (Brooks and Schulte-Fortkamp 2016).

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2. Today, the average smartphone has enough sophisticated technology: on-board microphones, GPS, time stamping to make it an extraordinary mobile monitoring device. Moreover, smartphones have become increasingly used by people, as urban life style trends show. According to the 2016 Ericsson Mobility report, as of May 2016, the total number of mobile subscriptions was around 7.4 billion, including 63 million new subscriptions, and 80% of all mobile subscribers use smartphones. LTE subscriptions grew at a high rate as well during the first quarter of 2016: 150 million new subscriptions, reaching a total of 1.2 billion worldwide. Subscriptions associated with smartphones also continue to increase.

Figure 1. Hush City app's icon. © Antonella Radicchi 2017

2.1. Advancement on the state of the art of mobile applications for crowdsourced noise & sound maps

In order to explore the possibility to re-use an existing app, a screen of mobile apps available on the market was conducted[3] in-between June 2016 and October 2016 through literature and market review.

Then, the state of the art outlined in (Figure 2) was built, by selecting only:

1. Mobile applications for the collection of qualitative and quantitative data related to the sonic environment, such as noise pressure levels and/or audio recordings and/or user feedback and/or pictures;

2. Mobile applications for representing the crowdsourced data by means of web-based maps, such as noise maps and/or sound maps.

Social media mobile applications – such as Facebook, Instagram *et similaria* – were not included in this review. Furthermore, only the mobile applications covered by research publications (e.g. Ear-Phone) or implemented in the framework of research projects (e.g. CITI-SENSE) have been included in the survey, even if they are not yet or not more available) on the market.

The result of this survey reports that twenty-eight mobile applications have been developed in the course of the past nine years: Noise Tube app has been the first one launched in 2008. After that, twenty-seven apps were launched in the following years, with a peak in 2014; they are (in alphabetical order): AirCasting, Ambiciti (improvement of SoundCity) Audio Spook, CART-ASUR (linked to Noise Tube), Citi-Sense, CITY SOUNDSCAPE, Ear-Phone, Geluidenjager - Sound of the Netherlands, I-SAY, MoSart, NoiseDroid, Noisemap, NoiseSpy, Noise Watch, Noise Tube, NoTours, Radio Aporee, Recho, Record the Earth, Sound City,

Soundscape Characterization Tool, SoundOfTheCity, Stereopublic, The Quiet Walk, The Noise App, Think About Sound, UrbanRemix, WideNoise

Out of the twenty-eight, seventeen are noise meter-based applications and eleven are audio recorder-based ones. Some of them also allow for the collection of mixed data, such as noise levels and user feedback (e.g. Noise Tube, CART-ASUR), audio recordings and user feedback collection (e.g. Think About Sound).

Figure 2. The Infographic depicts mobile applications for crowdsourced noise and sound maps. © Antonella Radicchi 2017

The result has been represented by means of this infographic (Figure 2) where applications are displayed according to the following criteria: 1) date of release; 2) main function (noise meter or audio recorder); 3) availability on the market.

How to read the infographic: the timeline goes from the left to the right and it shows at a glance when the applications were released. Audio recorder-based applications are placed above the timeline; and noise meter-based applications are located below the time line. The applications' logos were slightly modified in order to represent the apps' availability on the market: applications not yet available on the market, applications no longer available on the market, and off-the-shelf applications. The infographic also displays the exceptional *Favourite Sounds* project, curated by Peter Cusack: despite not having a related mobile app,

it represents the very first participative sound map launched on the web in 1998[4] and for this reason it has been included in the state of the art.

2.2. The Hush City App: innovative aspects and concept

After reviewing the state of the art, the option to re-use an existing app was discarded, due to the lack of an app that enables the simultaneous and sequential actions: recording sounds and calculating their noise pressure levels; taking pictures of the place where the sounds are recorded; collecting user feedback on the sounds recorded by means of a predefined questionnaire. Consequently the Hush City app was developed from scratch[5].

The most innovative aspects of the Hush City mobile application regard both the data collection and the data consultation processes.

In regard to innovation in data collection, the Hush City app allows the sequential collection on the same location and by the same user of a complex set of mixed data in a limited timeframe (approximately 3 minutes). The mixed data collectable consist of: audio recordings and related noise pressure levels; pictures of the place where the sounds are recorded; user feedback on the location where the sounds are recorded. User feedback are collected by means of a predefined questionnaire, structured in three section: soundscape; general issue and behavioural issue. Questions are designed to explore the correlation between the soundscape and the following topics: emotional responses, semantic descriptors, perceived quietness, positive and negative sounds, level of oral interaction and social communication, sense of the place, landscape quality, level of maintenance and cleanliness, sense of security, accessibility to the location. Additional information collected through the questionnaire regards: major sound sources, user status, weather conditions, number of people in the areas and major activities performed in the area. The importance of collecting and evaluating both qualitative and quantitative data is also conveyed through the design of the app's icon, in which the profile of an ear is placed on a heart to represent this ideal combination. The hearth also refers to the impact of the sonic environment on our mental and physical health (Figure 1).

The Hush City app offers also the possibility to collect multiple datasets on the same location by the same user or by different users, therefore allowing for further comparative evaluation according to time variation (e.g. seasonal and/or day/night variations).

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4. The *Favourite Sounds* project started verbally, on paper and as a collection of sound recordings in 1998 by the sound artist and researcher Peter Cusack (UK) with "the aim to discover, and celebrate, what people value about the soundscapes of the cities, towns and neighborhoods where they live and work". The online map appeared in 2009 in its prototype version and it was created during the Positive *Soundscapes Project* (2006–2009). The current version first appeared in 2010.

5. The possibility of using a web-based platform was also explored, thanks to the collaboration offered by Cristian Tapus. However, this option was later discarded due to technical problems, mainly related to the impossibility to record audio from iOS devices and to get accurate noise level measurements.
See <http://hushcityweb.azurewebsites.net/> developed by Cristian Tapus. I want to express my gratitude and thank Cristian very much for his generous and genuine interest in this project.

Concept

By accessing the Hush City app's home page, users are offered two main options through two buttons, displayed on the screen: "Map the quietness around you" and "Quiet Areas". In addition to these features, a menu allows the users to: return to home page; consult and eventually delete users's surveys; give feedback on the app; manage users account settings (e.g. change the password). Finally the Search button allows for consulting quiet areas in specific cities, by typing the name of the desired city in the blank space (See Figure 3, 5).

"Map the quietness around you"

By clicking on the button "Map the quietness around you", users are guided through data collection of their favorite "everyday quiet areas". The first action required is to record the sound of the chosen area: by clicking on the button "Record", the app starts recording and after 30 seconds it automatically stops. Secondly, users are asked to click on the button "Analyse" and the app calculates and displays the sound pressure levels of the sound recorded. Thirdly, users are asked to take a picture of the place where the sound was recorded, and finally they are invited to evaluate the soundscape and the surroundings by replying to a pre-defined questionnaire.

By using the Hush City app, data collection sequence starts with the recording of a 30-second long audio recording: this process was designed on purpose in the building of the app to make the users pause and listen to the sonic environment, therefore contributing to the improvement of their listening abilities.
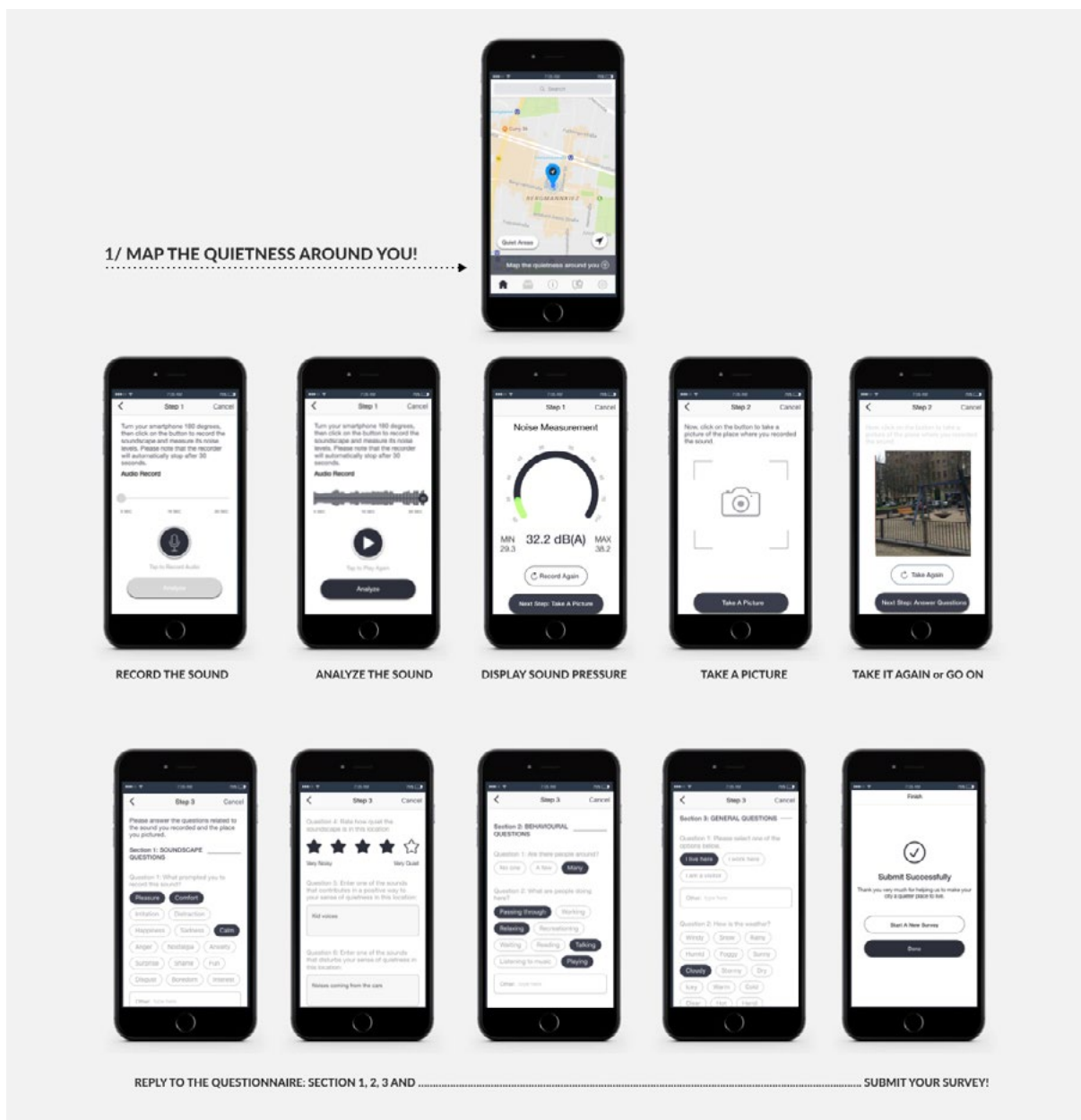
Figure 3. Hush City app: "Map the quietness around you" interface.

The questionnaire

Data collection's final step consists in replying to a pre-defined questionnaire, which is articulated in three sections revolving around soundscape issues, behavioral and general issues, such as the location quality, main uses of the location, sense of security, accessibility, weather conditions etc.. Replies can be given by means of: multiple choice, linear scale and free text rating methods.

"Quiet Areas"

By clicking on the button "Quiet Areas", users are guided through the exploration of datasets related to "everyday quiet areas" nearby – or in other cities worldwide – shared by other users. When the "Quiet Areas" button is active, the background map turns into dark and users are offered two view mode options to explore the quiet areas: the map view mode and the list view mode.

Map view mode

When the map view mode is active, colored markers are displayed on the dark background map. Colors are automatically assigned to the markers by the Hush City application, according to the sound pressure levels of each sound recorded. For example, light green markers indicate that in these spots sound pressure levels were approximately between 35−40 dB(A)[6] (see Figure 4). The color scale reference is taken from the strategic Noise Map of Florence[7].

▇	>75 dB
▇	70–75 dB
▇	65–70 dB
▇	60–65 dB
▇	55–60 dB
▇	50–55 dB
▇	45–50 dB
▇	40–45 dB
▇	35–40 dB
▇	20–35 dB
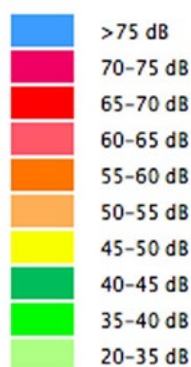
Figure 4. Colour scale and related L_{den} in dB(A).

By clicking on each marker, a window pops up displaying data collected on that spot, such as: date and time, address, sound recordings, pictures, sound pressure levels, and user feedback.

List view mode

When map view mode is active, users are given the possibility to explore datasets by means of list view mode. By clicking on the button located on the top-right angle of the display (in case of iPhone), datasets related to quiet areas collected by the community are listed. Again, by clicking on each item of the list, data collected on that spot are visualized, such as: date and time, address, sound recordings, pictures, sound pressure levels, user feedback.

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6. Noise levels calculated by the Hush City app may not be entirely accurate, depending on which smartphones are used, weather conditions and other factors.

7. http://www.arpat.toscana.it/datiemappe/mappe/mappa-del-rumore-stradale-firenze (accessed on May 20, 2017).
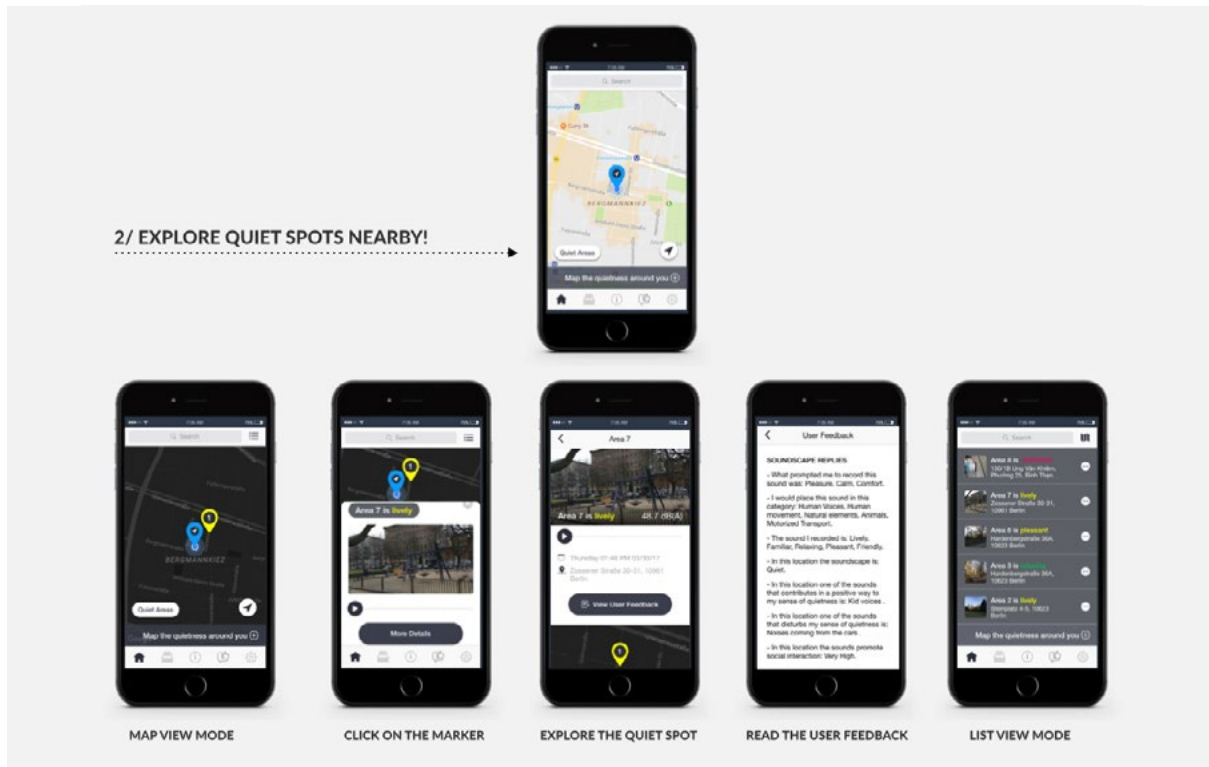
Figure 5. Hush City app: "Quiet Areas" interface.

2.3. Hush City App: technology

Hush City app is a free, native mobile application, which runs on both iOS and Android operating systems: iOS 9.0 and higher (iPhones 5/5C/5S/SE/6/6Plus/7/7Plus) and Android 5 and higher (any Android based smartphone). A Titanium platform is used as a framework to record and store the data and a LAMP stack is used as a repository. Audio data are sampled at 44.100Hz, with a resolution of 16bit. The maximum length of the audio file is 30 seconds. Respective sound pressure levels are calculated as numeric scale values and they are A-weighted (i.e. 45 dB(A)). The A-weight is considered as the most appropriate for assessing environmental noise, due to similarity to human hearing (Thenuis et al. 2017). L_{eq} (equivalent continuous sound level), L_{min} (minum sound level) and L_{max} (maximus sound level) are also calculated and displayed. NoiseTube's app libraries have been consulted to select the most appropriate formulas for sound pressure level calculation and calibration (Maissoneuve et al. 2009)[8]. These formulas have been also double checked by a team of acoustic consultants involved in the project (see credits' list below). Pictures are collected at a maximum resolution of 6MP and 24bit color. Sign-in feature: the users must verify their email before signing in and use the app as usual. If the users realize that they used wrong emails or made typos or mistakes after touching the Sign Up button, the app also allows them to change their email addresses.

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8. <http://www.noisetube.net/index.html#&panel1-1> (Accessed on May 20, 2017).

2.4. Hush City App: code & data ownership, data storage and privacy issues

Hush City app's code will be made public and shared on-line under an appropriate license. Datasets, collected by using Hush City app, are accessible at any time by using the app, and they will be made public and open in the final phase of the "Beyond the Noise: Open Source Soundscapes" project (tentatively in Spring 2018).

For the measurements and for compiling the maps on quietness, user precise location is needed. Various technologies are used to determine user location, including IP address, GPS, and other sensors. All and any collected data and personal information are sent anonymously electronically to the database stored in the host provider SERVER4YOU[9] run by Host Europe GmbH, a provider whose servers are based in Germany, where they are stored. Appropriate measures are taken to safeguard against unauthorized disclosures of personally identifiable information and all information is stored using the required industry-standard techniques. The collected surveys are made available strictly anonymously on the Internet and by means of publications in international journals and public presentations at conferences, symposia, and dissemination events in general. The Privacy Policy and Terms and Conditions document is accessible at any time on the Hush City app's webpage[10].

2.5. Hush City App: credits

Hush City's software development was curated by Dr. Martin Memmel – Head of the QUER-TEX GmbH, in cooperation with EdgeWorks Software, Ltd. The mock-up was developed by QUERTEX GmbH, in cooperation with EdgeWorks Software, following an initial concept provided by Antonella Radicchi. The app's icon (Figure 1) was designed by Antonella Radicchi. Acoustic consultants: Dipl. Ing. Michael Jäcker-Cüppers (DEGA, Technical University of Berlin), Dipl. Ing. Manuel Frost (Berlin Senate, Senate Department for the Environment, Transport and Climate Protection), Dipl. Ing. Mattia Cobianchi (Bowers & Wilkins, UK).

3. Discussion

Hush City app was launched on the market in the midst of April 2017. Initial communication campaign's measures consisted of disseminating the app by means of emails to personal contacts and posts on public platforms such as Linkedin and Twitter. After the first 30 days, at the end of May 2017, approximately 120 datasets have been shared by users from all around the world: thee most active city is Cambridge (USA), followed by Berlin (GER) and Lisbon (P). Datasets also come from the U.S. (e.g. New York City, Chicago), Italy (e.g. Rome,

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9. <https://www.server4you.net> (Accessed on May 20, 2017).

10. <http://www.opensourcesoundscapes.org/hush-city/> (Accessed on May 20 2017)

Florence, Milan, Bologna,), Romania (e.g. Bucarest), U.K. (e.g. London), Belgium (e.g. Ghent) and the Netherlands.

As reported in (Kardous and Shaw 2015), challenges remain with using smartphones to collect and document sound exposure data. Some of the main issues encountered in recent studies are being carefully studied and addressed (Drosatos et al., 2012; Huang et al. 2010). In regard to the Hush City app, the main challenges are related to the following issues.

Data quality

(Murphy and King 2016) proved that the measurements apps did a poorer job of accurately measuring at very low background and high noise levels: the latter is a concern given that environmental noise at higher levels is the key area of concern from a public health perspective.

In order to achieve data quality, NoiseTube's app libraries have been implemented for sound pressure level calculation and calibration (Maissoneuve et al. 2009)[11]. In order to test the ability of the Hush City app to calculate noise at different sound pressure levels (i.e. Background, 40 dB, 50 dB, 60 dB, 70 dB), a calibration procedure was followed[12], as recommended by (Murphy and King 2016). A coherent pink noise signal was played over computer speakers and measurements were simultaneously taken by using the Hush City app installed on a Samsung Galaxy A5 and a calibrated sound meter level (NTI XL2). The microphones of the smartphone and the sound meter level had the same distance in front of the speaker (30 cm).

In the case of the Hush City app on a Samsung Galaxy A5, the measured values differed by an average of –4 to –5 dB (A) at an average level (L_{aeq}) of 45–80 dB(A). Below 45 dB(A), the differences become larger (approximately –10 dB(A)). That means the calculations made with Samsung Galaxy A5 smartphones could be more inaccurate, the quieter the area is. This result does not constitute *per se* a relevant weakness, due to the fact that in cities small, quiet spots with sound pressure levels below of 45 dB(A) are barely found. However, for more credible results, calibration tests should be done with different smartphones. Future work may also imply improving automatically calibration processes.

Production and sharing of knowledge

According to (Brooks and Schulte–Fortkamp 2016), evaluating the sonic environments calls for interdisciplinary measures: integrating sound pressure level measurements with field recordings, psychoacoustic analyses and local experts' feedback, is highly recommended.

Hush City app's originality consists in the multiple facilities which are embedded in a unique tool: by using the Hush City app, users can assess the sonic environment by collecting

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11.   <http://www.noisetube.net/index.html#&panel1-1> (Accessed on May 20, 2017).

12.   I would like to thank Dipl. Ing. Manuel Frost (Berlin Senate, Senate Department for the Environment, Transport and Climate Protection), who kindly took care of the initial calibration tests.

datasets composed of: audio recordings, sound pressure level measurements, pictures and user feedback provided by replying to a predefined questionnaire. This leads to the production of qualitative and quantitative data not only related to quietness, but also to other issues, such as: the visual aspect, quality, accessibility, weather condition, people behavior – aspects that influence the evaluation of the sonic environment (Kang et al. 2016). Future work may imply the Hush City app's implementation with new facilities to investigate psychoacoustics parameters (such as: loudness, roughness, sharpness and tonality) in relation to the sense of quietness.

Using the Hush City app allows for the bottom-up production of informative and descriptive datasets of the way people experience quietness in cities in everyday life. Despite the fact that maps constructed with such datasets may be less statistically relevant, they could still give useful information for investigating specific and context-related issues (Theunis 2017); moreover they could constitute a resource to complement conventional methods for the assessment of urban noise (e.g. noise maps), as proven by previous experiments conducted in the field by (D'Hondt et al. 2013; Stevens 2012).

Civic awareness and bottom-up participation processes

In geography, urban planning and citizen science there has always been the tendency to support public participation (Haklay 2017). Today innovation in sensing technologies leads to the development of miniaturized sensors, creating opportunities for *participatory sensing* (Loreto et al. 2017), data collection and monitoring at a reasonable price (Theunis et al. 2017). This trend is also confirmed by the increasing number of mobile apps developed to monitor noise and air quality, especially in urban environments (see 2.1).

In soundscape research, public participation and civic engagement play a major role in soundscape evaluation and planning processes (Brooks and Schulte-Fortkamp 2016); however sensing technologies applied to research on quiet areas are still at the very beginning, with very few available examples (Matsinos et al. 2017).

Hush City app is aimed to fill this gap of knowledge by: 1) increasing community awareness about the importance of reclaiming and protecting quietness in cities; 2) empowering local communities to map and evaluate quiet spots in their neighbourhoods; 3) impacting on participatory planning processes by training committed citizens in soundscape action research. However sustaining motivation to participate in such studies is always a challenge (Murphy and King 2016): to tackle it, specific measures will be adopted, following trends in citizen science projects[13].

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13.   For an extensive bibliography in the field, see <https://ecsa.citizen-science.net/blog/collection-citizen-science-guide-lines-and-publications>, <http://www.buergerschaffenwissen.de>, <https://povesham.wordpress.com> (Accessed on May 20, 2017).

4. Future Work and Conclusion

The Hush City app constitutes one of the open source tools/outputs of the "Beyond the Noise: Open Source Soundscapes" project along with the "Everyday Quiet Areas Plan" (Radicchi 2017). The latter consists of a participative management plan, which gives indications on how to protect the existing quiet areas, by taking the results obtained at local level and scales them up to the city level, and by taking into consideration city policies and plans, such as the mobility plan, the green areas plan, the land use plan, and public housing policies.
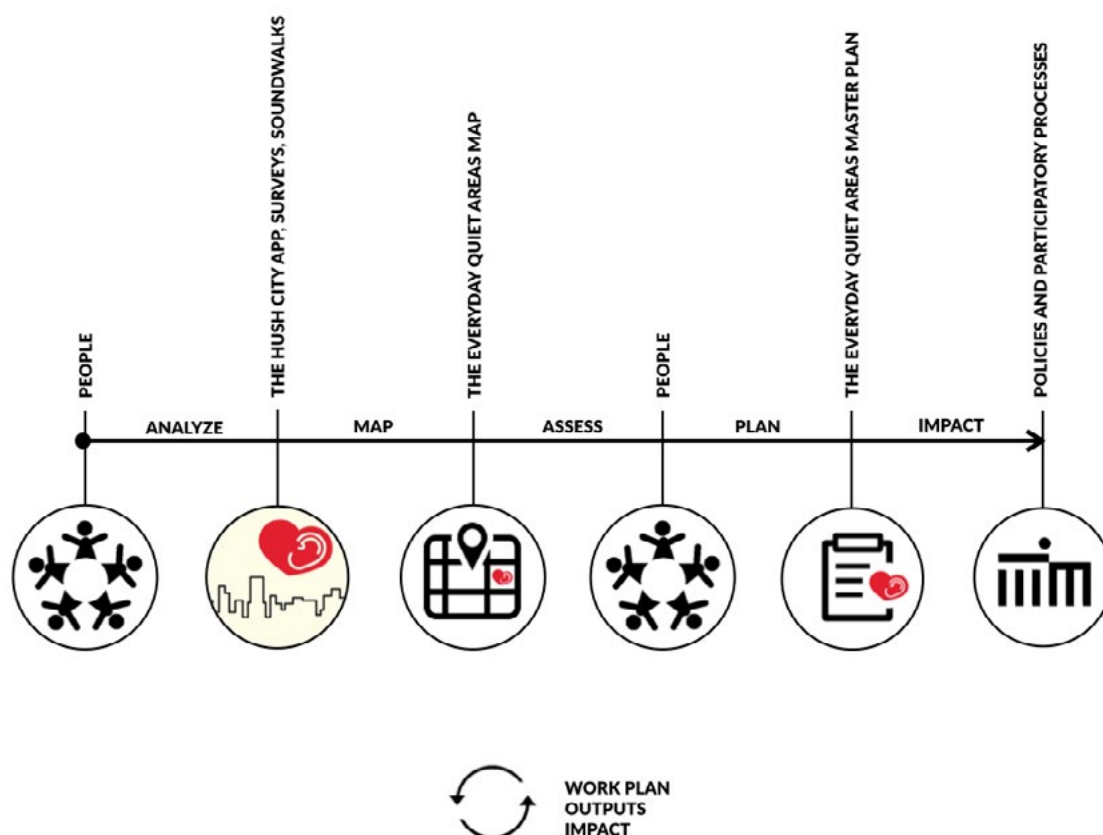
Figure 6. The diagram illustrates the "Open Source Soundscapes" approach's workflow, the outputs and impact.

This "open source soundscapes" methodology is currently under validation through a pilot study in the Reuterkiez, a Berlin neighborhood affected by noise pollution and high levels of environmental injustice. However, it could be applied to other Berlin neighborhoods and potentially to other cities, affected by noise pollution and environmental injustice, leading to meaningful comparative studies.

Grounded on the concept of "quietness as a commons", the methodology's theoretical, methodological and political impact could be measured on different levels.

- In relation to the scientific debate on the theories, tools and regulations of acoustic planning at the EU level: this novel mixed methodology can contribute to plan urban

quiet areas starting from public participation and embedding people's preferences into open source planning processes.

- In relation to the knowledge generated by the project, it could be embedded into civic participation management, spatial planning networks and policy processes through the collaboration with local authorities.

According to the workflow illustrated in Figure 6, the planning phase is expected to start by the midst of December 2017. Future work may imply: the implementation of new features in the Hush City app; a further investigation of the quiet spots identified by the participants, by means of psychoacoustic analyses; comparative studies with other cities worldwide.

Nowadays, to take action against noise pollution is imperative. Based on empirical evidence, the Hush City app and the "open source soundscapes" methodology have the potential to tackle this challenge and to address environmentally just and participatory urban planning processes in the city of Berlin and beyond.

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