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CITIZEN SCIENCE FOR PUBLIC DELIBERATION OF LOCAL ENVIRONMENT POLICIES

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ABSTRACT
Broadening citizen participation in scientific knowledge production has become a priority of national and supra-national institutions and research agencies. Out of their interest for scientific research and public learning, citizen science projects are often presented as offering a unique opportunity to involve more directly the public in policy-making. However, despite twenty years of flourishment of participative scientific research, making citizen science a tool to foster participatory democracy remains a challenge. Political outputs of citizen science are indeed often restricted to its role in the production of data to inform policy making processes. In this paper, we propose an innovative theoretical model of democratization through citizen science, in which participative data collection is associated with public online deliberation. Drawing both on online political deliberation research and citizen science literature, we argue that citizens' engagement in contributory science could help create the conditions of good-quality public deliberations. We then present a technical device (an online platform) that put this model into practice in the context of the regulation of public lighting in two French municipalities.

KEYWORDS
Public lighting, deliberation, contributory science, participatory democracy, environment

1. INTRODUCTION

Associating citizens in the production, the discussion and the public use of scientific knowledge has become a major challenge for European democracies. Indeed, on the one hand, European democracies give a central place to scientific knowledge in social innovation and the design of public policies; on the other hand, they promote an active form of citizenship, which would entail a more direct participation of citizens in political life, notably through public deliberation of policy decisions. Despite a large heterogeneity among European political cultures, this last requirement generally faces concrete difficulties linked to the often documented rise of mistrust or indifference from the populations regarding participatory democracy, in its different forms (Rojon and Pilet, 2021). However, at least in principle, the successful articulation of democratic exigency of participation with the central role of scientific knowledge as a governance tool depends on citizens' ability to form sound opinions on the basis of the best available scientific evidence, and to discuss them in the political arena. As a possible solution to this challenge, broadening direct citizen participation in scientific knowledge production has become a priority of national and supra-national institutions and research agencies (European Commission 2013; European Commission 2016; Office of science and technology policy 2019). In particular, "citizen science", as defined as "the non-professional involvement of volunteers in the scientific process", including "data collection (...), quality assurance, data analysis and interpretation, problem definition and the dissemination of results" is growingly seen as "a unique opportunity (...) to involve the public in EU policy-making" (European Commission 2020, p. 6 and p. 2). Citizen science includes a large diversity of practices (Bedessem and Ruphy 2020; Strasser et al. 2019) in many scientific domains, including astronomy (Kasperowski and Hillman 2018), biology (Kelly and

Maddalena 2015), medicine (Den Broeder et al. 2016), and (above all) in environmental sciences (European Commission, 2013; Dillon 2017; Turrini et al. 2018). Besides, participation of citizens in scientific inquiries currently takes a variety of forms (see Schrögel and Kolleck [2019] for a review of the typologies currently available). A classical classification of citizen science initiatives has been proposed by Bonney et al. (2009). The authors distinguish *contributory* science (where citizens are passive or active data-collectors supervised by scientists); *collaborative* science (citizens are engaged in other steps of the research process, such as data analysis or interpretation) ; co-created citizen science, or community-based research (the research program is initiated by citizens who aim at solving a problem that they themselves have identified).

Despite these twenty years of flourishment of participative scientific research, making citizen science a tool to foster democracy remains a challenge (Mirowski 2018). In a practical perspective, Schade et al. (2021) note that despite some citizen science projects that have already fed into local policy implementation (see Owen and Parker 2018 for an example), "the benefits of citizen science remain largely theoretical for most policymakers" (p. 362). They conclude that "more real-life examples are needed to build trust among policymakers in the societal return on investment" of citizen science initiatives (p. 362). These real-life initiatives could take a diversity of forms, depending on how one conceives the role of citizen science in governance (Göbel et al. 2019), and on the type of citizen science (e.g contributory, collaborative, co-created) one considers. This paper proposes an original mode of using citizen science (more precisely, contributory science) for participatory democracy through public deliberation. First, we make more precise the general objectives and scope of the study (section 2). Second, we define and justify this modality of citizen science for governance (section 3). Then, we present a technical device we developed to illustrate how our theoretical model can be translated into practice (section 4). This technical device was developed in collaboration with two French municipalities which are engaged in a process of reduction of public lightning. This technical device was then conceived as a way to engage citizens in this public policy making through a contributory data collection protocol. This device was then opened for citizens' participation by the municipalities. Unfortunately, the lack of public participation (due to various factors we discuss in section 4) does not allow further empirical analysis based on those cases. In section 5, we discuss the relevance of our approach with regards to its practical application and we propose some paths for future research aiming at testing our theoretical model.

2. BRIEF OVERVIEW OF THE STUDY: SCOPE, OBJECTIVES AND LIMITATIONS

Since this study presents very distinct theoretical, technical and empirical dimensions, it is worth clarifying as a first step its scope, objectives and limitations. Our main aim is to propose and argue for a model of citizen science-based deliberative process at the local scale. To do so, we first explain to what extent the use of citizen science for public deliberation would be innovative and promising both from the perspective of citizen science, and from the perspective of participatory democracy (section 3). In this theoretical framing, we use the concept of participatory democracy as an umbrella concept referring to all forms of direct participation of citizens in the elaboration, implementation or evaluation of public policies. As shown for instance by Lezaune et al. (2017), this participation might take a diversity of forms, among which one can find a variety of public deliberation processes. Once we have presented and defended this theoretical model, we show how it can be translated into practice by presenting a technical device (an online platform) which articulates contributory data collection with a deliberative process (section 4). This technical device was designed in the context of two public policy making processes aiming to regulate public lightning in two French municipalities. The opening of the platform for citizens' participation, under the control and the animation of these municipalities, has finally generated a low participation rate on the behalf of the population. This precludes any future empirical analysis of the relevance of our theoretical model on the basis of this case study. However, let us recall here that the objective of this contribution is primarily to present and defend, both as a theoretical model and as a technical device, a citizen science-based deliberative process. It is a programmatic paper: it does not aim at empirically testing the conditions of success of such an approach to public deliberation. Such a test would need developing a diversity of case studies in different contexts. We nevertheless discuss quickly, on the basis of the semi-structured interviews we led, the possible reasons explaining this low participation rate, and we propose (section 5) some paths for future researches which would aim to empirically study our propositions for citizen science-based deliberative processes.

3. CITIZEN SCIENCE FOR PUBLIC DELIBERATION: A CONCEPTUAL FRAME

a. In which senses citizen science may constitute a mode of governance?

In their review of how citizen science feeds into public governance, Göbel et al. (2019) distinguish four modes of citizen science engagement with political processes. First, and maybe most commonly, citizen science can consist of a source of information for policy making. By providing governments with scientific data,

citizen science (mostly contributory science) is or could be used for policy preparation, policymaking, policy implementation or evaluation. Local (e.g municipal) governments offer many examples of citizen science feeding into these different steps of the policy circle (Veeckman et al. 2021).

Second, citizen science can be considered as an object of research policy: as a specific but legitimate way of doing science, citizen science is part of "policies for advancing research, technology, and innovation" (Göbel et al., p. 4). This mode points to collaborative or co-created types of citizen science: for instance, stakeholders may engage in scientific knowledge production in order to solve local issues — typically, natural resources management conflicts (Yamamoto 2012, Pettibone et al. 2018) or air quality assessment (Ottinger 2010).

Third, the role of citizen science in governance can also be examined by interrogating the instrumental reasons that have led to its institutional promotion (Göbel et al. 2019, p. 6). A central topic of discussions here highlights the links between the promotion of citizen science and the new forms of neoliberal governmentality (Peters 2009). For instance, citizen science could be seen as cost-effective ways of producing scientific knowledge (Resnik, Elliott, and Miller 2015).

Fourth, citizen science may feed into governance through the design of technologies that have a "direct impact on the way that the world is structured without being reliant on any explicit policy support" (Göbel et al. 2019, p. 7). This form of governance gathers cases where citizen science generates practical approaches (devices, metrics) to tackle social problems (e.g. urban mobility, environmental pollution) rather than merely producing data or recommendations (see Göbel et al. 2019, p. 7-8 for examples).

While providing a convincing overview of the multiple modes of governance through citizen science, Göbel et al.'s typology does not aim to be exhaustive. In this paper, we would like to describe and illustrate a fifth mode of governance through citizen science. By contrast to the previous ones, this last mode is more prospective: this paper presents, to our knowledge, its first conceptualization; and the case studies we detail in section 3 constitute its first applications. In a nutshell, this mode of governance situates citizen science as a tool to engage citizens in public deliberations regarding those kinds of issues characterized by: 1/a need of scientific data to inform policy preparation, policymaking, policy implementation or evaluation; 2/the existence of a strong political conflictuality which makes relevant the building of public deliberative arenas to reach a socially acceptable compromise. Different kinds of situations may correspond to this description, notably in the landscape of local environment policies and resources management: one can think of the management of green areas to benefit human health and well-being (Wood et al. 2018), the adaptation of urban mobility to diminish air pollution (Pisoni et al. 2019), or the regulation of public lighting to preserve biodiversity (Pauwels et al. 2021). The general idea we would like to defend in this paper is that citizens'

engagement in contributory data collection could help participative democracy by *creating the conditions of good-quality public deliberations* regarding these kinds of issues.

b. Deliberative quality within online deliberation platforms

First coined by some constitutionalist scholars and philosophers of law in the first half of the 1980s, the notion of deliberation found its first theoretical formulations in political theory in the second half of the 1980s (Cohen 2005), followed by the first practical and experimental applications in the early 1990s ("deliberative polling", Fishkin 1991), while finding a mature definition in the works of Habermas (1996) and Rawls (1993). From then onwards deliberative democracy has become an umbrella expression for a plurality of approaches (Floridia 2017; Bächtiger et al. 2018), from "citizen representatives" or "mini-publics" (Urbinati and Warren 2008) to deliberative arenas that complement political representation (e.g the "Convention citoyenne sur le climat" which took place in France in 2019-2020 and the UK citizen's climate assembly started in January 2020). Despite this diversity of real-world experiments in deliberative democracy, the individuals' drivers behind such citizens' participation are still poorly known. Second, it is still an issue to identify the practical conditions of good-quality deliberations: that is, deliberations which comply with classical principles drawn from the rich literature on deliberation, such as respect, reciprocity, rationality or constructiveness (Shin and Rask 2021). Within this political deliberation literature, a growing number of works have focused on the specific case of online deliberation platforms. Indeed, the widely discussed crisis of representative democracy (Tormey 2015) has given rise, since the last decades, to many democratic innovations based on ICTs (information and communication technologies). Among them, online deliberative platforms have been developed and deployed in real environments by city, regional, or national governments (Aragón et al. 2017). While sharing the same commitment to allow discussions among contributors, these platforms are very diverse regarding their grounding principles and their technical features. In some of them, participants are required to post comments whether in support or against a proposal made by the authorities; the positive and negative comments are then sorted by the number of received votes (e.g. *Your Priorities*, Iceland, https://www.yrpri.org/domain/3). The *Cónsul* platform (Spain, https://decide.madrid.es/) allows a free discussion on the proposals. In-between approaches have been developed, such as the *Decidim Barcelona* platform (Aragón et al. 2017, https://www.decidim.barcelona/). Online deliberation research is currently studied along a variety of strands, as highlighted in Friess and Eilders (2015)'s review, including considerations on the design of the process or on its political outcomes. The issue of deliberative quality has given rise to a fecund body of works, at the crossroad between political theories of deliberation — whose

objective is to identify criteria to characterize the quality of a deliberation (e.g Giugni and Nai 2013) — and empirical research aiming to develop and apply deliberation quality index (e.g Steenbergen et al. 2003). Two decades of research have provided convincing criteria to characterize good-quality deliberations — such as rationality, interactivity, equality, civility, common good reference and constructiveness (Friess and Eilders 2015) — as well as many different quantitative indexes to concretely evaluate the quality of online deliberations (see Shin and Rask 2021 for a review). Overall, the main objective of these research efforts is to identify the social, political and technical conditions of good-quality online deliberation, in order to improve existing deliberative systems. Obviously, this task constitutes an ongoing process, which is continuously enriched by the analysis of innovative approaches to deliberation. Our proposition of using contributory science as a tool to foster good-quality deliberation aims to contribute directly to this endeavor.

c. The democratic promises of citizen science

Since a decade, a rich literature has emerged which interrogates the epistemic, social and political impacts of citizen science on participants, along various dimensions: science learning (Phillips et al. 2018, Aristeidou and Herodotou 2020); changes in attitudes towards science (e.g. trust, Vitone et al. 2016); changes in individuals' interests and attitudes towards specific topics, notably biodiversity and the environment (Peter et al. 2019); empowerment of groups of citizens which may play, through citizen science, a role in decision making by supporting social movements (see Ottinger 2010; Landström 2020 for examples). This last dimension interrogates directly the democratic potential of citizen science, which is commonly presented as a tool to foster citizens' participation in democratic decisions (Turrini et al. 2018). However, as convincingly argued by Herzog and Lepenies (2022), the full democratic potential of citizen science remains to be unlocked. In particular, these authors interrogate the possibility, for citizen science, to be part of deliberative systems — in the sense of Mansbridge (2012). In this frame, the authors mainly insist on the need to discuss the inclusivity of citizen science approaches (which subgroups are involved?), and the possibility to really engage citizens not only in data collections, but also in the decisions or reflections about the goals and implications of research. This second point is quite demanding (notably when considering exigencies of inclusivity), since it involves a more intense engagement of citizens in the research process, in all its aspects: formulation of the research questions, design of the protocols, analysis and interpretation of the data, discussions on the applications and implications of the results. It also implies the existence of active grassroots movements, or social, political and cultural conditions for developing them. This perspective on the democratic potential of citizen science is certainly relevant in various situations — as proved by the many examples showing how citizen science has been used to defend some community or group-

based political agenda, see Herzog and Lepenies (2022) for exemples. However, we argue that it might be necessary to propose alternative solutions for developing more broadly citizen science as a tool for deliberative democracy. These solutions should be less demanding for citizens (in order to engage a large number of individuals), but also for governments, in order to encourage them to institutionalize and generalize the use of citizen science as a tool to engage citizens in deliberative democracy — notably, at the local scale. We argue that the mode of governance through citizen science we propose in this paper may constitute one of these alternative solutions.

d. Our proposal: contributory science for promoting good-quality deliberations

The thesis we defend in this paper is the following: contributory science (that is, participative data collection) may be used by governments, and specifically local governments, to foster good-quality public deliberation in the sense defined in section 3-b. More specifically, the approach we propose for discussion is the following. Let us consider a given local government (e.g, a municipality) which aims to engage citizens in a participatory democracy process to prepare, implement or evaluate a public policy regarding one of those issues we define in section 3-a. To collect the necessary data, this local government may collaborate with scientists to build a contributory science project grounded in an online platform. Within this platform, participants share their data by following a rigorous protocol defined by scientists, and *when they have contributed at least once*, they are given access to an online deliberation space. Depending on the cases, this space may allow citizen scientists to make proposals and/or discuss proposals from authorities. The guiding principles justifying this approach are the followings: through engagement in data collection, participants might acquire a better knowledge of the issue at stake; develop a specific interest for it as a political problem that should be solved collectively; reinforce their self-confidence and feeling of legitimacy to engage in a deliberative process. Consequently, participants might increase their ability to enter good-quality online deliberations — that is, deliberations which comply with principles such as rationality, interactivity, equality, civility, common good reference and constructiveness. The credibility of this approach lies in the well-established transformative potential of citizen science regarding individuals' relationships to science and rationality, individuals' interest or engagement towards the specific topic or issues at stake, and citizens' empowerment (see section 3-c). In the following, we present an example of technical implementation of this model of citizen science-based public deliberation at the local scale, under the form of an online platform. We then discuss future research paths in order to study in practice the relevance of this approach to public deliberation.

4. A TECHNICAL DEVICE FOR CITIZEN SCIENCE-BASED DELIBERATIVE PROCESSES: THE SPOT PLATFORM

In this section, we propose an illustration of how our theoretical propositions may be implemented into a technical device (an online platform) supporting a participatory approach. To translate our idea of citizen science-based public deliberations, we took as an application case a project of regulation of public lighting led by two French municipalities: Libourne (Southwest of France, 25000 habitants) and Melesse (Northwest, 6000 habitants). These municipalities, which both aimed to develop a participatory process regarding the regulation of public lighting, were chosen in May 2021 through a call for expression of interest. The aim of this collaboration for the research team was threefold:

- (i) developing a technical device which implements our model of citizen science-based public deliberations. This device is based on the articulation between a contributory science protocol, and a deliberative space. As described more in details later on, the participants are first invited to contribute with their data, and then (in a second step), those who contributed at least once can access the deliberative space — constituted by a function of comments of others' contributed data, a space of interactions with the municipality, and a page for individuals recommendations and collective discussions.

- (ii) testing the success, first in terms of public participation rate, of such an approach;

- (iii) get data (for future research) about the deliberation processes within the platform. As already noticed, the low participation rate precludes the realization of this last objective.

In the following, we present the context of this project as well as our technical device (the SPOT platform), and we discuss the reasons for the low participation rate which was obtained by the municipalities.

a. Context of the project

The politics of public lightning is becoming a central issue for local governments (Sanchez-Sutil and Cano-Ortega 2012). Out of the relevance of diminishing night lightning to save energy, it is well documented that light pollution is detrimental both for biodiversity and human health (Navara and Nelson 2007; Pauwels et al. 2021). On the other hand, the regulation of public lighting may also raise security issues, both for driving security (Elvik and Vaa, 2004) and individual security — even if the link between the lack of urban lighting and criminality is unclear (Tompson et al. 2022). Consequently, the regulation of public lighting faces a number of oppositions (Peña-García et al. 2015). Public policies related to public lighting are then

potentially conflictual, as well as (at least ideally) strongly dependent on data from different scientific disciplines — ecology, geography, environment psychology. In particular, this last discipline (which studies the relationships between human behavior and attitudes, and the surrounding environment) is crucial as it may contribute to exploring our relations to darkness, in terms of feelings, perceptions and attitudes. Whatever the way it is performed (through citizen science or through traditional approaches), environmental psychology research usefully feeds in public policy making, since it helps understand the obstacles and levers for the regulation of public lightning.

The municipalities of Libourne and Melesse, which are both engaged in a policy of regulation of public lightning for which they want to develop a participatory democracy approach, present contrasted situations, as shown by official data (see https://www.insee.fr/fr/statistiques/1405599?geo=COM-33243, the data presented here are from 2020). Libourne (25000 habitants) has relative socio-economic difficulties, with a rate of unemployment of 19.3% (against 8% at the national level), and 20% of its population is under the poverty line (14.6% at the national level). In comparison, Melesse (600 habitants) presents a lower unemployment rate (7.4%), and a relatively low rate of poverty (5%). In terms of political participation in electoral processes, the rate of abstention for the 2nd turn of the last presidential election is quite similar (28.65% for Libourne and 17.52% for Melesse, against 28.0%1 at the national level). Regarding political participation in general, both cities have an elected representative dedicated to "participation", who is in charge of animating or supporting public consultations, local committees, and public meetings between citizens and the local executives. That said, let us note that we will not insist more on Libourne's and Melesse's socio-political features since the study of the dynamics of participation in the SPOT project is out of the scope of this paper.

b. General scope and organization of the SPOT project

The SPOT project was constructed in coordination with Melesse's and Libourne's municipalities, and in particular with the elected representatives and civil servants responsible for "political participation". This collaboration was conceived and organized as follows. The research team (led by the MOSAIC team unit from the MNHN, which is specialized in building online platforms for citizen science) was in charge of designing an online platform which articulates contributory data collection and public deliberation. The description of the content and architecture of this platform (SPOT) is one of the central contributions of this paper. The platform (described in detail in the following sections) was opened from April to June 2022. Its content was intensively discussed with the local representatives. For this pilot device, we chose to design our citizen science protocole as an environmental psychology study. That means that the collected data are susceptible

to be used as a research material for studying individuals' perceptions and relationships to obscurity. In theory, those data may then prove to be useful in themself (that is, independently of citizens' participation in the decision process) to guide public policy decisions. However, the important point here is that out of its interest for scientific research and for policy-related expertise, this data collection process is politically relevant since it may drive individual self-reflections about one's relationships to urban darkness, and then possibly enrich future (online) deliberations.

The municipalities were in charge of the political dimensions of the project, which uncovers two aspects. The first aspect is the animation of the device itself, that is, the advertisement of the platform and the recruitment of participants. From February to June 2022, they communicated about the project through public announcements, public meetings, and articles in local newspapers. The second aspect is the choice of the mode of decision regarding the regulation of public lightning — a particular issue being the weight to be given to the outcomes of online deliberations. It is important to note that we decided not to manage these two aspects of municipal activities (communicating about the platform and choosing a mode of decision), in order not to interfere with the democratic process in itself. However, we (as the research team) insisted on two points when communicating with the municipalities : (i) the ethical and political duty of taking into account public participation in the final decision; (ii) the need to express clearly, when advertising the project, that participation in contributory data collection gives the possibility to participate in a public deliberation regarding public lightning.

c. Technical description of the SPOT platform (1): access to the platform

The so-labeled SPOT contributory science platform ("*Science participative, obscurité et territoires*"— citizen science, obscurity and territory) was launched on the first of April 2022, and closed on the 30th of June 2022. The homepage of the platform (figure 1) gives a small description of the project, which indicates that inhabitants are invited to participate in a "citizen science program" dedicated to ones' relationships with night. Potential participants are also told that by contributing to data collection, they will be given the possibility to participate in the policy making process regarding public lightning. At this stage, they have the possibility to open a page labeled "Why should I participate?", which gives them access to a 30 lines text explaining more in detail the aim of the project and the architecture of the platform, and notably the modalities of their participation in the policy-making process (as presented in the next section). In particular, this text states clearly that the local executives are engaged towards the "execution" of the final recommendations made by the inhabitants (without specifying the way the expressed preferences will be weighted), "in the limits of their technical and financial feasibility, and of municipalities' engagement towards energy consumption". If they wish to

participate, inhabitants then create an account, and they are clearly told the ethical rules which apply regarding their data, in particular : data are totally anonymized (participants create a pseudo and there is no possibility to identify them behind their contribution); data are stored during 5 years exclusively by the research team; participants can delete their registration at any time; and they can give their consent for being contacted by e-mail by members of the research team. They are also told that anyone (municipality, inhabitants who did not participate...), anytime, can access all participants' contributions (childhood memories, observations, questions, comments, and recommendations) under their pseudonymized or anonymized format.

Figure 1. Homepage of the SPOT online platform for Libourne.

Figure 2. Citizen science protocol, as presented to the participants in the platform.

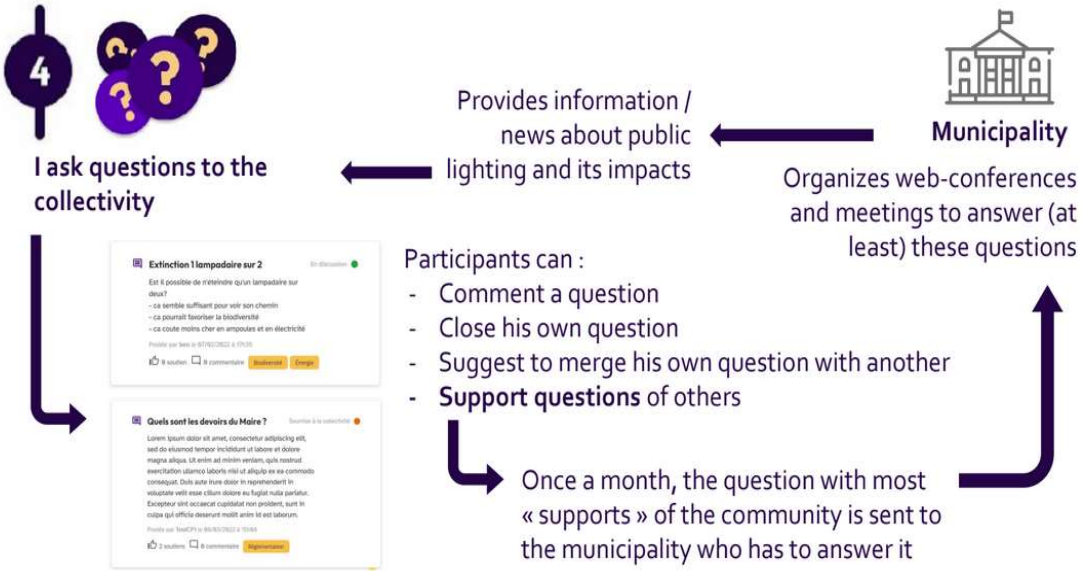

Figure 3. Structure of the modulus designed to share and comments questions to the municipality

d. Technical description of the SPOT platform (2): from contributory science to online deliberation

The architecture of the platform aims to articulate contributory science and online deliberation. To do so, participants access sequentially the contributory science part of the platform, and then, the deliberative space. More precisely, in a first step, participants are invited to follow the protocol presented to them as in figure 2. They then enter a five steps process. First, they can share a childhood memory linked with darkness (this step is not mandatory). Second, they apply a

citizen science protocol which consists in 1/going outside under specific environment conditions to be chosen by the participants; 2/ remaining at the same place for 3 to 5 minutes, and 3/ at home, reporting online notable observations (natural or artificial elements) and filling a form to describe individual perceptions and feelings, as well as photos and recordings. Participants are invited to repeat this experience as many times as they want, under different conditions. They are also invited to synthesize these different observations by qualifying their general experience of darkness.

Once they have contributed at least once, participants can access the deliberative space of the platform. This deliberative space is constituted by three different functions:

- Participants can comment on others' contributions, that is, the data they collected by applying the procole;

- Participants can ask questions to the municipality, or vote to support other participants' questions. They can also comment on others' questions. Every month, the question with most support is selected and answered by local authorities during public webinars. This process is represented in figure 3.

- They can formulate recommendations (and change them at any time) regarding the different dimensions of the regulation of public lighting: places where extinction should apply, seasonality and timeframe of extinction. Participants have also access to the consolidated data from the whole community. Importantly, they can comment and discuss on others' recommendations.

e. Field research

Out of the design and the launch of the platform, we also led two 2 months-field research campaigns in both cities. The first campaigns were led from April to June (before the launch of the platform), and the second ones from July to September (after the beginning of the program). These campaigns were designed to answer three families of questions: 1/What are local governments' motivations to enter this citizen science-based deliberation process? (first campaigns); 2/What are the inhabitants' perceptions of darkness and public lighting? (first campaigns); 3/What are the drivers and obstacles of inhabitants' participation in the SPOT platform? (second campaigns). During the first campaign, we led 36 1h-semi-structured interviews in Melesse, with 8 elected representatives, 5 municipal civil servants, and 22 inhabitants. In Libourne, we conducted 30 semi-structured interviews, with 3 elected representatives, 4 municipal civil servants, and 14 inhabitants from the city. During the second campaign in Melesse, we conducted 16 semi-structured interviews with SPOT's participants, and a questionnaire was circulated among the population, from which we got 155 answers. In Libourne, we conducted 17 semi-

structured interviews with SPOT's participants, and 10 interviews with inhabitants that did not participate in the program.

f. Some elements about the lack of participation in the SPOT project

At the end of the 3-months experiments, SPOT got only 22 participants (that is, inhabitants that have contributed at least once) in Melesse and 22 participants in Libourne. Participation is well balanced in gender (49,1% of men in Melesse, and 41,8% in Libourne), and most of the participants are between 30 and 59 years old (71% in Melesse and 81% in Libourne). To date, the decision-making process is still ongoing, and it is unclear how the municipalities will mobilize citizens' contributions. We will discuss in section 5 the significance of this low participation rate to assess the relevance of our citizen science-based approach on public deliberation. Before that, let us give some elements we may deduce from our qualitative and quantitative data to explain this relatively low level of habitants' engagement in SPOT.

The first dimension we found out is common to most of the participatory approaches, which often face a form of mistrust or indifference from the populations, as shown by Rojon and Pilet (2021) in their comparative analysis of four mini-public initiatives in Europe which were organized to inform decision making on different environmental issues. Furthermore, these authors show that engaged citizens are often part of these sub-groups of the population which are already more concerned about the environment. The data we got from our field studies in Libourne and Melesse confirm this finding. The survey circulated in Melesse after the start of the project (second campaign) shows a significant positive correlation between the participation in SPOT and a pre-existing interest towards the issue of public lighting, measured by the familiarity with the ecological concept of "light pollution" (p-value after Chi2 test=0.001) and "black corridor" (p-value after Chi2 test=0.045). Similarly, participants associate less than non-participants the regulation of public lighting to security issues (p-value=0.002), which suggest that they value its ecological dimension more. Consistently with this last result, participants feel significantly more in security outside at night than non-participants (p-value=0.02). The results from semi-structured interviews also confirm that a certain mistrust towards the initiative and its political outputs might have played a role: "the trust of citizens in democracy is over, mostly for working classes" (*inhabitant of Melesse, 29/06/2022)* ; "[citizen participation] is made for pretending citizens' opinions are considered whereas the decision is already made" (*inhabitant of Melesse, 28/06/2022*).

"[Citizen participation] is good because we can say what we have to say, but at the end we do not have nothing, nothing" (*inhabitant of Libourne, 04/05/2022*). The lack of time was also evoked: "the reason is the lack of time in our societies (...). Democratic activities are not a priority for people" (*inhabitant of Melesse*,

20/06/2022); "I do not have enough time to engage really" (*inhabitant of Libourne, 26/04/2022*).

The second dimension concerns the topic itself — the regulation of public lighting. It appears from the semi-interviews we conducted with inhabitants from Libourne and Melesse (first and second campaign) that public lighting was not yet an important topic for most of the population. In other words, it seems that inhabitants do not consider, at first glance, public lightning as a priority for public policy making. By contrast, inhabitants appear to feel more concerned by the issue of private lightning, for which they have strong pre-existing opinions: "Bank, estate agencies, illuminated at nights, that should not exist"; "I am clearly more bothered by private lightings from shops that by public lighting" *(inhabitants of Melesse, 03/03/2022*); "When I see this shopping center illuminated at night, I get crazy" (*inhabitant of Libourne, 11/04/2022*). The issue of public lighting does not raise such emotion-driven reactions. As expressed by an inhabitant from Melesse, "I do think that for many people [public lighting] is not a matter for debate. Maybe it is the reason why your project is not working a lot" (*28/06/2022*). It is out of the scope of this paper to propose explanations for this relative lack of interest, but two hypotheses can be formulated. First, if the topic of public lighting is not perceived as an important issue by the population as seen as a whole, it is possible that some specific groups feel more concerned — for instance, citizens who may be particularly affected by the security issues linked to darkness, such as women. Second, it is worth noting that the apparent lack of interest for public light regulation is in contradiction with the strong reactions from citizens in case of public lights dysfunctions, as reported by the elected representatives and civil servants from Melesse and Libourne (data from the semi-structured interviews conducted during the first campaign). This remark suggests that the observed disengagement from the topic may be linked to the difficulty of seeing it as a global issue, which goes further than individuals' focus on public lighting at the scale of the street they live in.

The last notable dimension which came out from our field works points to the specific difficulties raised by the use of online tools. First, it is well known (see e.g Bélanger and Carter 2009) that the use of digital information and communication technologies (ICTs) may exclude this part of the population who sometimes define itself as "computer-illiterate" (*inhabitant of Libourne, 25/04/2022*): "Internet is catastrophic for me, I am not interested in using it" (*inhabitant of Melesse*); "It is needed to be friends with computers, and it is very hard for me" (*inhabitant of Libourne, 25/04/2022*). Nevertheless, it has to be noted that people under 30, which are deemed to be more familiar with ICTs, were underrepresented within the participants, which undermines the role of the digital divide as an explanatory factor of the low participation level. Either way, these elements point to the coupling

between the development of online participation tools and the physical presence of municipal agents dedicated to the guidance of the population towards the platforms. Data from semi-structured interviews clearly suggest a need for physical meetings to motivate citizens' participation. As expressed by an inhabitant from Libourne, "this kind of thing should be verbal, people need to talk with a human being" (*04/05/2022*). Yet, field animations with researchers or municipal employees were not planned by the municipal agents. It would have been relevant to organize workshops where the inhabitants could test the protocol in presence of the researchers, and be told about the expected political outputs of the project.

5. CONCLUSIONS

The main objective of this contribution was twofold: defending, in a theoretical manner, the potential role of contributory science (that is, the participatory collect of data guided by a scientific protocol) to foster good-quality deliberation at the local scale; and proposing a concrete implementation of this model into a technical device. This second aspect was realized by collaborating with two municipalities which aimed to implicate citizens in policy-making regarding the regulation of public lightning. The main objective of this collaboration, for the research team, was to illustrate in a concrete case how citizen science-based deliberative processes could be technically implemented. Consequently, the policy aspect of the project (that is, the concrete use of the device to construct public policy and make a decision) was entirely left to the municipalities. Despite this clear task sharing, the low participation rate obtained by the local executive might nevertheless be considered as a potential threat to our approach in itself. However, this interpretation is not supported by the empirical data we obtained from the qualitative and quantitative field work. Indeed, these data point to very classical obstacles, well documented in literature on participation (e.g Rojon and Pilet 2021, Gherghina and Geissel 2019, Bélanger and Carter 2009): the mistrust of indifference from the population; the (ir)relevance of the chosen topics as a matter for public deliberation; and the proper difficulties of using digital tools. It also has to be noted that contributory science, as a method for collecting data, is a robust and well-known method which has proven to be able to attract a lot of participants (Fraisl et al. 2022). In other words, the grounding principles of our approach (the use of citizen science as a support for public deliberation) does not seem to be in itself a reason for the low participation rate. The challenges seem to be rather situated in the choice of a well-suited public policy problem, and in the practical modalities of motivating citizens' participation — in particular, the coupling between the online platform and physical animations. That said, let us note that in the case of SPOT, the specificity of the protocol itself could also explain the relatively weak rate of citizens' engagement. SPOT was designed as a citizen science project in environmental psychology. Consequently, it

was mostly dedicated to the collection of one's feelings and perceptions, rather than objective facts — contrary, for instance, to programs aiming to monitor biodiversity. In our interviews, this required expression of individuals' emotions appears to be quite confusing for some inhabitants of Melesse and Libourne. Citizens might indeed tend to associate science for policy to the collection of precisely measured data from the external world, and do not see the value of individuals' emotions for policy-making. In other words, a citizen science protocol drawing on ecological sciences might have mobilized a larger group of inhabitants[1]. This issue interrogates the role of social sciences for public policies, the way this role is perceived by citizens, and citizens' (lack of) familiarity with the aims and methods of social sciences and humanities research.

Finally, our study calls for more practical implementations of our theoretical and technical propositions, in various contexts, in order to test its background assumption — that is, the hypothesis that engagement in contributory data collection might foster good-quality public deliberations. To do so, it would be possible to treat the data from participants' interactions and recommendations made within a SPOT-like platform (in a case where participation would be important enough) along at least three dimensions. First, it would be interesting to analyze the comments on each others' contributions or recommendations by considering them as online discussion data. It would then be relevant to lead a content analysis and to apply a quality deliberation index, by considering the intensity of individual participation in contributory science (e.g the number of individuals' contributions to data collection) as a relevant explanatory variable for deliberation characteristics. Second, the questions-answers function may provide researchers with important data about the relationships between participation and the raise of a specific interest towards the object of the public policy at stake. Third, the analysis of the recommendations could provide the researchers with data about the degree of polarization of inhabitants' opinions as a function of the intensity of their contributions. Finally, depending on the local executives' political choices, the opening of physical arenas of deliberation could allow interesting comparison between participants and non-participants in contributory data collection in their ability to mobilize deliberation skills. We hope our contribution will motivate the design of such experiments in participation aiming to mobilize citizen science not only as a data collection method, but also as a way to foster public deliberations of policy decisions at the local scale.

[1] We can refer here to an interesting citizen science approach to study the effect of public lightning on biodiversity in various german cities: https://www.tatort-strassenbeleuchtung.de/beteiligte-projektgebiete/

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