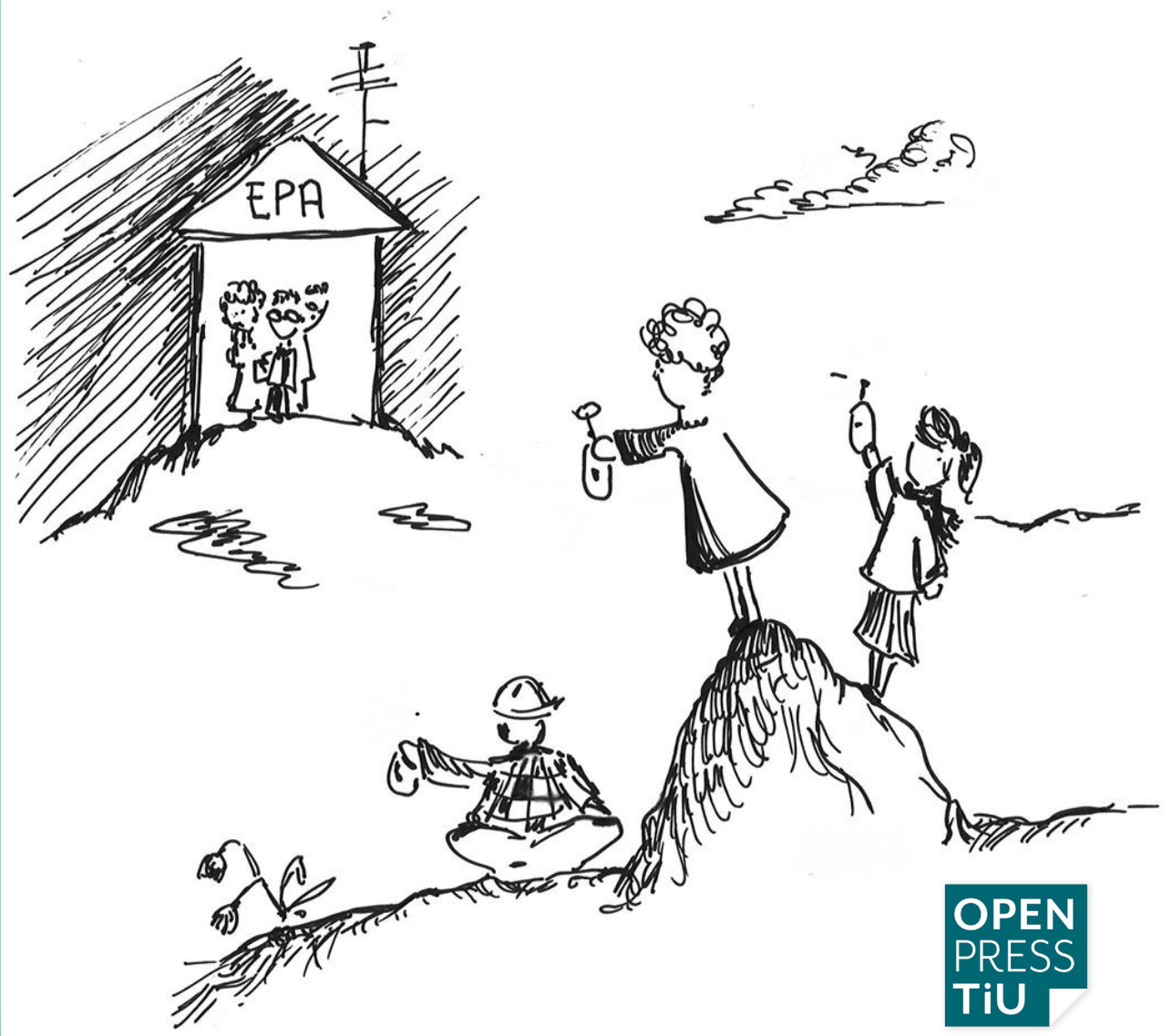
SENSING THE RISK

A CASE FOR INTEGRATING CITIZEN SENSING INTO RISK GOVERNANCE

ANNA BERTI SUMAN



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A case for integrating citizen sensing into risk governance

by Anna Berti Suman

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To Samantha Adams,
who guided and inspired the beginning of this journey but could not see its end.

Preface

Credit: ph. L. Dematteis, Ecuador, Amazon Rainforest.

Grassroots-driven environmental monitoring ('citizen sensing') could substantially influence and contribute to environmental risk governance. The passion for environmental protection that accompanied my adult life pushed me to wonder why, despite this potential, citizen sensing is rarely called upon over controversial risk matters. As a true believer in the power of an active citizenship for the management of environmental issues, I decided to engage in this research and to address it to citizen sensing communities, but also to potentially interested institutions. In particular, this booklet speaks to citizens that wish to have their citizen-sensed data used for policy- and decision-making, and to policy-makers that wish to consider such data in their decisions, as well as to researchers in the field. When I entered the field, I soon realized that research on the institutional integration of citizen sensing was still in its infancy, especially in terms of empirically-based studies and of studies from an (environmental) law perspective. Furthermore, the existing academic and grey literature on citizen science rarely embraced the idea of combining the elements of risk and the grassroots-driven monitoring to wonder avenues for having the latter contribute to institutional risk governance. In current (scholarly and civic) discourses revolving around risk governance and citizen sensing, an integration framework for structurally including citizen sensing into risk governance has never been developed so far. *"Sensing the risk. A case for integrating citizen sensing into risk governance"* aims at filling this knowledge gap, offering an accessible 'toolbox' for interested communities, policy-makers and researchers to navigate this complex arena.

Summary

'Citizen sensing', framed as grassroots-driven monitoring initiatives based on sensor technology, is increasingly entering the debate on environmental risk governance. When lay people distrust official information or just want to fill data gaps, they may resort to sensors and data infrastructures to visualize, monitor and report risks caused by environmental factors to public health. Although through a possible initial conflict, citizen sensing may ultimately have the potential to contribute to institutional risk governance. The practice brings the promise to make risk governance more transparent and accountable. Whereas studies on broader citizen science and on citizen sensing often focus on the learning gains for the participants, this research rather explores the potential for the sensing citizens to concretely influence risk governance and complement it by means of integration. Building on previous empirical research based on a combination of methods, including ethnographical research, descriptive analysis and fuzzy-set Qualitative Comparative Analysis (Berti Suman 2021, *"The policy uptake of citizen sensing"*, Edward Elgar), this contribution offers an accessible 'toolbox' for interested communities, policy-makers and researchers that wish to shape citizen sensing initiatives in a way to contribute to risk governance. The identification of a 'dilemma of integration' deriving from the incompatibility of integration with strongly community-led projects will serve as a warning on the complexity of this process.

Keywords: citizen sensing; environmental citizen science; risk governance; public participation.

Credit: ph. NPS, U.S., Rocky Mountain National Park.

Visual Summary

Credit: own drawing, "Sensing citizens in action"

Roadmap

Based on the theoretical and empirical assessment of how technology, the grassroots-drive, the risk element and distrust from the sensing citizens towards the competent institutions influence the policy uptake of citizen sensing (see Berti Suman 2021)

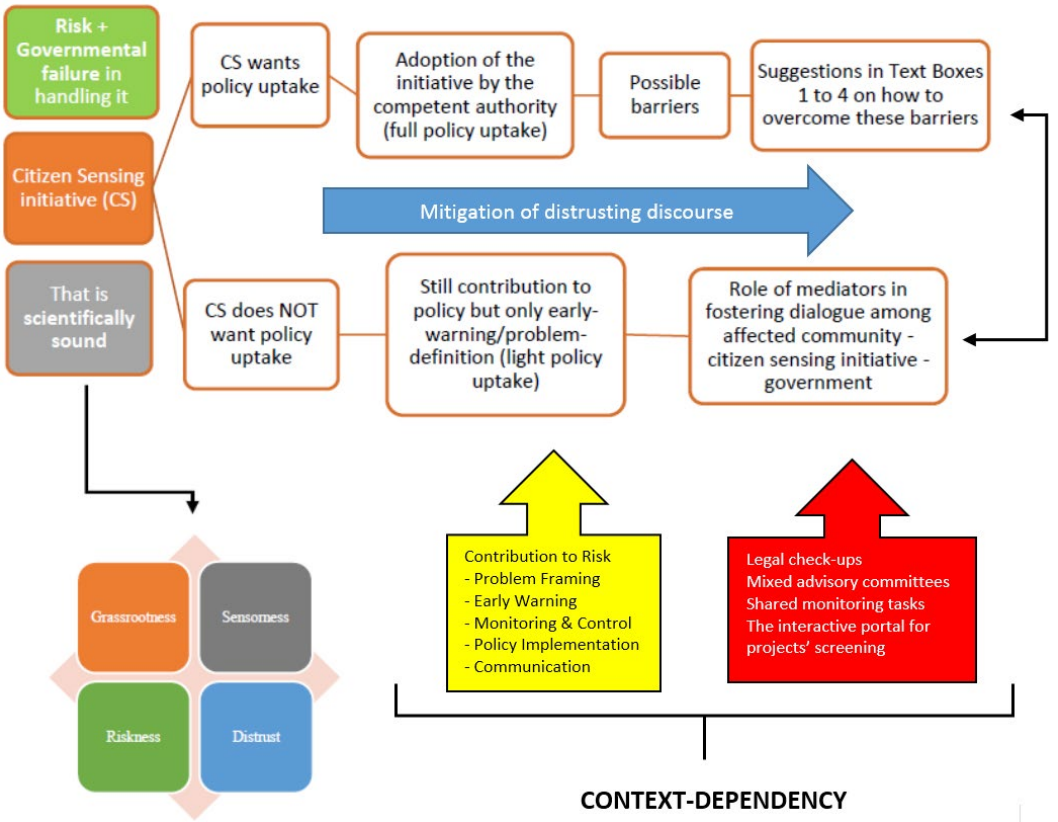
Construction of **the integrative framework** based on the empirical results, complemented with adjacent integrative experiences

Demonstrating that, under certain conditions, citizen sensing can contribute to the governance of environmental risk to public health

But integration can have adverse consequences, for example for the initiative's independence.

Credit: ph. GitHub, "Umarell'.

The integrative framework at a glance



Reference: "Two avenues for an initiative wanting integration or not", taken from Chapter 3 of this booklet.
Note: Text Boxes 1-4 can be found in the main body of text in Chapter 3.


Connected to device 2001
Waiting for a first GPS location
22 CPM
0.063 µSv/h
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SAFECAST

Chapter 1

Chapter 1 - *Introduction*

1. Background: (perceived) failures in risk governance

In a web survey[1] conducted for my doctoral research project,[2] a participant – describing a citizen sensing initiative developed in response to a major environmental disaster and confronted with a question[3] on the actual impact of the initiative – affirmed:

> "[The citizen sensing initiative provided] a meaningful contribution to individuals and to society. There are families who made important decisions about their lives. Those decisions were *fraught with doubt and uncertainty*. [The initiative's] data assuaged some of that. *Governments* too, may not have been comforted by [us] *looking over their shoulder*, but I believe their work was '*adjusted*' because [we] set an example of openness and objectivity" [emphasis added].

This quote captures two crucial aspects of this research: a (perceived) uncertainty over a risk problem and a technology-mediated push by civil society actors for influencing both social and governmental decisions over the risk. *Citizen sensing* captures the response from civil society to the uncertainty of environmental risks to public health, especially when the institutional response is not trusted by the grassroots. The extent to which governmental actors 'adjust'[4] their interventions as a consequence of a citizen sensing initiative through policy and, eventually, regulatory measures is framed as 'the policy uptake of citizen sensing'. In the book "The policy uptake of citizen sensing" (Berti Suman 2021), I explore the factors contributing to what I define as *a meaningful policy uptake* of citizen sensing. A meaningful policy uptake is defined as "the adoption by institutional actors of (some component of) the initiative and/or the performing of policy/regulatory/factual interventions expressly demanded by the initiative or, in any event, stimulated by the initiative". Aware of the complexity of the field, this contribution – hereinafter named as 'booklet' – offers an

1. Available at https://tilburglawschool.eu.qualtrics.com/jfe/form/SV_50e6PvHGAeEKCIB. Accessed March 3, 2020.
2. Doctoral thesis titled "Sensing the risk. In search of the factors contributing to the policy uptake of citizen sensing", defended at Tilburg University, Tilburg 2020, on May 8, 2020. PhD project hosted by the Tilburg Institute for Law, Technology, and Society (TILT), Tilburg Law School, and supervised by Prof. dr. R.E. Leenes, Prof. dr. J.M. Verschuuren and dr. T. Broer. Members of the doctoral committee: Prof. dr. J. Gabrys; Prof. dr. M.L.P. Groenleer; Prof. dr. H.C.O. Renn; dr. F. Sindico; dr. S. Schade and dr. L.E.M. Taylor.
3. The survey question reads: "In your opinion, what impact did [the initiative] have on the way radiation was/is monitored and understood?"
4. Over the booklet, I will be using single quotation marks ('…') to refer to words that are either unusual or used in a context that is not that in which one would expect to find these words. Instead, I will use double quotation marks ("…") to indicate passages taken *verbatim* from a piece written by another author, duly quoted, or for interview/survey's extracts. Italics will be used to stress words in the main text or within quotes. Italics and single quotes will be used to indicate neologisms such as *'Sensorness'*, *'Riskness'* and *'Grassrootness'*.

accessible 'toolbox' that, building on the lessons from previous empirical research, advance a proposal for integrating citizen sensing into risk governance. It does so for interested communities, policy-makers and researchers that wish to shape citizen sensing initiatives in a way to contribute to risk decision-making.

Citizen sensing is here understood as a form of grassroots-driven monitoring initiatives aimed at tracking environmental factors (in alternative or in addition to official governmental monitoring), making use of Information and Communication Technology (ICT), in general, and, in particular, of sensors. I define citizen sensing 'a technology, a social phenomenon and a method' as well as "a form of (environmental) rights in action".

In this booklet, I essentially inquire whether and how citizen sensing can be integrated institutional (environmental) risk governance. Where scientific knowledge is losing *social authority* (Bijker, Bal and Hendriks 2009, 6-7), concerned citizens seem to occupy spaces previously reserved only to scientists. Such "laypersons [...] have skills and insights that in terms of expertise [may] put them *on a par* with established scientists" [emphasis added] (Bijker, Bal and Hendriks 2009, 25). They claim their role in the debate over shared risks also and primarily affecting them, and they do so by *mobilising* citizen sensing technologies to offer an alternative or complementary measure (and framing) of the risk. In doing so, they make use of data infrastructure and data flows "as a critical site of contestation", which Beraldo and Milan (2019, 8) identify as a central feature of the "data activism" phenomenon. Citizen sensing, as a form of *data activism,* can underpin and give rise to "contentious politics of data", which have been framed as "transformative initiatives contesting existing power relations" that are using "data as stakes" or, in other words, as "objects of political struggle" (Beraldo and Milan 2019, 1, 8).

Yet the *active* engagement of laypersons in the monitoring of environmental risks still has to demonstrate, especially in the eyes of policy-makers, its potential to contribute to environmental decisions, law and policies. If on one side it can improve the quality, efficiency and even legitimacy of environmental risk governance enhancing broader society's ability to cope with *uncertain* and *ambiguous* environmental risk, it may also "tear it apart", using the words of Berman (1997, 426), stimulating even more division and distrust. Throughout this booklet, I suggest a proposal for a 'healthy' integration of citizen sensing into risk governance frameworks, when certain conditions are met.

2. Missing perspectives on citizen sensing for environmental risk governance

To date, a vast majority of studies of citizen sensing and broader citizen science focuses, both from a quantitative and from a qualitative perspective, on the potential of the practice for 'engagement', understood as the mobilization of citizens around a matter of concern (Phillips et al. 2019). Other studies emphasize the 'learning' potential for the citizens to become knowledgeable of scientific facts (Becker et al.

2013; Bonney et al. 2014) and to gain new skills (Den Broeder et al. 2017). Nonetheless, research is expanding on the possibility of citizen science (and sensing) to impact on society, on science and *also on policy* (Bonn et al. 2018, 466; Shanley et al. 2019).[5]

Indeed, in recent years, scholars (among which Shanley et al. 2019; Hecker et al. 2018; Schade et al. 2017; and Haklay 2015) provided evidence of the increasing acceptance of citizen science within policy-making and implementation. Nascimento et al. (2018) showed the potential of citizen science to stimulate more *transparency* in policy-making. Bonn et al. (2018) highlighted how citizen science can foster *innovation in* open science, society and *policy*. Research conducted for the European Commission (EC) illustrated the three main pillars of citizen science in the policy cycle, consisting of scientific excellence, citizen engagement and *policy-relevance* (Bio Innovation Service 2018, 18). Making a point for this research, Kullenberg (2015, 70) stressed the need for in-depth case studies of citizen science projects in order to *understand the political implications* of citizen science investigations. Kullenberg, Kasperowski and Mäkitalo (2017), along this line, identified *gaps in research* that need to be filled for enabling policy makers to assess the real potential of citizen science.

In spite of the lively debate that the use of citizen-sensed data[6] for policy has recently triggered in the literature, to date research on citizen sensing at the intersection of (environmental) risk governance and environmental law lacks. Scarce attention has been devoted to the possibility for the sensing citizens to concretely influence and *complement risk governance* and to the *legal grounds* that would justify or allow it. Some studies explored these avenues from the perspective of risk governance (such as GFDRR 2018, where success factors in crowd-sourced geographic information use in government were identified). These studies, however, mostly miss an inquiry into the potential that the citizens-driven monitoring complements or even substitutes institutional risk governance.[7] Furthermore, the majority of the studies on citizen science for environmental risk governance and - also - for environmental justice action stems from the perspective of the United States (U.S.), as they have been mostly stimulated by the active role that the U.S. Environmental Protection Agency (EPA) played in the debate (see for example EPA 2018a and 2018b). Nonetheless, research on the topic from a European standpoint is growing (Haklay and Francis 2018; Mah and Davies 2019).

5. Very recently the *Citizen Science: Theory and Practice Journal* launched an entire special issue dedicated to "Policy Perspectives on Citizen Science and Crowdsourcing". See Shanley et al. 2019.

6. Or the broader concept of 'Citizen-Generated Data' (CGD), currently under discussion in a forthcoming publication by Berti Suman, Schade and Abe on "Exploring legitimization strategies for contested uses of citizen-generated data for policy" accepted in the Journal of Human Rights and the Environment.

7. The interplay between citizen sensing and risk governance has been recently discussed with regards to environmental and public health risk in the (smart) city (Berti Suman 2018b) and in relation to airport-induced noise (Berti Suman 2018a; Berti Suman and Van Geenhuizen 2019).

Lastly, studies on the implications of citizen sensing practices for governmental processes and interventions are scarce to date. Craglia and Shanley (2015, 690), partially along this line, defend the societal and policy benefits of "opening up the bases of decisions by government agencies and private corporations [to contributions from] citizen science". Misuraca and Pasi (2019), more broadly discussing the potential of ICT-enabled social innovation, note that it can constitute *a resource for governments*, supporting the provision of better and more efficient social services and increasing the wellbeing of citizen. Literature on public participation in (local) governmental processes (Michels and De Graaf 2010; Kelty 2017), however, has also highlighted the challenges of interfacing grassroots and institutional actors, and the shortcomings that policy-makers and citizens experience when governments 'adopt' or 'support' citizen initiatives. Instead, scarce attention has been devoted to exploring such experiential outputs in the case of citizen sensing and to the implications that such a study may have for designing and governing participatory processes. This contribution will show that drawbacks of policy adoption exist also for citizen sensing and should be carefully considered when pushing for policy uptake. However, my analysis will also demonstrate that successful (yet very context-dependent) instances of policy adoption are possible, and reflect on the factors underpinning this outcome, in order to guide governmental responses to citizen sensing.

Drawing on risk governance theories and taking (mostly) the perspective of European environmental law and rights, this booklet targets the policy dimension of citizen sensing offering an accessible 'toolkit' for integration, on the blueprint of past experiences such as those developed by the Making Sense project (2018) and by the California Academy of Sciences (2019). It does so situating the practice in scenarios where complex environmental risks affecting public health are at issue, the institutional response is (largely) distrusted by the concerned citizens and this (or a genuine desire to contribute, in less distrusting scenarios) gives rise to citizen sensing initiatives.

3. Filling knowledge gaps: the research design and question

This study aims at answering the question *"How can citizen sensing be integrated in environmental risk governance frameworks?"* by drawing an accessible toolbox for interested actors and communities. The question implies an investigation both on the side of the citizens, i.e. whether and to what extent citizens are directing their 'sensing actions' to policy-makers with the aim of contributing to policy, and on the policy-makers' side, i.e. what makes them receptive to the inputs from the sensing citizens and willing to integrate the practice into institutional risk governance.

In my doctoral project, I empirically research the policy uptake of citizen sensing and the influence of four key factors plus social uptake on this outcome. This booklet conveys the final stage of my doctoral research, where a proposal for a regulatory

framework is developed from these findings, aimed at integrating citizen sensing in institutional risk governance, only if and provided that certain conditions manifest.

The four elements, three of them working as 'preconditions' for an initiative to be considered for the aims of this research, one relevant for the outcome but not indispensable, have been derived from my earlier exploratory empirical analysis of the field and are framed through theoretical concepts extracted from review of the relevant literature. They are translated into 'constructs', which are: '*Grassrootness*', capturing the extent to which the initiative is driven by civil society actors; '*Riskness*', identifying the extent to which the problem that the initiative tackles is serious; '*Sensorness*', representing the extent to which the initiative relies on sound technology, produces valid data and adopts effective data visualization and dissemination strategies; '*Distrust*', expressing the individual and collective distrusting discourse of the initiative towards the authorities competent for managing the risk at issue.[8] The study on the influence of the four elements on policy uptake is complemented by the analysis of an additional element, i.e. the social support ('social uptake') that the initiative receives, which may influence the policy uptake but can also be influenced by the first four elements discussed.[9]

Based on this previously conducted empirical research on the policy uptake of citizen sensing and the influence of selected key factors on this outcome (Berti Suman 2021), I here suggest a regulatory framework for integrating citizen sensing into institutional risk governance, only if and provided that certain conditions manifest. The research underpinning the integrative framework is represented in Figure 1-1 below by the "causal model testing" stage. The integrative framework design occurs after the "critical juncture", that is, when a citizen sensing initiative meets the conditions to be successfully integrated into institutional risk governance.

The *theory of change* in a nutshell is that, under certain conditions, citizen sensing can *complement and contribute to* the governance of environmental risk to public health, both in terms of its efficiency and quality, and in terms of its social legitimacy and accountability. In the advancement of this argument, the most challenging aspect that will emerge is what I will frame as a 'dilemma of integration'.

8. It should be noted that these words used to refer to the constructs are neologisms that I decided to create as existing words (such as *'Riskiness'*) had a different meaning than what I wanted to convey with my constructs. By using neologisms, I could capture and express the meaning that this thesis gives to each construct. I will refer to them in italics to stress their nature of neologisms.

9. See extensively Berti Suman 2021.

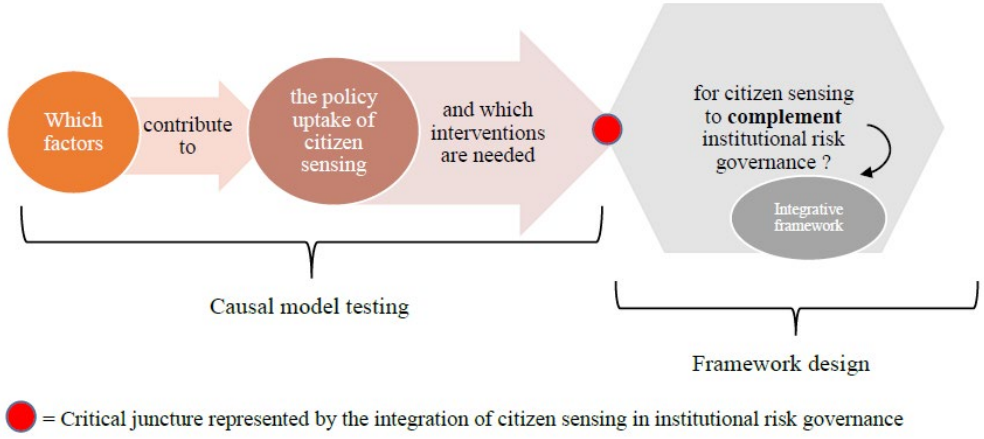

Figure 1-1 - The critical juncture of integration

4. Methodology and methods

While the underpinning research for the framework is mostly empirical, this booklet does not contain directly empirical data, but it does discuss findings from previous empirical research conducted through a *triangulation* of methods. A detailed illustration of the data, methodology and methods adopted, as well as a thorough reflection on ethical considerations associated with the research is available in the methodological section of Berti Suman 2021.

Overall, the data underpinning this research have been collected primarily in the *field* of environmental risks to public health and of citizen science and sensing initiatives responding to these types of risk. The data collection and respective analytical strategies adopted can be summarized as follows:

- *Literature review*[10] aimed at collecting *non-elicited* or *secondary data*[11] from scientific publications (such as academic papers revolving around the topic of citizen sensing; legal, socio-political and STS scholarship on risk governance, environmental justice, co-production and the role of non-expert knowledge in society, which served the construction of the theoretical frame) and grey literature (such as white papers, reports and toolkits produced by citizen

10. Search terms for the literature review included 'citizen science', 'citizen sensing', 'community-based monitoring', 'crowd-sensing', 'participatory science', 'public engagement', 'citizen participation', 'co-production', 'lay knowledge', 'risk governance', 'environmental risk to public health', 'environmental rights', 'environmental justice', 'environmental compliance assurance', 'environmental monitoring', 'sensor technology', 'environmental/health data sharing', 'accountability', 'legitimacy', 'distrust' etc.

11. The dichotomy elicited *versus* non-elicited data used to describe the data sources was inspired by Swanborn (2009, 64, 86).

science and sensing projects, and by the U.S./European Citizen Science Association - (E)CSA and the European Commission - EC on citizen science for environmental policy);

- *Legal review* on environmental law documents from national, international and European Union - EU legislation (such as the Aarhus Convention and the Stockholm Declaration) and on regulatory frameworks for environmental risk governance;
- *Case law review* on relevant jurisprudence dealing with environmental rights, with environmental issues pinpointed by citizen sensing initiatives, and with the use of citizen-sensed data in courts;
- *Secondary analysis* of data files of earlier social research (such as prior case study research performed on existing citizen sensing projects);
- *Text and network analysis* of mass communication messages (such as citizen sensing-related blog posts and newspaper articles), of citizen sensing-related websites, and of email discussions within citizen sensing groups;
- *Qualitative analysis of:*

  (1) *observed spontaneous behaviour in the field*, observed systematically at the AiREAS premises, Eindhoven, The Netherlands; at the Safecast premises, Japan; and at the EC Joint Research Centre (JRC), Ispra, Italy, in addition to occasional observations at thematic workshops and citizen sensing encounters;[12]

  (2) *responses from in depth semi-structured interviews* with key persons in the citizen sensing field and in other relevant fields, such as environmental risk governance and environmental law, and with participants and project leaders of citizen sensing initiatives;

  (3) *responses from (exploratory and targeted) web surveys* with participants and project leaders of citizen sensing initiatives, where the exploratory survey was functional to identify respondents for follow-up in-depth interviews, and the second survey to explore the interplay of variables;
- *Descriptive analysis* of a large-N data set consisting of 503 cases[13] of citizen science for environmental policy developed by the JRC;
- *Targeted fsQCA* on a data set of selected practices extracted from the larger data set (consisting of 45 cases[14] selected in the JRC study out of the 503 cases).

12. Funding for Japan-based field research obtained from Tilburg University Special Data Collection Requests ("BAD") Fund for PhD projects entailing intensive data collection.

13. Data set and metadata available at http://data.jrc.ec.europa.eu/dataset/jrc-citsci-10004. Full inventory available at https://data.jrc.ec.europa.eu/dataset/jrc-citsci-10004. Accessed March 14, 2020.

14. Data set of selected practices available at https://data.jrc.ec.europa.eu/dataset/jrc-citsci-10004. Accessed March 14, 2020.

Data	Source	Sampling Method	Mode of analysis
Secondary data on citizen sensing; legal, socio-political and STS scholarship on risk governance, environmental justice, co-production and the role of non-expert knowledge	Academic and grey literature	Systematic, involving theory-driven search	Literature review
Environmental law from national, international and European Union legislation and regulatory frameworks for environmental risk governance	Public (online) repositories and archives	Purposive, adopting a topic-relevance criterion	Legal review
Case law on environmental matters, especially relevant for citizen sensing initiatives and for the use of citizen-sensed data in courts	Public (online) repositories and archives	Purposive, adopting a topic-relevance criterion	Case law review
Secondary data of earlier social research on citizen sensing projects	Academic and grey literature	Quota sampling to the extent possible, for an overview of the population studied	Case study analysis
Citizen sensing-related mass communication messages, websites, and email discussions	Online platforms and discussion groups	Referral or snowball sampling	Text and network analysis
Spontaneous behaviours in the field of sensing citizens or citizen sensing-related actors and institutions (primary data)	Observations from presence on site	Purposive, adopting a topic-relevance criterion	Qualitative analysis
Responses of key informants in the citizen sensing field/adjacent, and of participants/project leaders of citizen sensing initiatives (primary data)	Data elicited from in depth semi-structured interviews	Purposive, adopting a topic-relevance criterion	Qualitative analysis
Responses of participants and project leaders of citizen sensing initiatives on general information on the project and on key variables (primary data)	Data elicited from (exploratory and targeted) web surveys	Purposive, adopting a topic-relevance criterion	Qualitative analysis
Data set consisting of 503 cases of citizen science for environmental policy developed by the JRC	Public data set	Availability/No sampling (only data set of this kind to date)	Descriptive analysis
Data set of 45 cases selected by the JRC out of the 503 cases of citizen science for environmental policy	Public data set	Availability/No sampling (only data set of this kind to date)	Fuzzy-set Qualitative Comparative Analysis

Table 1-1 - Overview of data, sources, sampling and method of analysis, readapted from Berti Suman 2021

The preceding description and Table 1-1 above illustrate the main data analysed for the overarching research process (including the empirical research conducted for my doctoral project), the data sources, the criteria according to which these data have been selected to be included in the underpinning study (sampling method), and how these data have been analysed throughout the research. This illustrative material is extracted and readapted from Berti Suman 2021. In bold in Table 1-1 are highlighted the materials (secondary data plus some observations) discussed directly in this booklet.

5. The structure of the booklet

The following chapters will be structured along the following lines. *Chapter 2 - Integrating citizen sensing in environmental risk governance*, taking a normative stance, will start with wondering why citizen sensing should be integrated into institutional risk governance in the first place. The argument will be developed on the theoretical framing of citizen sensing as both a 'reference' and a 'resistance' practice. I will set the conditions under which such an integrative outcome should be sought based on evidence from the field. From my earlier empirical insights and the review of literature on integration of citizen sensing into institutional risk governance, I will extract key lessons to build an integrative framework. I will hint to an emerging 'dilemma of integration'.

Chapter 3 - Overcoming challenges towards integration; the framework will first identify and review technical, legal, political and socio-ethical challenges of the integration process. Subsequently, I will move to the design of an integrative framework, envisaging various levels of integration, depending on the needs and on the extent to which the citizens are willing to have their initiative adopted and the policy-makers are ready to cooperate with/integrate the initiative. The framework will also target possible inhibitors and challenges to the integration, and be flexible to context-dependency. As part of the integrative framework, I will outline a proposal for a legal instrument regulating citizen sensing and including a legitimate base for it, eventually to be grounded on a still-under-construction 'right to contribute to environmental information'. I will also advocate for the adoption of specific, targeted measures to remove the outlined barriers, yet bearing in mind the context-dependency aspect. Yet, I will acknowledge the existence of an unavoidable 'dilemma of integration' and make a case for avoiding integration in certain cases.

In *Chapter 4 - Conclusion*, I will summarize the findings of this study and its implications. I will make suggestions for a future research agenda and identify retrospectively some limitations of this research. I also provide a summary of the main recommendations as deriving from my framework in the form of implementable suggestions addressed to citizen sensing communities and to policy-makers.

Through the illustrated flow, this booklet complements the forthcoming book "The policy uptake of citizen sensing" (which wonders under which conditions

community-led citizen sensing can complement risk governance), through policy uptake illustrating which interventions are needed for the practice to result in this contributory outcome. In drawing recommendations for the integration, the booklet meets a threefold goal. First, it addresses designers, founders and participants of citizen sensing initiatives indicating useful or even indispensable 'ingredients' to make their citizen sensing projects capable of influencing policy-making. Second, it speaks to institutions that may benefit from citizen sensing giving them a suggested *structure* to integrate citizen sensing practices in existing risk governance frameworks. Lastly, the booklet is addressed to regulators as it suggests a series of regulatory *interventions*[15] that should be implemented to facilitate the integration and remove barriers to it. It almost goes without saying that the overall discussion can also be of interest for academics and other researchers engaged in studying citizen science and sensing for policy.

6. Aspects deserving preliminary reflections

Some caveats must be made before entering the substance of the booklet. First, at a substantial level, the (qualitative) findings collected in previous empirical research suggest that a preliminary question to be asked when suggesting integrative intervention is whether citizen sensing *should* be structurally integrated in institutional risk governance. In this manuscript, a (non-exhaustive) answer to this question is provided on the basis of two main arguments. First, citizen sensing is an advisable complementation to risk governance *only under certain conditions*. Second, *not all citizen sensing initiatives want to be integrated* in the system and for these types of initiatives *an alternative* to the integrative framework must be conceived. Again, learning from the empirical analysis, this booklet will engage in a work of relativizing the application of the integrative framework by stressing the importance of (hard to capture) contextual factors that may substantially affect the success of the integration itself.

Second, still at a substantial level, using Haklay's terminology (2015, 4), it is worth noting that, whereas the mentioned book "The policy uptake of citizen sensing" concerned "citizen science used in support of public policy", here I engage with a reflection on "policy[16] that facilitates citizen science." In addition to Haklay's work, the recently formed Law and Policy Working Group[17] of the U.S.-based Citizen Science Association (CSA) has also stressed this differentiation, defining its two primary themes as follows: "Using Citizen Science to Influence Law and Policy" and "Laws and Policies that Shape Citizen Science". Focusing on *policy for citizen science* rather than *citizen science for policy,* I here aim at suggesting policy interventions that can stimulate the integration of citizen sensing within risk governance.

15. Here 'regulatory' is intended as an overarching concept including also legal interventions.

16. Including regulatory interventions.

17. See https://www.citizenscience.org/working-groups/law-policy-working-group/. Accessed June 22, 2019.

At a terminological level, I adopt the word 'model'[18] to refer to a set of different citizen sensing initiatives that share specific characteristics that make them apt to contribute to risk governance. A model of a successful citizen sensing initiative for the aims of this research represents *a basic or ideal type of citizen sensing initiative* having certain characteristics that allow it to contribute to environmental risk governance. Such a representation of the (or of an ideal) reality is clearly different from the integrative framework that I will also develop here, which is instead a set of rules guiding the process of integration of citizen sensing into risk governance. The model and the framework are in a relation of *functionality*.

I conceive a risk governance framework, generalizing the definition of the IRGC,[19] as *a guidance delineating the allocation of power and roles* in handling risks involving multiple stakeholders and setting rules, procedures and enforcement mechanisms (all imbued with values) to "frame, assess, evaluate, manage and communicate" risk issues. A risk governance framework is generic and adaptable to the type of risk and organization involved. Timely to the present analysis, the framework suggested by the IRGC comprises four interlinked elements and three cross-cutting aspects: "1. Pre-assessment - Identification and *framing* [of the risk]; [...] 2. Appraisal - Assessing the technical and *perceived* causes and consequences of the risk. [...] 3. Characterisation and evaluation - Making *a judgment* about the risk and the need to manage it. [...] 4. Management - Deciding on and *implementing risk management options*. [...] 5. Cross-cutting aspects - Communicating, *engaging* with stakeholders, considering the *context*" [emphasis added]. In drawing here an integrative framework, I will bear in mind this conceptualization.

As in this research the role of the *perceived* risk is central, I tend to embrace also a definition of framework that includes not only rules but also "ideas, [and] beliefs that [are] used to plan or decide"[20] over the handling of risks. I focus especially on the rules' aspect as the main research question of this booklet aims at identifying policy measures and regulatory interventions facilitating the integration, rather than socio-cultural aspects. Nonetheless, ideas and beliefs are considered in here as long as they play a role in the risk governance system (and its norms), underlying rule formulation, application and revision. Thus, I capture ideas and beliefs both in the legal analysis and in the qualitative empirical analysis, where respondents often referred to ideals and values. Furthermore, when barriers to the integrative framework are discussed, I include in the analysis also barriers that are not strictly legal. I indeed target as well

18. I differentiate between 'framework', which is aimed at providing a set of rules, procedures and mechanisms guiding a certain process, circumscribing a certain reality but *not necessarily representing* it, and 'model', which represents a state or situation.

19. See https://irgc.org/risk-governance/irgc-risk-governance-framework/. Accessed August 21, 2019.

20. Extract from Cambridge Dictionary under 'framework': https://dictionary.cambridge.org/dictionary/english/framework. Accessed July 7, 2019.

political, technical and socio-ethical aspects possibly challenging the framework. Such other barriers are somehow related to the law (as said, the law includes political and socio-ethical considerations) but go also *beyond* it.

Considering the preceding reflection, I can stress another disclaimer with regards to what I mean for 'rules'. Rules here are not understood as only laws (also including rights as recognized by constitutions and international treaties) and regulations but also *political processes* leading to the adoption of a law and those socio-ethical and technical aspects that the law has to deal with. I thus embrace a broad concept of 'law', which seems more appropriate for this booklet's aims, especially considering the research fields (i.e. environmental law and law & technology) in which this research is mainly situated.

As a last terminological caveat, when I use the word 'integrative framework', I will be referring to the building of a regulatory guiding structure that allocates *power and roles* for the integration of citizen sensing into environmental risk governance. I thus adopt *a broad understanding* of regulatory framework including all legally binding instruments set by the authorities within this space, irrespective of their form, and the socio-ethical, political and technical considerations that underpin such instruments. Some of my suggestions will go in the direction of enacting specific laws resembling for instance the U.S. Crowdsourcing and Citizen Science Act;[21] other statements will go in that of introducing new rights such as the 'right to contribute to environmental information'; lastly, other arguments will suggest the issuing of standards-setting (EU) instruments e.g. defining minimum citizen sensing's data quality thresholds for specific policy purposes (either under the form of a Directive, Regulation or Communication).

Overall, this discussion on terminology ties in a broader discourse on the absence of a strict line between what is legal and what is instead non-legal. As a matter of fact, even if by 'legal' one means written rules in binding legal documents, there may still be norms that can/must be interpreted through political, socio-ethical and, in case of new and emerging technologies, also in light of technical considerations. Moreover, one could argue that the 'legal' also includes unwritten rules or customs, where political and socio-ethical aspects play an even more pervasive role in determining the application of the norm. Thus, as a general disclaimer, I acknowledge that by talking of legal interventions, legal barriers etc. I do not mean a sharp division between the worlds of the legal and of the non-legal, but rather a *blurred field* where other than predominantly legal barriers also play an important role. Lastly, when I suggest interventions and then stress the remarks on context-dependency, I am aware of the

21. 15 USC 3724 (2016) - The Crowdsourcing and Citizen Science Act. Available at https://tinyurl.com/y3wa5tur Accessed July 31, 2019.

impossibility to suggest legal measures without taking into account political, socio-ethical and technical contextual factors.

Chapter 2

Chapter 2 - *Integrating citizen sensing in environmental risk governance*

1. Introduction

This chapter paves the way to answer the fundamental question "How can citizen sensing be integrated in environmental[1] risk governance framework(s)?" The discussion looks at the theory *enriched* by the empirical analysis performed during my doctoral research and contained in the book "The policy uptake of citizen sensing" (Berti Suman 2021). I indeed build the framework bearing in mind my earlier findings with regard to those factors, inherent to the citizen sensing initiative, that facilitate policy uptake and those barriers which can obstruct or fully prevent it, on the side of the policy actors. Such findings have been complemented with and juxtaposed to existing theoretical efforts from academic and grey literature that went on the direction of integrating citizen sensing within institutional (risk) governance.

The methodology for the present chapter is mostly based on literature review of existing academic resources and grey literature that share my research aim of integrating citizen sensing within institutional settings. In addition, the chapter includes secondary analysis of my own empirical data, especially with regard to the identified factors facilitating or hindering policy uptake. Lastly, with regards to a specific development, that of the drafting by the European Commission (EC) of guidelines for using citizen science in environmental monitoring, I will discuss some on-site observations.

The next sections are structured in light of this methodology. First, a *model* of citizen sensing cases that has shown to be working in terms of contributing to environmental risk governance is presented. The description of the reality captured in the model serves the work of building a framework which is both *descriptive* of the integrative process and *normative* inasmuch as it adds a value judgment on such a process. I indeed also engage in a discussion on whether this model suggests that citizen sensing can not only challenge but also *complement* institutional risk governance. I will justify my choice to take a normative standpoint in arguing that, if certain conditions are met, citizen sensing *should* be integrated within institutional risk governance. Yet, I acknowledge that an intrinsic conflict may emerge between the challenging and complementing nature of citizen sensing, especially when avenues for integration are analysed. Then, I complement these reflections with lessons extracted from a number of existing toolkits and guidelines similarly aimed at integrating citizen sensing within institutional settings.

1. The word 'environmental' should be intended as implying also institutional governance frameworks addressing human health issues associated with environmental degradation (e.g. air pollution, radioactive contamination etc.).

2. A model of citizen sensing working for environmental risk governance

The analysis of trends across the 500+ data set (Full Inventory - FI) and the 45 selected cases (Selected Practices - SP) contained in the JRC inventory (EC et al. 2018), and of the relative report (Bio Innovation Service 2018) showed how difficult is for an initiative to 'make it' to policy (and to demonstrate it), beyond its intention to do so. Also based on my exploratory and targeted qualitative analyses, I could witness that integrative experiences are currently a minority. Moreover, this minority is predominantly composed of cases in which the initiative served for policy implementation or monitoring purposes, whereas other forms of policy adoption, such as use of the civic data for compliance assurance, are scarce with just a small minority of cases aiming at and succeeding in such an uptake.[2] Other uses, like early-warning or problem definition, are also less frequent. However, I also noted that the JRC inventory's trends might not fully represent the reality of very local policy influences (such as early-warning of local governments on a very localized issue). My earlier inquiry into a local case like the Eindhoven air quality monitoring case, AiREAS,[3] provided some interesting (but casuistic) insights.

Although a minority of initiatives (both from the full inventory and those selected cases for which a more thorough assessment of policy uptake is provided) seemed to have succeeded to achieve policy uptake, the JRC study (Bio Innovation Service 2018) notes that initiatives that from their design are aimed at performing policy implementation or monitoring tasks are more likely to be adopted by competent authorities, as shown in Figure 2-1. However, citizen sensing initiatives frequently start in a *spontaneous* way, mostly driven by events. Consequently, often it is not possible to design beforehand a citizen sensing initiative that will perform tasks that exactly meet policy implementation or monitoring purposes. The message in brief is that, when the launchers of a citizen sensing project can plan and design it 'at the table' and wish to have influence on policy, they should bear in mind that *performing implementation and monitoring tasks enhances the likelihood of policy uptake for the initiative*.

Still linked to the aspect of spontaneity in a citizen sensing initiative's development, from the earlier in-depth case study analysis (especially of the post-Fukushima radiations monitoring case, Safecast [4]), it resulted that policy uptake may indeed *not* be a *targeted* aim of the initiative and may *just* occur informally. It indeed seems happening through reliance on personal connections between some sensing citizens and officials, which I characterized as 'serendipity'. An important aspect of the integrative framework will be that of creating *avenues and spaces* where sensing citizens

2. Yet, future research should further inspect the potential of citizen sensing for compliance assurance purposes.
3. See http://www.aireas.com/. Access August 18, 2020.
4. See https://safecast.org/. Accessed August 20, 2020.

and policy makers can meet each other and initiate a fruitful dialogue. The possible role of mediation techniques and, again, of institutional champions will be called in.

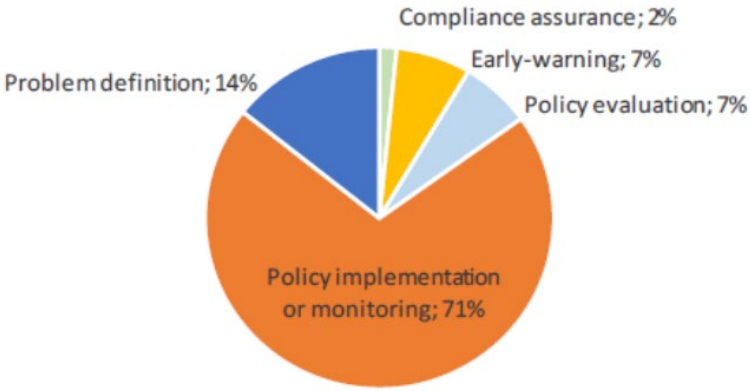

Figure 2-1 - Distribution of types of policy uptake in the JRC inventory (Bio Innovation Service 2018, 44)

Figure 2-1 (Bio Innovation Service 2018, 44) illustrates that the main phase of the policy cycle potentially impacted[5] by the initiative at present is mostly situated in the policy implementation or monitoring domain. Thus, initiatives whose data are apt to be used to "concretize and put into effect laws and political decisions" and to support "the implementation of policies" through monitoring (EC et al. 2018) have a higher potential to be listened or even adopted by policy-makers. This can be paraphrased as initiatives whose data facilitate the transposition of laws and policies *into actions*. For example, in the FI an initiative is said to support policy implementation by "routinely supply[ing] data to local authorities for screening planning applications" (FI, EC et al. 2018). In the SP data set, another initiative's data are said to be "used in some cities by public health agencies to assist decision-making and apply control and remediation actions" (SP, EC et al. 2018). Citizen sensing seems more successful in providing data that can *support* institutional functions by ensuring that laws and policies are applied. The integrative aspect seems key: data are used in support of governmental actions *along with* institutional data.

Another important element to be considered in suggesting an integrative framework is the *different pathways* for policy uptake, especially in terms of the role played by the social uptake. For cases like Safecast, the critical mass created through the initiative (considerable social uptake) managed to attract the attention of institutional players (Brown et al. 2016). In other instances (such as the AiREAS case), policy-makers may

5. Assessed based on information available on project websites, see Berti Suman 2021 for the limitations of this assessment, which is here understood as a 'potential' influence (more a policy intention rather than actual uptake).

be engaged from the beginning in a *structural manner* which ensures policy uptake, but this can occur at the detriment of social support. The initiative thus struggles to scale up and sustain over time. Both identified pathways are successful in terms of meaningful policy uptake, but the second one may not obtain the critical mass needed to 'survive' as the structural cooperation with policy-makers from the beginning may not appear 'inviting' for new participants.

The fsQCA developed during my doctoral research showed that government's engagement from the beginning (initiatives with some forms of governmental support and with low '*Grassrootness*') is favourable to policy uptake. Yet, the data also indicate that these cases have a lower social uptake.

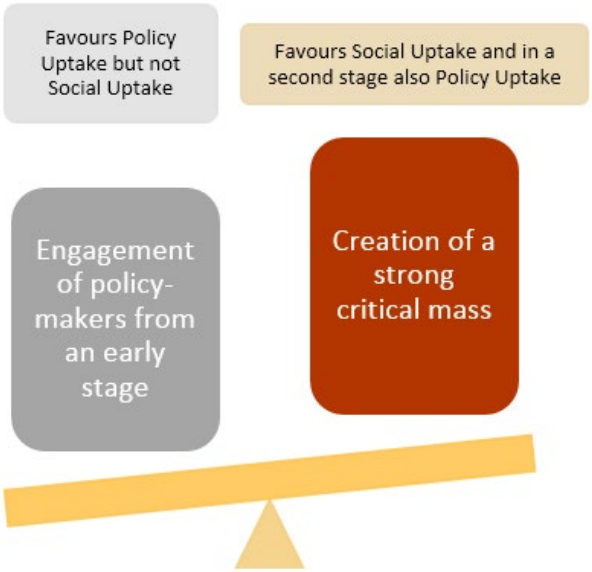

Figure 2-2 - Balancing engagement of governmental actors and critical distance.

A citizen sensing initiative should thus manage to strike a fair balance between engagement of institutional actors and maintaining social support and a critical distance. However, as social uptake seems favouring policy uptake, keeping a critical distance may be the preferable strategy as this seems to favour social uptake which will then stimulate policy uptake (Figure 2-2). Furthermore, having a critical mass that 'survives' the issue, meaning that it remains 'united' in the initiative even when the environmental issue is solved, seems crucial to have communities available to identify and address *future issues* or engage with institutional stakeholders in a *preventive dialogue*.

However, as a general disclaimer, I wish to stress that the object of this booklet is the policy uptake, with the social uptake researched only to the extent functional to policy uptake. Consequently, the empirical analysis I have performed does not

allow me to make recommendations for the social uptake phenomenon, apart from stressing that governmental engagement in the initiative *may* have (unfavourable) consequences on social uptake. This has also been underlined by the JRC study that did analyse social uptake thoroughly (Bio Innovation Service 2018), but from my in-depth case knowledge no clear correlation between policy uptake and lower social uptake emerged. Future research could consider targeting this aspect.

Going deeper into the characteristics inherent to a citizen sensing initiative, the empirical data collected and analysed during my doctoral project and discussed in "The policy uptake of citizen sensing" (Berti Suman 2021) suggest that projects that gain attention of policy makers and motivate them to take action generally share the following characteristics:

- First, almost as a '*condicio sine qua non*', the project relies on *strong technology* and on *effective data visualization/dissemination techniques*; is able to demonstrate to be a reliable, unbiased, recognized source of high quality data, and to meet the data quality requirements needed for a specific policy purpose through reliance on standards, certification mechanisms and clear metadata.
- The initiative responds to a *considerable risk* and manages to clearly communicate that it is responding to a pressing risk, objectively measurable as such, and that the risk at issue is strongly perceived as serious by the affected community, which emerges from people's discourse.
- In addition, the risk (and its perceptions) is increased by governmental failures in addressing it, and the initiative is able to show that it is *filling institutional gaps* (i.e. demonstrating that there is an issue, the government is not addressing it properly, and the citizen sensing project is exactly tackling that problem).
- The project shows to be able to *contribute to different stages of the risk governance cycle* (e.g. prevention/problem-definition/early warning, aftermath, communication, even decontamination if applicable) through factual interventions.
- In addition, a manifest *distrust* discourse of the initiative can eventually 'open the eyes' of policy-makers on a social concern and trigger uptake as well.
- Being *too 'grassroots-driven'* does not facilitate policy-uptake, whereas government's engagement and support to the initiative from the beginning favours it (together with support from Non-Governmental Organizations - NGOs and professional scientists).
- The initiative manages to gain *considerable social uptake* as this favours policy uptake.

Among the cases empirically analysed, the AnalyzeBasilicata initiative,[6] on civic monitoring of oil and other forms of environmental contamination in the South of Italy, which received certification for the quality and reliability of its technologies, data

6. See https://covacontro.org/category/ambiente/#. Accessed August 19, 2020.

and methods, is a good example of a scientifically strong initiative recognized as such. The Safecast case also appears as a great example of an initiative clearly responding to a pressing risk, which managed to demonstrate the objective and perceived extent of the risk beyond its circle of participants, to identify governmental failures and to show contribution to different phases of the risk governance process. A case such as the Tonawanda Coke case,[7] where citizen science was used to demonstrate pollution associated with a coke manufacturing facility, appears as an excellent proof that a distrusting discourse can push policy-makers to act in response to the demands of the sensing citizens, e.g. implementing measures against the polluting company.[8]

Summing up the characteristics above and adding some nuances, I can conclude that a *model of citizen sensing that works for contributing to institutional risk governance* is primarily able to meet the data quality requirements needed for the specific policy purpose to which the initiative aims to contribute. It is preferably capable of showing reliance on standards, mentioning certification mechanisms and referring to formats that are familiar to policy-makers. In addition, it manages to portray itself as neutral and apolitical as possible thus lowering data biases' concerns (see, for example, the Safecast's approach to be 'just an infrastructure'). Lastly, the initiative is able to provide thorough and understandable metadata (e.g. specific details on who gathered the data, with which educational background, when and how, etc.).

On the risk side, the initiative makes policy-makers aware both of the objective and of the subjective extent of the risk, and of the urgency thereof, which is presented as increased by government failures that the initiative aims to mitigate. Such evidence should give policy-makers additional reasons to consider alternative governance approaches and see where, in the risk governance cycle, the initiative could fit.

On the distrust side, an initiative adopting a distrusting discourse (of the citizens towards the competent authorities), particularly pinpointing governmental failures associated with a pressing risk, resulted in being a winning strategy to trigger government's attention. However, distrust leading to the act of cross-checking governmental data should over time become trust towards institutions as the measured discrepancies between the two sets of data are removed (either by both or one side's adjustments). Trust from the citizen and the institutional side is indeed fundamental for a successful integration.

With regards to the grassroots' aspect, as anticipated above, a fair balance between government's cooperation from the beginning and independence is crucial to ensure

7. U.S. District Court, Western District of New York, *The United States of America v. Tonawanda Coke Corporation and Mark L. Kamholz* [2014] No. 1:10-cr-00219-WMS-HKS.More on the case at https://csresources.org/our-history/; https://publicintegrity.org/environment/clean-air-case-yields-rare-criminal-convictions-in-new-york/. Accessed May 6, 2019.

8. For a detailed illustration of the cases, see Berti Suman 2021.

policy-uptake while maintaining social support. Initiatives perceived by institutions as having a strong community drive and 'counter-system' approach are less likely to lead to policy uptake. Support from NGOs and professional scientists appeared also to be beneficial for policy uptake. In terms of social uptake, which I presented in a trade-off relationship with governmental engagement in the initiative, achieving a critical mass (considerable social uptake) is also a fundamental ingredient of an initiative that makes it to policy.

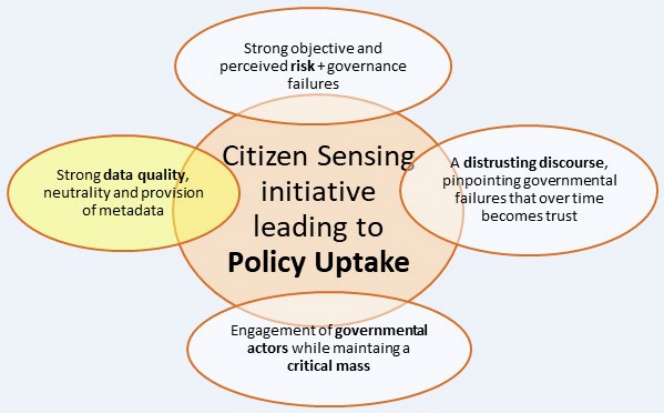

Figure 2-3 - Components of a successful initiative leading to policy uptake.

Figure 2-3 shows the winning 'recipe' for an initiative that wishes to achieve the policy uptake stage. Strong data quality appears in yellow as it resulted to be a '*condicio sine qua non*' (indispensable) for the policy uptake. All the four key elements (plus social uptake), represented as sets, share with the set policy uptake only a minimal part. This illustrative choice is aimed at conveying the inexplicability of *other factors* potentially determinant for the policy uptake, such as organizational and institutional traits, which could not be studied in-depth as variables in this research. In other words, even if a project has all the elements indicated as favourable for policy uptake and meets the data quality condition, it may still not be adopted for policy purposes because of other factors that intervene. Furthermore, a totally different set of elements may still make the initiative succeed in contributing to policy (*equifinality*, in fsQCA terminology), but this research just could not capture all possible pathways.

The working model just outlined has a number of limitations. First, limitations derive from its non-exhaustive nature (leaving out alternative winning ingredients) and its incapacity to capture (key) contextual factors. In addition, it leaves open the question, also raised by Van Oudheusden et al. (2019, 4), "how to engage with grassroots citizen science". Strongly community-driven citizen science will still struggle to be visible to policy-makers and to be *actually* listened. For these types of project, an alternative scenario is presented later on. Yet this analysis of the factors leading to (or better facilitating, as these may be necessary but not sufficient conditions) a meaningful policy uptake is functional to the design of a framework containing guidelines for the crafting of citizen sensing projects that are *influential* on and *contributory* to policy-making. Thus, this effort of defining a working model is mostly addressed to sensing citizens striving for policy influence, whereas the sections that follow will be also addressed to authorities interested in how to handle citizen sensing.

3. Challenging or complementing institutional risk governance? The integration dilemma

This section illustrates how citizen sensing has both the potential to *challenge* and to *complement* institutional risk governance. In light of this consideration, I will discuss later that citizen sensing *should* contribute to risk governance if two premises hold (and many more or different standpoints can be adopted). Yet, I consider appropriate to open the discussion with a reflection on the question: "should citizen sensing contribute to risk governance *by means of integration*?".

Considering the aims of this booklet, i.e. to leverage the contribution of citizen sensing to environmental risk policy, I see the need for an integrative framework to ensure that, if set conditions are present, citizen sensing can be incorporated into risk governance. I enumerated the benefits of citizen sensing for environmental risk policy in Berti Suman 2018a and 2018b, and "in the forthcoming" Berti Suman 2021. Briefly summarizing them, I affirmed that the act of making risk governance more inclusive by *structurally* including citizen sensing in it (if certain conditions are met) could enhance people's *trust* in the system and reduce the perceived need for evidence checking ex-post by the citizens. Furthermore, structural participatory mechanisms could make environmental risk handling a *more transparent and accountable* process. Moreover, citizen sensing can *bring into effect rights* such as the right to live in a healthy environment and to access environmental information. Lastly, citizen sensing essentially needs policy uptake because often the sensing *alone* cannot remove or mitigate risks and still institutional measures are needed.[9] For these reasons, I defend that citizen sensing – when meeting certain conditions – *should* be structurally integrated into risk governance.

This normative claim has been put forward both by the literature and by citizen sensing communities. The U.S. National Research Council (2008, 226), although referring more generally to public participation rather than specifically citizen science or sensing, argued that:

> "Public participation *should* be fully incorporated into environmental assessment and decision-making processes, and it *should* be recognized by government agencies and other organizers of the processes as a *requisite of effective action*, not merely a formal procedural requirement" because it can "lead to better results in terms of environmental quality and other social objectives. It also can enhance *trust* and understanding among parties" [emphasis added].

Along this line, Van Oudheusden et al. (2019, 5) lamented "the lack of a *regulatory framework* for citizen engagement in nuclear safety governance" [emphasis added].

9. However, there is also the possibility that a critical mass and behavioural adaptation substitutes policy uptake.

Quoting Brown,[10] Van Oudheusden et al. (2019, 5) refer to Safecast as a citizen sensing community that "repeatedly called for the establishment of *official guidelines* that allow for *including* citizen groups in monitoring, communication and decision making in order to create a *regulatory risk governance environment* [...] where formal institutions work with citizen scientists in the interest of safety" [emphasis added]. Yet the literature has also acknowledged the challenges of implementing such a normative approach. Van Oudheusden et al. (2019, 5), referring to these regulatory efforts, argue: "it remains to be seen how in such a framework *responsibilities* are apportioned and distributed among actors operating at different institutional levels" [emphasis added], also recalling the definition of governance framework here adopted. Among the first steps to be taken to make integration of citizen sensing in the system possible, Van Oudheusden et al. (2019, 5) suggest that the "*asymmetries* in the relations between formal institutions and citizen science groups" have to be removed and "the value of bringing together various stakeholders to talk with one another to [...] build *mutual trust*" [emphasis added] should be acknowledged (Van Oudheusden et al. 2019, 6). My framework-building effort will take into account this need to pay attention to the allocation of responsibilities and the mitigation of asymmetries in the system.

Despite championing the need for an integrative framework, I still maintain that the 'conflictive element' between citizens and competent authorities (CAs), and a spark of distrust should not be fully eliminated. First, the conflict is a central trigger that makes citizens engage in citizen sensing. In addition, the empirical analysis proved that distrust may facilitate policy uptake. Furthermore, as stressed in the preceding chapters, the act of cross-checking by citizens can render the system healthier because it makes the authorities perceive the 'control' of citizens and may be a stimulus for them to be more transparent. A crucial aspect to keep this element of control is that of ensuring that any integrative framework preserves a certain *independence* of the initiative with regards to policy-makers. Nonetheless, here I am referring to a 'physiologic' conflict, whereas often in cases of environmental crises the conflict is 'pathologic' and the resistance to dialogue and mutual understanding among the actors involved, responsible or affected, just worsens it and prevents the reaching of shared solutions. Also 'unconstructive' conflicts where actors are opposed *a priori*, which means for ideological positions that are considered as divergent even *before* the emergence of the problem, should in my view be removed as 'unhealthy' for the system.

In view of these reflections, and recalling Kullenberg's statements (2015) on citizen sensing as both a resistance and a reference practice, I can conclude that citizen sensing, *in principle*, can *both* challenge *and* complement the institutional system. As a challenging factor, it can still trigger (more) transparency and accountability

10. Blog post by Brown, "Safecast at the IAEA", available at https://safecast.org/2018/10/safecast-at-the-iaea/, accessed on August 1, 2020.

if *properly* integrated within the system. As a complementing factor, it can improve risk response and governance by bringing new data, knowledge and perspectives to institutional actions. In addition, the act of challenging governmental patterns can be regarded *per se* a form of contribution to risk governance acting as an external catalyst for improvement. However, not to sound naïve, I have to acknowledge that a fundamental dilemma emerges (i.e. 'the dilemma of integration'): integration does not come without costs as it could also be at the detriment of independence (and, as illustrated after, of social support). I noted in the previous lines that citizen sensing 'in principle' can both challenge and contribute to risk governance by integration. Yet, this can happen only if proper checks and balance mechanisms are put in place to ensure that a certain independence of the initiative is maintained even when integrated into governmental structures. Risks of co-optation and buy-in may emerge if, for example, the sensing citizens are influenced by policy-makers in deciding how, where and when to conduct their monitoring actions. A first principle for integration could be then framed as follows: "*Integration: yes, but not too much*". In discussing the barriers further on in this booklet, especially the political ones, I will bear in mind this dilemma and suggest measures aimed at ensuring separation of powers and at preventing undesirable influences from the policy side to the involved citizens.

Moving the attention to the premises for integration, I have affirmed that citizen sensing is an advisable complementation to risk governance *only under certain conditions*. These conditions can be summarized in two premises which can be regarded as two other principles for integration (Figure 2-4 below). First, citizen sensing should be integrated only when the environmental risk at issue is not handled properly by the competent authorities (which could be due to lack of resources, political interests, lack of knowledge etc.). In other words, *governmental failures* in environmental risk governance justify the displacement or delegation of some risk governance power and competences to citizen sensing.[11] Of course then the question is: "Who decides that the risk is not handled properly?" Clearly, citizens may have a very different opinion than policy-makers on this point. I suggest that three criteria are used to make a judgement on this aspect. First, *perceived* governmental failures matter (i.e. if a considerable number of citizens, beyond the sensing group, deem the risk not handled properly by the competent institutions, and the initiative responds to this feeling, this is already a proof of a governmental failure). Second, *other institutional and semi-institutional (e.g. NGOs) actors* beyond the competent authority may recognize the failure too. Third, policy uptake can be seen (but different views are equally legitimate) as *an evidence of an admitted governance failure* in handling the risk and openness to do it otherwise.

11. I have reputedly affirmed that this view may well be contested by supporters of participation *per se*, regardless the presence of governmental failures.

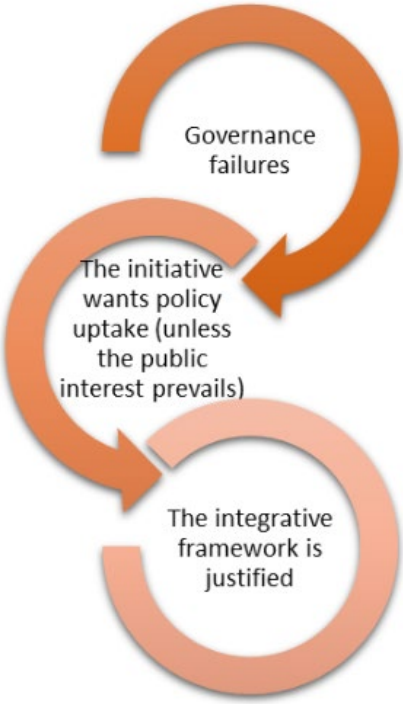

Figure 2-4 - Premises for the integrative framework

In addition to the first premise, I wish to stress that *not all* citizen sensing initiatives want to be integrated in the system. As a matter of fact, in certain contexts and political constellations, the sensing citizens may *not want* the policy uptake as it would not be beneficial for the initiative (loss of credibility vis-à-vis fellow citizens leading to decrease in social support; fear of government's control), which is also another evidence of the 'dilemma of integration'. The integrative framework that I will draw will make sure that consideration is paid to these instances and a solution envisaged, as an *alternative* to integration. In these cases, the need to preserve the '*Grassrootness*' element will prevail on the push for integration. A dilemma here manifests again: essentially, pure grassroots-led initiatives may be *incompatible* with integration.

Despite stressing the principle that integration should occur only if this is what the sensing citizens aim to, I identify an exception to this rule. The principle thus would be: "*Integration only if wanted, unless...*" From the perspective of the citizen sensing community, one could argue that when they do not want policy uptake, this choice should be respected. However, taking into account the political dimension, from the perspective of the public interest, there may be instances where a 'forced policy uptake' against the citizen sensing community's will may be justified and even advisable. For instance, if a citizen sensing project shows data demonstrating that a certain disaster may occur if the competent authority does not take action but the sensing community is not willing to share their data, tools and/or methods with the government, the competent institution may nevertheless have to bypass the civic will and appropriate the citizen sensing's information and/or infrastructure. Another case could be when adoption of a citizen sensing initiative is needed to better protect vulnerable communities exposed to an environmental issue. Even if the sensing citizens (overlapping or not with the vulnerable community) do not want policy uptake, authorities are still obliged to perform their obligation in the best way and may proceed to policy uptake nevertheless, appropriating the citizen-sensed data, tools and/or methods.

4. Integrating citizen sensing within environmental risk governance; learning from examples

4.1. Existing guidelines and toolkits for integrating citizen sensing into policy

4.1.1. *Outline of the discussion*

Over the course of this research, the literature review performed and the exchanges I had with (academic, civic, scientific, policy) experts in the sector allowed me to collect a number of resources that partially shared my integrative goal. Such resources include frameworks, guidelines, recommendations and toolkits that have been produced to answer the inquiry on how citizen science can better *contribute* to policy by being *integrated* in it.

In the following paragraphs, I analyse some of those resources discussing selected aspects that I consider particularly functional 'bricks' to build my integrative framework, in addition to those elements already provided in the previous sections of this chapter. The selection of those aspects has been based on a *thematic analysis* guided by the elements emerged in the previous empirical and theoretical research as crucial for integration. The illustration of selected resources will thus follow the key themes of this booklet: starting from the risk element and the use of citizen sensing for *risk* governance, to citizen sensing's identified key components, i.e. the *'Grassrootsness'*, *'Distrust'* and *'Sensorness'* elements, and their role for policy uptake (Berti Suman 2021). Theory is here selected based on its functionality for integrating the (empirically emerged) model into governance structures. Exactly because of the illustrated functionality of the discussed resources to my framework, I wish to stress that what follows is by no means an exhaustive discussion of the existing resources on integration. For a matter of focus, only the aspects meeting the specificities of my research and following the key themes listed above have been considered. In addition, as every evolving field, resources may have been produced when the literature collection for this research was already concluded.[12]

In view of a balancing of viewpoints, material coming from European institutions and authors have been flanked by material from U.S.-based and Asian experts. Nonetheless, as a methodological disclaimer, I have to acknowledge that a dominant source of inspiration for this chapter is the work of the JRC together with DG Environment on guidelines on citizen science for environmental monitoring (from now on 'JEG', EC 2020).[13] The study, released in July 2020, is titled 'Best Practices in Citizen Science

12. Date set on 15 November 2019.

13. For a matter of focus, only the targeted guidelines have been discussed here but other resources should be considered in future research, such as the JRC Handbook "Science and Evidence in the Policy Ecosystem" (JRC forthcoming) and the just published "Science for Policy Handbook" still by the JRC.

for Environmental Monitoring' - SWD(2020)149 final[14]. This choice is motivated by the primary location of this research (Europe), the opportunity I had to follow closely the work of the JRC as visiting researcher there[15] and, most importantly, the alignment between the JRC aims and this booklet' integrative goal, which made the JRC study on the topic play an important role. For these reasons, before diving into the four key themes relevant for this analysis, I will introduce the approach of the EC towards the integration of citizen science into institutional environmental policy (and the – observed – reactions from concerned stakeholders to it) as I expect the EC to a leading role in shaping this envisaged process of integration.

4.1.2. *The EC standpoint on integration, perceptions among stakeholders*

An analysis of the EC's standpoint on integration is provided here, whereas selected extracts from the JEG will be discussed after, in the thematic analysis. In brief, the EC JRC and DG ENV have been recently very active on the topic,[16] by engaging in a process of consultation of interested stakeholders[17] and in a review of existing regulations and policies in light of understanding the need for amendments and for further interventions to support the integration of citizen science into environmental policy. The JEG present a number of key aspects that are worth stressing. First, the JEG result of intense consultations with a *vast array of stakeholders*. Second, the JEG are considered an *evolving document* as they will be reassessed in 3 years' time. Third, they are especially intended – which is particularly relevant for the accountability aspect of this booklet – to support environmental *compliance assurance* and citizens' complaints handling at the EU level.[18] Fourth, the JEG are also rooted in *experimental*

14. Document available at https://tinyurl.com/y5vt3rlk Policy-related context can be found at (in 'action 8'): https://ec.europa.eu/environment/legal/reporting/fc_actions_en.htm. Accessed September 10, 2020.

15. In order to be allowed to conduct my research on site, I obtained a research visa (under the "Unpaid Visiting Researcher" scheme) covering the period between November 2018 and February 2020. I was at the JRC approximately for a week on a monthly basis and, there, I was inserted in the cluster 'CSData', led by Sven Schade. Specifically, I followed their work on citizen science for environmental policy.

16. See the study 'Citizen Science for environmental policy: Development of an EU-wide inventory and analysis of selected practices' (Bio Innovation Service 2018). Available at https://op.europa.eu/en/publication-detail/-/publication/842b73e3-fc30-11e8-a96d-01aa75ed71a1. Accessed July 26, 2019.

17. For example, the Workshop "Citizens Science and Environmental Monitoring: Benefits and Challenges" on 21 and 22 November at the JRC, Ispra (Italy), to which I took part. See https://digitalearthlab.jrc.ec.europa.eu/activities/citizens-science-and-environmental-monitoring-benefits-and-challenges/57857. Accessed July 26, 2019. Another important gathering has been the fourth formal meeting of the European Environmental Protection Agencies' Interest Group on Citizen Science, organized by the Swiss Federal Office of the Environment in Zurich (Switzerland). The whole process and rounds of consultations are indicated in the document "Roadmap and Consultation Strategy on Action 8 COM(2017)312 final", updated as of June 20, 2019, contained in the Information Package for the Stakeholder Workshop on Citizen Science for Environmental Monitoring, 10 October 2019, Brussels (Belgium).

18. Citizen Science has been recognized as an action point, Action 7, in the EC's communication "EU actions to improve environmental compliance and governance", (COM(2018)10 final), available at https://tinyurl.

work carried out by the JRC on citizen science applications (especially on invasive alien species) and air quality sensors to verify the suitability of civic data to meet the required EU standards. Lastly, the JEG are informed by the experience and expertise on citizen science available 'in-house' at the EC, deriving from the partners of the Environmental Knowledge Community (EKC).[19]

Similarly to my approach, the JEG are addressed to EU policy-makers (within EU institutions), to national and local authorities, to citizen science communities and networks (including NGOs and other partners), and to researchers. The JEG extensively engage in an analysis of the potential and actual value of citizen science for environmental policy and of existing EU initiatives, legislations and bodies/networks supporting it. In addition, the document provides examples of environmental citizen science projects that effectively delivered evidence for policy-making to support institutional environmental monitoring. Among the recommendations contained in the JEG, I will quote in the thematic analysis only a few that are particularly fitting to the integrative aims, together with some relevant insights from the recommendations of the EC study (Bio Innovation Service 2018) on which the JEG are based.

In addition to attending and observing the activities of the stakeholders engaged in the workshop organized by the EC on the inventory of citizen science cases for environmental policy,[20] I also had the opportunity to attend the follow-up stakeholder workshop[21] organized with the aim of advising the EC on the first draft[22] of the JEG. I will share here some overall considerations derived from my engagement with the analysis of the guidelines in view of the workshop and my observations performed in that occasion.

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com/y3sf66b3, and as an action point, Action 8, in the EC's communication "Actions to streamline environmental reporting", (COM(2017)312), available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=COM:2017:312:FIN&rid=2. Accessed July 26, 2019.

19. The EKC is "a collaboration between different services of the European Commission (EC) and the European Environment Agency (EEA) to exploit new ways of creating and exchanging knowledge that is related to environmental policy-making. As part of their work they operate a Knowledge and Innovation Project (KIP) on Citizen Science". See http://digitalearthlab.jrc.ec.europa.eu/networks/environmental-knowledge-community-ekc-citizen-science-kip. Accessed July 26, 2019.

20. Workshop on "Citizen Science and Environmental Monitoring: Benefits and Challenges" on November 21-22, 2018 at the JRC, Ispra, Italy.

21. "Stakeholder workshop on Citizen Science for Environmental Monitoring", on October 10, 2019 at the EC, Brussels, Belgium, organised by DG ENV with the support of the EEA, the JRC and the DG Research and Innovation. The workshop took place in the context of the Commission's 'Action Plan to Streamline Environmental Reporting'. The purpose of the workshop was to collect stakeholders' feedback and input on the recommendations for guidelines on citizen science for environmental monitoring.

22. The draft version (Version 2.7 dating September 26, 2019) has been shared by the EC with the participants of the workshop, and we were asked to contribute to the discussion, putting forward ideas for concrete actions that could be proposed. European Commission. *Citizen Science for Environmental Monitoring - Guidelines*. DRAFT Document Version 2.1 dated 19/06/2019 and Version 2.7 dated 26/09/2019.

First of all, an aspect that I noted as an evolution of the text[23] of the guidelines (also in comparison to the study on the inventory that preceded it)[24] is a growing critical attitude of the EC towards the complexity and possible drawbacks of integration. To exemplify this, I identified three main aspects. First, a topic that emerged in the draft guidelines is that of an "overall complexity" (JEG, EC 2020, 18) of the process, especially with regards to identifying the right linkages to policy of an initiative and meeting the standards demanded by complex monitoring protocols. Another aspect, also particularly relevant for my research, is the insertion of the risk of "conflict of interest" as a challenge to use of citizen science in policy (JEG, EC 2020, 18). The motivation of people to participate in citizen science projects may make the data (at least in the eyes of policy-makers) biased. Yet, the JEG also stress that the citizen science community is coming up with solutions to ensure that research integrity is preserved and proved.

An even greater acknowledgement of this possibly problematic integration is the passage in the JEG (EC 2020, 19) on "possible reluctance to collaborate with governmental institutions". The JEG note that, especially in cases of:

> "*grassroots* citizen science– i.e. activities that are carried out primarily because of the community needs [...] *initiated due to distrust* in governmental decision-making", there is a challenge in recognising results without entering into close collaboration. "The community (or its members) might want that *their data and knowledge is used for better decision making, while maintaining their independence*."

I see how these reflections can have been in part inspired by the discussions I had with the JRC team working on the topic, presenting my research insights on the role of grassroots and of distrust in the scene, and my analysis of a 'dilemma of integration' and of the need to integrate while keeping independence discussed here. Furthermore, I identify in the JEG (EC 2020, 8) the aspect of a "meaningful" contribution to policy by the sensing citizens, which could also lead to changes in the regulatory framework. Especially this link to regulatory interventions seems particularly relevant for my analysis. Lastly, I appreciate the focus on the "gap"-oriented approach adopted by the JEG (EC 2020, 21) which argue that citizen science should be promoted where there is still a gap in scientific evidence for policy-making, similarly to what I also identified as premise for integration.

Aspects that I 'sensed' during the workshop include some general considerations on the team that worked on the draft and some specific notes on the attitude and reactions of the participants. I appreciated that the participants were asked for very 'concrete' input, meaning practical, implementable suggestions, which stimulated

23. I could view a first draft from June 19, 2019, Version: 2.1.

24. See Bio Innovation Service 2018.

a fruitful discussion closer to the *practice* of citizen science and of official or civic environmental monitoring rather than on abstract theoretical reflections. This in my view was also facilitated by the fact that policy-makers and representatives of citizen science communities joined the discussion. I particularly noted an attention for *trust*-building between the two sides. Moreover, it was argued that already discussing with institutions 'what and how to measure' could be a stimulus for trust. Also consideration was paid to *spotting missing voices*, such as very community-driven projects (or projects motivated by reactionary social movements), in line with my arguments.

In addition, I noted an attention not only for 'up-scaling' successful projects but also 'down-scaling', that is, paying attention to keep the project relevant for the *local actors* that engaged in it and their direct needs. Also a need to coordinate projects' indicators to official ones emerged in line with what defended here later in the chapter. In particular, the idea of comparing citizen science's indicators with those of national statistics databases emerged. An interesting debate on terminology suggested that it may be wiser to refer to 'initiatives' rather than 'projects' as this can better capture the idea of longer span and the evolving nature of the actions of each specific citizen sensing collective. Another relevant remark regarded instead the need to differentiate between normal and crisis scenarios: in the first case, there can be more time for a planned integration and a discussion on standards and interoperability, whereas in the second other strategies for integration and priorities should be considered.

Trends also emerged *in contrast* with my findings and views expressed here. For example, according to some participants, it will be harder to overcome scientists' scepticism towards citizen science practices rather than policy-makers' resistance. A suggestion that I will here problematize for the risk of 'capture' was that of having citizen science participants seconded to a policy institution to observe its works and learn from it. This, however, can be advisable for more institutionalized/NGOs-driven citizen sensing initiatives, Another trend which quite contrasted what I have argued here was that of exploring the market-side of citizen science, e.g. conceiving projects (if the participants wish so) as small 'start-ups' and promoting venues for the initiative to encounter the market. I consider it also problematic for a risk I envisage of market-capture.

4.1.3. *Citizen sensing for risk governance*

Citizen sensing within Millstone and the IRGC models

During my doctoral research, I identified and described four risk governance models based on Millstone's classification (2010). I also discussed critiques and developments of such models, taking as reference the work of the IRGC (2005) and of Renn, Klinke and van Asselt (2011). Here these resources become useful to verify how the model of citizen sensing initiatives described in Figure 2-3 can fit the Millstone's model that I identified in my doctoral thesis as more apt to embrace citizen sensing,

that is, the so-called 'co-dynamic model' (Millstone 2010, 8-9). This model could be the one closer to include a contribution from lay people, for the importance it gives to societal values behind scientific and technical considerations, and as it stresses that experts and policy-makers must legitimate their choices on these societal values. The evolution that I suggested to the co-dynamic model (in fact, no direct input from lay people is envisaged by Millstone) is that also *citizen* scientists (and, more specifically, *sensing citizens*) could contribute to provide input to *accountable* policy-makers that are in charge of implementing risk-related decisions. In addition, the need for more *integrative* models mirrored in the IRGC's updated model (IRGC 2005) is acknowledged in my framework. The revised IRGC's model is characterized by two elements, *communication* and *stakeholder involvement* (Renn, Klinke and van Asselt 2011, 236), that are indeed key to the integrative proposal of this booklet.[25]

Drawing on the IRGC's model and the model as revised by Renn, Klinke and van Asselt (2011, 237), I can affirm that citizen sensing can contribute to the following aspects of the risk governance cycle. First, it can contribute to 'pre-assessment' of the risk problem and specifically to the 'early warning' on the risk (consideration which will be particularly timely for designing the integrative framework), possibly addressing governance failures. Second, it can support the 'risk appraisal' phase by bringing in data about risk perceptions and social concerns (eventually mitigating the distrusting discourse). Lastly, citizen sensing could improve risk management by facilitating 'monitoring and control' interventions (again, relevant for the integrative framework). Furthermore, citizen sensing might enhance and support 'risk communication', which can also contribute to mitigate the distrust element. In addition, my framework responds to the need, stressed by Renn, Klinke and van Asselt (2011, 237) of a risk governance model embracing "formal and *informal* networks that promote *collective risk handling*" [emphasis added]. Overall, the discussed risk governance models, here re-read in light of my subsequent theoretical and empirical analysis, can be particularly enlightening for the integrative framework's design. Yet, as stressed, all these efforts of categorization have the fundamental limitation of oversimplifying and missing the complexity of real social dynamics.

Integration of citizen sensing within the JRC Disaster Risk Management Knowledge Centre

During my visiting research period at the JRC, I also had the occasion to engage in a number of exchanges[26] with experts from the EC Disaster Risk Management Knowledge Centre (DRMKC)[27] within the JRC. The insights that will follow are

25. In my doctoral thesis, I noted that these two elements are relevant because citizen sensing often arises from communication deficits and brings the promise to spread a horizontal and open communication about risks. Moreover, a prerequisite of citizen sensing is exactly (non-professional) stakeholders' involvement.

26. Meetings and feedback sessions took place on March 5, 2019; April 10, 2019; and July 10, 2019 at the JRC premises in Ispra, Italy.

27. The DRMKC "provides a networked approach to the science-policy interface in disaster risk management,

considered particularly helpful to imagine how integration of citizen sensing within an existing risk governance infrastructure may look like. These insights, however, are more relevant for citizen sensing initiatives with a higher risk level (such as Safecast), whereas low risk citizen sensing (such as AiREAS) seems less apt to be integrated in *disaster risk management* frameworks, lacking the disaster element.

The staff from the DRMKC showed significant interest in integrating civic forms of risk monitoring into official risk response strategies. So far, the DRMKC primarily relies on governmental data on risk and emergencies, and makes use of citizens' data only as an additional support to their forecasts. Mostly, they use passive data from Twitter and similar social media and run analyses through artificial intelligence tools. The data are then sent to the EC Emergency Response Coordination Centre (ERCC)[28] through which the EU offers help under the form of information to countries under risk all over the world. In addition, the ERCC is connected worldwide through the Global Disaster Alerting Coordination System (GDACS).[29] The ERCC has a site at the JRC where a data collection centre, a computational centre, and a dissemination centre are hosted. In the future, one can imagine that the ERCC's data collection centre takes a *proactive approach in spotting citizen sensing initiatives* that effectively respond to risk knowledge gaps. These initiatives to be integrated should prove to be *especially trusted* in terms of data quality and reliability, and should show that *gatekeepers* from the initiative itself make sure that only reliable information is published on the platform (as occurs, for example, in Safecast). In addition, the DRMKC currently has a list of platforms considered 'good for warning' (reliable in comparison with official sources) which is constantly updated. To be more visible to the DRMKC, citizen sensing platforms should ensure to be active on existing platforms such as Twitter; use keywords that make them recognizable to tools used by the EC; use an internationally recognized terminology to describe crises (e.g. the Sendai framework); and be visible on existing networks.

The DRMKC team indicated that civic data can play a role in different stages of the risk handling process (which, in the IRGC's model, is summarized as 'Risk Management'): in the *response, recovery, preparedness,* and *adaptation* phases. Currently, civic data from Twitter and similar platforms are mostly used in the response phase and partially in the recovery phase. It is indeed in the immediate deployment or aftermath of a crisis that is most needed to rely also on civic data as less information is available.

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across the Commission, EU Member States and the disaster risk management community within and beyond the EU." See https://drmkc.jrc.ec.europa.eu/. Accessed July 26, 2019.

28. The ERCC is "the heart of the EU Civil Protection Mechanism and coordinates the delivery of assistance to disaster stricken countries". See https://ec.europa.eu/echo/what/civil-protection/emergency-response-coordination-centre-ercc_en. Accessed July 26, 2019.

29. The GDACS is a "cooperation framework between the United Nations, the European Commission and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters". See http://www.gdacs.org/. Accessed July 26, 2019.

However, the team wishes to explore further avenues to use citizen sensing also in 'beyond-disaster situation', i.e. to enhance preparedness and prevention. Some steps in this direction are already ongoing at the DRMKC, for example in terms of flood prevention (creation of a flood activity index based on Twitter data through artificial intelligence powered-text mining methods). In general, the experts stressed that for authorities handling risks, having the chance to rely on a 'ground truth' is particularly beneficial, especially if they are under-resourced and do not have enough capacities.

A gaps' filling, evidence-informed, preventive approach

The JEG suggest that opportunities to connect citizen science data to policy-making processes have to be created by clearly identifying evidence gaps. From there, I extract the suggestion to a *'gaps-oriented matching'* between citizen science projects and institutional informational gaps. Policy instruments should support citizen science projects falling in those areas where these gaps are identified, especially in crisis scenarios characterized by a higher need to use resources efficiently.

Van Oudheusden et al. (2019), referring specifically to disaster scenarios in contexts where scepticism from institutions towards citizens' data is higher, note that the citizens will have to put particular efforts in demonstrating that their data are *filling data gaps* and their claims are *evidence-informed* (Van Oudheusden et al. 2019, 10). An issue however emerges, especially in post-disaster situations and in case of institutional gaps: the pressure that citizen science practitioners may perceive to *not* release the data (Van Oudheusden et al. 2019, 10). Such actors should receive support of peer citizens and scientists to ensure that the information that they hold can be *safely published*. In parallel, it is advised that, in contexts of higher public censorship, risk governors should "demonstrate more accountability and responsibility to the international community by increasing opportunities to [...] collaborate with [international] actors [...] (e.g. international oversight bodies)" (Van Oudheusden et al. 2019, 11). Such international oversight mechanisms should mitigate the risk of censorship for the sensing citizens.

Lastly, a key point is addressed to emergency responders, relief organizations, and public authorities to consider citizen science and sensing *preventively*. It is noted that these stakeholders "should tap into this crowd-sourcing trend [i.e. citizen science/ sensing] *now rather than wait* until an accident occurs [and] develop methods together that *integrate* data and observations from a variety of sources" [emphasis added] (Van Oudheusden et al. 2019, 12). Yet again this suggestion may be easier in words than in facts, although the seriousness of the risk may make it easier for institutions to 'accept' help from the citizens.

4.1.4. *The role of the 'Sensorness' element in the integration*

In previous empirical research (Berti Suman 2021), it emerged that the soundness of the technology used is almost a '*condicio sine qua non*', i.e. an *indispensable* requirement to the policy uptake. Any integrative efforts should thus start from a gate-keeping check which assesses whether the citizen initiative aiming to contribute to a policy process is scientifically sound. In this section, literature suggestions are reviewed to get insights into methods to assure the quality of citizen sensing before even starting its integration. Guidelines, standards and certification mechanisms aimed at demonstrating quality and reliability of both the data, the methods and the technology used by the sensing citizens are explored.

In terms of promoting a *benchmark* for data quality of citizen science, the U.S. Environmental Protection Agency (EPA) played an important role by releasing a Handbook (EPA 2018b),[30] addressed to citizen science projects, providing guidance to citizens engaged in collecting environmental data who want their data to be used in institutional environmental monitoring.[31] The Handbook sets a frame to develop a Quality Assurance Project Plan (QAPP)[32] which can be used, by citizens, to meet the standards needed for the goal sought and, by policy-makers, to check whether the citizens' data meet the quality standards for a specific policy purpose. The Handbook provides templates[33] in the form of a Quality Assurance & Documentation checklist for citizens to properly document the quality of their data.[34]

Such an approach is considered particularly advisable: having *a single, standardized (but adjustable) template for data quality and documentation* of the initiative which is recognized and provided by the competent authority that will then evaluate whether to rely on the initiative. As the sound technology element is crucial for the integration but also the need to provide the data in a way that authorities can *understand* them,

30. Also available online at https://www.epa.gov/citizen-science/handbook-quality-assurance. Accessed July 26, 2019.

31. Currently, I am contributing to enhance the Handbook's outreach by joining the advisory group formed by the Association of Public Health Laboratories, the U.S., in collaboration with the U.S. EPA, to help promote the Handbook among potentially interested communities. In September 2020, the final output of the project will be released titled "Working Together to Improve Environmental Data Quality. A Guide for Governmental Agencies to Support Citizen Science".

32. A QAPP is "a document that explains how organizations ensure, using quality assurance and quality control activities, that the data they collect can be used for its intended purpose" (EPA 2018b, 5).

33. Available at: https://www.epa.gov/sites/production/files/2019-03/documents/508_csqapptemplates3_5_19_mmedits.pdf Accessed 26 July 2019.

34. As sensors may under or overestimate the actual pollutant levels, another way to ensure data quality in citizen science is to *design and apply automatic procedures* [...] to detect data anomalies without human intervention" [emphasis added] (Schade et al. 2019). Artificial intelligence methods can also help validate citizen-sensed data, especially in the field of biodiversity citizen science (Affouard et al. 2017; Servajean et al. 2017; Joly et al. 2016). This aspect cannot be researched in-depth here, but could be the object of future research.

the suggestion of a QAPP will be used for the integrative framework. Especially, it may be worth introducing a similar mechanism also at the EU level, by having European authorities agreeing on a standardized template for quality assurance and documentation, in consultation with e.g. the European Citizen Science Association (ECSA). Among potentially suitable authorities to set this benchmark, I identify the European network of Environmental Protection Agencies (EPAs)[35] or, for its more substantial role on the current European scenario, the European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL)[36] and the EU Environmental Knowledge Community (EKC), the latter currently operating a Knowledge and Innovation Project on Citizen Science.[37]

Another source of inspiration from the literature is the recent "Joint Statement on new opportunities for air quality sensing - lower-cost sensors for public authorities and citizen science initiatives"[38] (Schade et al. 2019). Despite targeting air quality data from citizen science, some of the recommendations can be extended to broader citizen science and sensing. A good suggestion on the authority's side is that to "identify possible *conditions for data use*, such as the requirement of clear information about the quality of the measurements and their source (metadata)" [emphasis added], such metadata including "e.g. measurement accuracy, calibration, methodology used, etc." (Schade et al. 2019, 4-5) but also limitations, uncertainties and possible measurement biases (JEG, EC 2020, 33). A calibration and quality control[39] is considered essential to further proceed into inspecting the possible uses of the sensed data. Such screening should indeed operate as a *preliminary check* for the integration, although "one does not necessarily need data of the highest accuracy,[40] but data of an accuracy that is known, and *sufficient to address a given research question*" [emphasis added] (Schade et al. 2019, 5).

The quality of the citizen-sensed data also depends on the type of participants involved in the monitoring and their background/training. Cigliano et al. (2015, 85)

35. See http://epanet.pbe.eea.europa.eu/. Accessed November 9, 2019.
36. See https://www.impel.eu/. Accessed November 9, 2019.
37. See https://digitalearthlab.jrc.ec.europa.eu/networks/environmental-knowledge-community-ekc-citizen-science-kip. Accessed November 9, 2019.
38. The statement resulted of a discussion on data quality, data interoperability, and data assimilation and calibration in citizen science among a group of 38 organisations from 14 different countries, comprising governmental authorities, network operators, citizen science initiatives, environmental NGOs and academic researchers. I will here quote those recommendations from the statement which proved to be particularly useful to ensure data quality vis-à-vis the integration.
39. Including e.g. assessing measurement range, meteorological condition of the sensor operation, environmental conditions etc.
40. For example, a way to make use of data from citizen sensing that are of recognized lower accuracy is their use in environmental modelling, as input in models or to make comparisons among models (Schade et al. 2019, 6).

suggest that the following considerations should be borne in mind when starting a data collection by citizens:

> "(1) Who has the ability to collect the *kind of data* needed for the project; (2) What kind of *training* is required for accurate data collection; (3) What kind of supervision is necessary for accurate data collection; (4) What *kind of participants* are most effective to engage in this project; (5) What, if any, [...] goals, do you have as a part of your research that might help decide *the ideal participant* to engage?" [emphasis added].

The answers to all these questions, documented in metadata, could also be particularly helpful to orient policy-makers in understanding the extent to which a citizen sensing initiative provide data of a quality that is fit for their purposes. However, these questions sound to me more suitable for more 'top-down' or, at least, very planned forms of citizen sensing.

Once an initiative passed this quality check, the authority should support the initiative with "*guidance and standard operating procedures* for the deployment and calibration of lower-cost sensors in order to increase the data quality delivered by participants" of the sensing initiatives [emphasis added] (Schade et al. 2019, 4). This may entail offering resources, knowledge and training to citizen sensing communities in order to boost their preparedness to perform a certain monitoring task. I will discuss later how this can also be problematic.

Another key element is *comparability* between civic and official data. It is important that the data form the citizen sensing initiative can be compared with data from other sources, such as reference stations, meteorological conditions, models, and emission data (Schade et al. 2019, 5). To this aim, agreeing on guidelines and standards and promoting *interoperability* are essential steps. Interoperability can be stimulated by the set-up of an adequate infrastructure facilitating "re-use and long-term curation of [...] sensing results" (Schade et al. 2019, 5). The European Open Science Cloud (EOSC) could provide such an infrastructure. In addition, open access for cross-checking measurements is deemed essential to promote comparability of official and unofficial data (Schade et al. 2019, 6). Data sharing platforms and open access to resources on data management are also key to enhance data quality and scalability of citizen science projects (JEG, EC 2020).

Other insights come from Strum et al.'s reflections (2017) developed in their study on "principles for mobile apps and platforms development in citizen science". The importance of interoperability is also stressed by the authors. A good point is that also quality assurance procedures, including validation, should be interoperable. A specific point for reuse is made: when writing the code of a citizen sensing initiative, the designers should "keep reusability in mind", basing as much as possible the design on existing standards (Strum et al. 2017, 8). This also facilitates integration as official

actors may be interested in *reusing the app or platform* for different or shifted purposes and it should not be hard for them to readapt the project.[41]

An important note to be added is that interoperability should be implemented on different sides. From a technical perspective, citizen sensing devices should be able to communicate among themselves and their data should be comparable and mixable. From a semantical point of view, the language of citizen sensing projects should be interchangeable (see *infra* on ontologies). From an organizational perspective, an infrastructure should be in place to ensure sharing of citizen science information among (public sector) organizations (such as the INSPIRE[42] infrastructure at the EU level). Lastly, from a legal perspective, interoperability entails harmonization among laws and regulations addressing citizen science. Yet, at present, a unique law or regulation on citizen science is lacking in Europe (in contrast to the U.S. where a Crowdsourcing and Citizen Science Act[43] is in force), thus we cannot speak of a harmonized regulatory framework on citizen science. Further research should target more in-depth the various dimensions of the concept of interoperability and their implications for citizen science.

Standards enhancing interoperability, open access and reuse, and ensuring quality are thus a key component of the integration process.[44] However, *at which level and by whom* such standards should be established? With regards to the level, it seems not desirable that each Member State, for the EU, or each U.S. state has its own standards. Supra- and cross-national organizations such as the EU Network for the Implementation and Enforcement of Environmental Law (IMPEL) and the U.S. EPA could be the appropriate instance to set overall standards for each sector (e.g. air quality citizen science; nuclear radiations' citizen science etc.) but, again, in consultation with organizations like the CSA or ECSA (hereinafter (E)CSA) to ensure community representation. The JEG (EC 2020) too suggests that standardized cross-national quality assurance certification mechanisms are provided in order to reach better harmonization and usability.[45] In relation to the harmonization process, whereas biodiversity citizen science can already count on an established community with agreed standards, it may be harder to reach (EU-wide) harmonized standards for more recent citizen science fields such as waste monitoring.

Ideally, such standards to be agreed upon for citizen science projects should follow and be compatible with general, *internationally agreed standards* for the field of

41. Other very concrete suggestions can be found in the study (Strum et al. 2017).

42. See https://inspire.ec.europa.eu/about-inspire/563. Accessed July 29, 2019.

43. 15 U.S. Code § 3724 (2016) - The Crowdsourcing and Citizen Science Act.

44. Recalling the following sub-section on ontologies, the JEG (EC 2020) recommend that citizen science networks pool information on citizen science projects, tools, and resources in single data repositories that are networked, interoperable, and accessible by multiple interested stakeholders.

45. See *infra* on this topic for a "Citizen Science Quality Assurance Label".

monitoring in which the sensing initiative operates, e.g. ISO standards This way, the greatest interoperability and certification would be attained. Yet, the sensing community may struggle to follow and afford the very specific process necessary to obtain such standards. To balance the need for standards with the grassroots element, a solution could be found in having *mixed certification bodies* including both citizens and authorities, but set-up *ad hoc* for citizen science projects. In order to ensure that policy-makers do not 'impose' standards that may be unbearable for the sensing community, mechanisms of oversight, e.g. with members from the (E)CSA joining the process, are needed. The topic is crucial, yet the question on who should establish such standards could be endless. I will not deal with the matter in-depth here but rather refer to my study (Berti Suman 2019) on *community* versus *scientific standards* for enhancing scientific robustness of citizen science. A considerable push for renovating and reinventing scientific standards, however, has to be acknowledged here as a sign of a conceivable need to give more space and attention to grassroots-defined standards.[46]

Another aspect that has to be stressed here is the importance for authorities to *follow other authorities' experience* in making use of citizen science data. Under this aspect, important lessons come from the JEG (EC 2020) where it is stressed that – when a governmental actor makes use of citizen-sensed data – it should *openly acknowledge and gives credit* to the project.[47] To ensure reference to citizen science contributions there is a need of *traceability* of the data. This is why authorities should develop a strict methodology to trace the use of citizen science along the policy cycle. A suggested way to ensure traceability would be the inclusion of "*persistent identifiers* [...] e.g. Digital Object Identifiers (DOIs) , *in citizen science datasets*" [emphasis added] (JEG, EC 2020, 29). This can also respond to the need of citizen science communities to be made aware of *when their data have been used and in which context*. Indeed, as noted in this and numerous other studies (Bio Innovation Service 2018, 83; Cooper et al. 2014; Hyder et al. 2015), tracing back the use of citizen science data both in science and in policy is particularly challenging.

4.1.5. *Spaces of encounter stimulating mutual trust*

Interestingly, the JEG suggest that *place-based networks of interests* or for collective impact and cooperation (EC 2020, 11, 17) have to be created, focusing on the specific environmental issue of that place and based on people's knowledge and affinity for their home environment. I consider this a good idea to fuel encounters between individuals within institutions and citizen sensing communities, yet again this may be easier in theory than in practice in highly conflictive and distrusting scenarios. Other

46. See for example the approach suggested by the California Academy of Sciences 2019 and the experience of the "Next Generation Science Standards", https://www.nextgenscience.org/. Accessed July 29, 2019.

47. As done for example by The Netherlands National Institute for Public Health and the Environment - RIVM, see https://samenmeten.rivm.nl/dataportaal/. Accessed July 29, 2019.

suggestions worth mentioning, at a higher scale, is the creation of *central portals or interfaces* (but also organizing events) where the authorities (or other end-users) can publicise their data or other knowledge needs and citizen science communities respond (JEG, EC 2020). Concretely, this central portal or interface can be made interactive "by *inviting* citizen science projects to respond with appropriate data and methods" [emphasis added] and thus "match-making[48] data needs with available resources" (Bio Innovation Service 2018, 84). However, here there may be the problem of the 'uninvited' citizen sensing projects that still may want to be heard.

In terms of creating spaces of encounter, establishing communication channels between citizens and institutions seems central. It has been suggested (GFDRR 2018, 34) that "open and clear lines of two-way communication between government and [citizen sensing] communities" are established. This aspect seems crucial especially under emergency scenarios. Citizen sensing initiatives should provide to risk responsible authorities *a contact* of the individual in the sensing project *that will take care of the initiative-authority interface*. Conflicts arising between channels of reporting should be especially avoided as this undermines the meaningful contribution to the emergency. Institutional champions (GFDRR 2018, 9) play a central role in facilitating communication with the citizen sensing initiative. In stimulating communication between staff members and the project's leaders, however, specific attention should be paid to the risk of capture (i.e. that project's leaders are persuaded to stop or shift focus of their monitoring). A *one-channel approach* is advisable to reduce confusion (the authority knows that for that emergency, in that context, it will have to contact that civic organization). Yet, it is also true that multiple channels can strengthen the governmental response and civic actors too may prefer reliance on a variety of initiatives. In these cases, proper management of the different channels should be ensured.

The level at which these communication channels should be established is, as first resort, that of local governments[49] (The National Advisory Council for Environmental Policy and Technology - NACEPT 2018, 30). Cigliano et al. (2015, 83) suggest that "project will be successful [if they manage to] build *trust among and with local stakeholders*. This requires identifying and engaging with *local leaders*" [emphasis added]. Communication at the local level seems a key catalyser of trust. However, not always the local level is the most appropriate. Cigliano et al. (2015, 84) note that projects need to be *at the appropriate scale*.[50] An open discussion on the appropriate level at

48. Another important suggestion (Bio Innovation Service 2018, 84) is that *a system for tracking the contribution* of a specific citizen science initiative to a specific policy development and progress towards its targets should be in place. The data needed or used to make this policy step have to be clearly referenced and the role played by the civic project openly flagged.

49. These local instances are indeed the most suitable to raise awareness about environmental issues and lead environmental protection and education programs dealing with local concerns (NACEPT 2018, 30).

50. The authors note: "A global citizen science program may not be able to focus on specific local or regional

which the problem at issue should be handled seems fundamental. This statement again stresses the relevance of my study (especially) for local authorities.

If clear and trustworthy communication on the side of the citizen sensing initiative is crucial, also on the side of government agencies a clear flow of information and determination of end-goals play a key role.[51] Especially in risk-related communications, both citizens and agencies should make sure to pay "explicit attention to both facts and values" and promote "explicitness about assumptions and uncertainties" (The U.S. National Research Council 2008, 234). All parties must overall commit to "good-faith communication" (The U.S. National Research Council 2008, 230). Yet this good-faith attitude implying a true willingness to cooperate may be easier in words than in practice, as *distrust* from both sides may persist in spite of integration. As realistically distrust cannot be fully eliminated and, as I stressed already, some distrust may be beneficial for the system, one needs to acknowledge that the spaces of encounter may have to cope with unavoidable varying levels of (dis)trust.

Again in terms of creating spaces of encounter, Wyeth et al. (2019, 10260-1262)[52] noted that competent authorities should *adopt a clear 'Citizen Science Strategy',* i.e. "formally embrace citizen science and convey that message throughout their programs" (Wyeth et al. 2019, 10260). The authors also suggest that "agencies should *meet citizen scientists halfway*" [emphasis added] (Wyeth et al. 2019, 10261), meaning that policy-makers should take action to facilitate a flow of information from citizens to authorities and back,[53] possibly in those spaces of encounter discussed above. Wyeth et al. (2019) again stress that citizens should *reach agencies even before they begin their data collection* to really understand what the data needs are. Indeed, early contact can substantially increase the chance of policy uptake (yet this may be problematic for very grassroots-driven project, as discussed later). Lastly Wyeth et al. (2019) suggest that citizen science projects *should learn from other successful cases.* Citizens should try to recreate conditions of fellow projects that have been used for policy purposes. To this aim, spaces of encounters also *within* the citizen science community seem particularly

management regimes without a separate effort. On the flip side, a small community effort may not be helpful for managers operating at the regional level."

51. The U.S. National Research Council (2008, 227) suggests that, when governments engage in environmental public participation, "they should do so with clarity of purpose, a commitment to use the process to inform their actions, [and] to self-assessment and learning from experience."

52. A more extensive discussion of the publication is contained in Berti Suman 2021.

53. From Wyeth et al. (2019, 10261): "Agencies might, for example: establish clear procedures and platforms for submitting information, provide guidance on research design, provide guidance on what kinds of data will be considered acceptable for different potential uses, develop protocols for making use of data that do not comport with normal agency requirements, but which can be informative or may provide value in interpreting official data, and analyse and, if possible, develop protocols for crowdsourcing to recognize that data from large numbers of lower-cost devices may provide highly reliable conclusions even if the individual devices are not approved for regulatory use."

useful. In these spaces of encounters, also experts and researches on citizen science and sensing may be welcomed as a supporting expertise (Wyeth et al. 2019).

4.1.6. *Preserving the 'Grassrootness' component in the integration*

Remarkably, the JEG (EC 2020) encourage policy-makers to *spot and support community-led citizen science projects*. The preparatory EC study (Bio Innovation Service 2018, 85) along these lines suggest to governments to "develop a [comprehensive] database of bottom-up/community led projects [...] as well as [to promote] policy to increase their visibility and connections, and possibly their number". This recommendation was also voiced in the U.S. context (NACEPT 2016, 19), where it has been stressed the need for "prioritizing better support for grassroots and community-based partnerships in EPA grant-funding strategies." Yet, as these projects may *not want* financial means from authorities or forms of integration, this recommendation needs to be problematized and an 'alternative' to integration envisaged, to cope with the integration dilemma.

In terms of prioritizing the grassroots' component in the integration, useful resources can be found in the literature. Within the citizen sensing community, notable has been the approach adopted by the city of Bristol, in cooperation with Knowle West Media Centre (KWMC) and Ideas for Change, working on urban participatory sensing applied to shared (environmental) issues. A method, *the Bristol Approach,*[54] was defined (KWMC 2015).

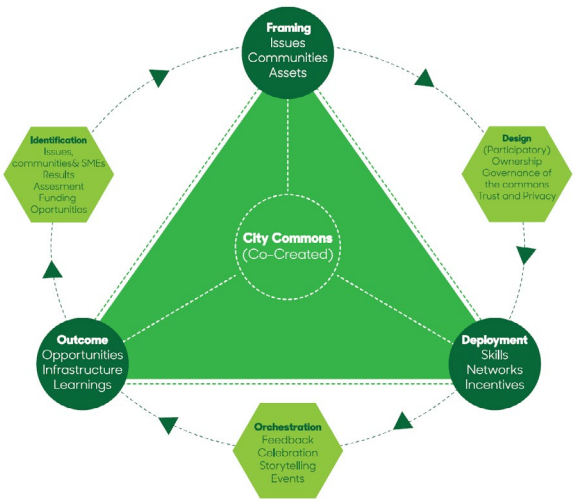


Figure 2-5 - The Bristol Approach (KWMC 2015, 5)

Remarkably, Bristol city council was involved from the beginning in supporting these initiatives. Despite not explicitly contemplating the case of emergencies, the Bristol approach could be extended to risk instances too.[55] The Bristol Approach suggests that the initiative should be '*issue-driven*': it must address issues that are *relevant to the citizens*. In addition, the approach is strongly *community-driven* as the participants with their expectations and aims play a leading role in the "*framing, deployment and outcome*" of the sensing project

54. See https://www.bristolapproach.org/. Accessed July 29, 2019.

55. Notably, in the document describing the Bristol Approach (KWMC 2015), the case of Safecast is mentioned as an example of a form of participatory sensing that led to the creation of a 'commons' (open radiation maps) and that clearly responded to an issue

through "*identification, design and orchestration*" of the monitoring actions (KWMC 2015, 3) [emphasis added], but all with the support of institutional actors. This flow (Figure 2-5) can be of inspiration for designing my integrative framework, although the Bristol Approach takes a more 'institutionalized' perspective.

Still from the sensing literature, and specifically from the field of participatory geographic information system (GIS), Haklay and Francis (2018), discussing participatory GIS and community-based citizen science for environmental justice action, defined a six-stage methodology that can be useful in terms of valorising the community element in the integration. Figure 2-6 illustrates the methodology (to be noted that the stages, presented as serial, should be understood as iterative). An important aspect[56] is the *rooting of the initiative in the local context*. The first stage, 'introduction to existing public information' (aimed to understand what is already available or can be provided by the competent authorities under the Aarhus Convention[57]) and second stage, 'priorities setting', both take place *on the site* where the environmental issue is located and engage the actors exposed to/affected by it (Haklay and Francis 2018, 4). Only from these first two stages a clear idea of what are the data gaps emerge. This way the initiative can target governmental failures rather than replicating efforts. To set the scene for the sensing initiative, it can be of help the '*diagnostic questions*' (Figure 2-7) that the U.S. National Research Council developed (2008, 224). The questions, although addressed more in general to participation in environmental assessment and decision-making, may be helpful in this context for the shared aim of defining the context in which participation will be inserted.

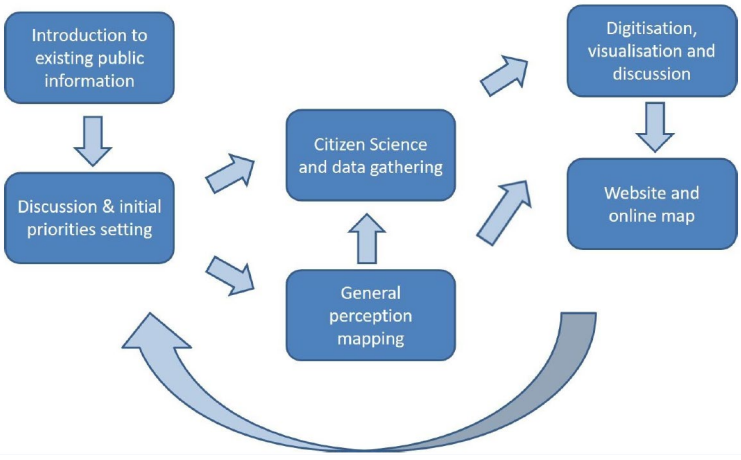


Figure 2-6 - Methodology for participatory mapping and citizen science (Haklay and Francis 2018, 4)

56. In the impossibility to dive deeper into the six stages, only the key points to the building of my framework are here mentioned.

57. Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (25 June 1998) 38 ILM 517, with a Protocol on Pollutant Re-lease and Transfer Registers (21 May 2003) UN Doc. MP.PP/2003/1.

This stage leads to a 'general perception mapping' stage where citizens are engaged in "recording qualitative *local knowledge* that is not about physical features in the area but aspects such as *local history, memories, or feelings* about places" [emphasis added] (Haklay and Francis 2018, 6). The mapping is either functional or parallel to the actual 'citizen science and data gathering stage'. The idea of complementing actual sensing through technology with more qualitative, sentiment- and perception-related information gathering is an excellent suggestion.

BOX 9-1
Diagnostic Questions to Assess the Challenges to Public Participation in a Particular Context

Questions About Scientific Context

1. What information is currently available on the issues? How adequate is available information for giving a clear understanding of the problem? Do the various parties agree about the adequacy of the information?
2. Is the uncertainty associated with the information well characterized, interpretable, and capable of being incorporated into the assessment or decision?
3. Is the information accessible to and interpretable by interested and affected parties?
4. Is the information trustworthy?

Questions About Convening and Implementing Agencies

1. Where is the decision-making authority? Who would implement any agreements reached? Are there multiple forums in which the issues are being or could be debated and decided?
2. Are there legal or regulatory mandates or constraints on the convening agency? What laws or policies need to be considered?

Questions About the Abilities of and Constraints on the Participants

1. Are there interested and affected parties who may have difficulty being adequately represented?
   a. What does the scale of the problem, especially its geographic scale, imply for the range of affected parties?
   b. Are there disparities in the attributes of individual potential participants that may affect the likelihood of participation?
   c. Are there interests that are diffused, unorganized, or difficult to reach?
   d. Are there disparities across groups of participants in terms of their financial, technical, or other resources that may influence participation?
2. What are the differences in values, interests, cultural views, and perspectives among the parties? Are the participants polarized on the issue?
3. Are there substantial disparities across participant groups in their power to influence the process?
4. To what degree can the individuals at the table act for the parties they are assumed to represent?
5. Are there significant problems of trust among the agency, the scientists, and the interested and affected parties?
   a. Are there indications that some participants are likely to proceed insincerely or to breach the rules of the process?
   b. Are some participants concerned that the convening agency will proceed in bad faith?
   c. Do some participants view the scientists as partisan advocates and so mistrust them?

Complementing Figure 2-6, an approach worth inspecting is that of 'community modelling', defined as "a participatory technique enabling local people to use scientific models to track [environmental conditions]".[58] Community modelling is a method "for local people to access the tools used by scientists and authorities to manage environmental problems."[59] Under such an approach, models from environmental science adapted in a way that includes local knowledge are used to influence policy decisions and measures.

Figure 2-7 - Diagnostic questions prior to engage in public participation (The U.S. National Research Council 2008)

These models are adjusted to represent the needs of the local community and then used to solve an environmental issue. The community modelling approach works with *a facilitator* (usually a social scientist, who could play the role of mediator, as mentioned above), *a modeller* in charge of advising the selection of the appropriate

58. Speech by Catharina Landström. University of Oxford, School of Geography and the Environment, "Community Modelling: Reclaiming scientific tools for use by local communities", during the "STS Italia Conference: Technoscience from below", which I attended, June 14-16, 2018, University of Padua, Padua, Italy.

59. Definition from the Community Modelling website, see http://www.communitymodelling.org/. Accessed July 31, 2019.

model, *a natural scientist*, *a partner organization* (a local environmental group that cares both about the specific community and environmental issue) and, of course, *the community* who will engage in community modelling sessions. This approach can be of inspiration in designing the integration.

Still with regards to the grassroots component, an important point is raised by Haklay (2015, 61) who argues: "because of the need for multiple skills to run successful projects, citizen science activities should receive [...] *appropriate long-term funding* to support sustainability" (as also stressed in GFDRR 2018, 32). Funding is fundamental to ensure that integrative efforts are not vain as the integrated project soon ceases its activities due to lack of resources. However, as money streams can enhance the risk of capture from policy-makers, funding mechanisms will have to be agreed with the citizen sensing community itself as they have to be *acceptable and fair* for them.[60]

4.2. Facilitating the integration: the need for an agreement on terminology and ontologies

In Berti Suman 2021, I illustrate the efforts ongoing at the EU level to reach standards in describing citizen science projects. I mentioned the EC COST action 15212's Working Group 5 "Improve data standardization and interoperability".[61] Within this action, efforts are made to present citizen science projects in a homogeneous way, with a view to enhancing its uptake by external actors. As I stressed also in the sub-section on the '*Sensorness*' element, a standardized way to present citizen-sensed data will likely *facilitate adoption* by institutions, as adjusting to ever changing standards and terminology is considered a loss of time and energy, especially from the institutional side. This aspect is thus briefly explored in this sub-section to illustrate how the institutional integration of citizen sensing may start from a shared understanding on key concepts underpinning the practice. When I say 'shared', I refer not only to terminological standards for researchers into citizen sensing, but also to project's designers and policy-makers documenting its uptake. This is considered as essential for integration as a standardized terminology can ensure that when the sensing citizens refer to e.g. 'participant' or 'quality assurance' they mean exactly *the same thing* that researchers and interested authorities *understand.*

The recent "Geneva Declaration on Citizen Science Data and Metadata Standards", issued on June 6, 2018 in occasion of the ECSA summit,[62] set a benchmark on

60. An anti-nuclear citizen sensing initiatives may likely reject finances from a nuclear power company or from the governmental nuclear agency.

61. Working Group's page: https://cs-eu.net/wgs/wg5. The EC COST action is an EU-funded programme promoting interdisciplinary research networks across Europe and beyond. See http://www.cost.eu/. Accessed May 21, 2018.

62. See https://www.cs-eu.net/sites/default/files/media/2018/06/COST-WG5-GenevaDeclaration-Report-2018.pdf. Accessed June 21, 2018.

how to represent data and metadata in citizen science. In my doctoral research, I operationalized my variables following the terminology proposed by the JRC and the dedicated COST Action Working Group.[63] A shared lexicon referring to citizen science should start from *an agreed 'ontology' of the citizen science project*. During my visiting periods at the JRC,[64] I could follow the work of the JRC team on defining an *evolving knowledge base* making use of the categories and attributes used in the EC study on citizen science for environmental policy and the related inventory (Bio Innovation Service 2018). Both the study and the inventory were conceived as a standard-setting proposal aimed at reaching a common vocabulary to refer to components of citizen science projects.

At the moment, the JRC has built a demo platform[65] where data from the inventory (Bio Innovation Service 2018) can be easily explored for multiple purposes.[66] The idea underlying this effort was that, as anticipated above, a standardized terminology would make it easier for policy-makers to understand what a project refers to, especially when it describes certain quality standards. For example, projects should agree on scales and units to document their data quality and communicate reliance on such measures in a harmonized way. This way policy-makers could assess projects that identically refer to certain standards of quality (e.g. 'spatial granularity') with same units of measure, compare these projects and choose the type they need most. The evolution of the knowledge base is to build *a screening system* for policy-makers through which they will be able to search for projects according to their policy needs (*purpose-specific search*). Within such a system, also knowledge from and best practices of citizen science projects could be shared.

63. Yet adjustments had to be performed and, at instances, the JRC categorization did not fit my theoretical design compelling me to deviate from it. For example, I could not follow the JRC's choice of separating environmental health and environmental risk from e.g. noise, air quality and water (quality) which I considered environmental health risk as a whole (although I acknowledge that environmental health can include also epidemiology e.g. hay fever, and environmental risk can include also extreme event e.g. flood). However, for my analysis, I decided to consider environmental risk to public health a genus, and air quality, radiation etc. species. Another example regards the options in the primary category of project (e.g. crowd-sourcing, DIY…). I had to deviate from the JRC's approach to classify them all as included in the broader notion of 'citizen science'. In noted that, for example, crowd-sourcing has been often distinguished from citizen science. Whereas the JRC applied a wider notion of citizen science and then used these categories (e.g. crowd-sourcing, DIY…) to be more specific, I instead decided to separate citizen science from other categories that I consider adjacent typologies but not sub-sets of citizen science.

64. In particular, targeted discussions on the topic took place with two experts involved in this process on March 4 and 5, 2019 at the JRC, Ispra (Italy).

65. See https://ec-jrc.github.io/citsci-explorer/. Accessed September 10, 2020.

66. The demo platform, based on a standardized ontology of the citizen science project, should evolve into a database where information on a project can be found through filters to be applied depending on the specific subject of interest. This central knowledge base is intended as a resource that is inherently interoperable as various layers depending on updates and further developments of projects can be added by individual/group-end users (for example, the QCA analysis performed on the inventory within my research could be added to the knowledge base).

The JRC contributed to the developing of an ontology of citizen science projects with the aim to complement the COST Model realized in the European context and other existing models.[67] During my exchanges with the JRC team working on this 'metadata model' – i.e. a data structure indicating ontologies for how to refer to the project's characteristics in a uniform way – I could study the evolving models and add my own suggestions (Figure 2-8).

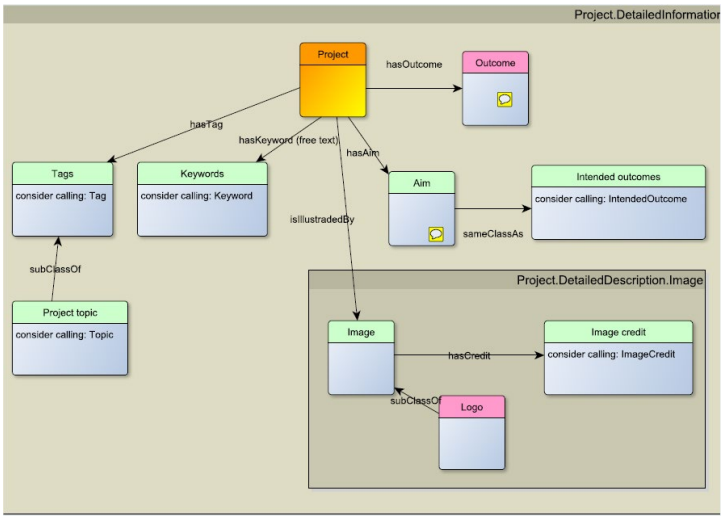


Figure 2-8 - Proposed ontology of a citizen science initiative (readapted from Ceccaroni et al. 2018)

Specifically, I suggested that under "Aim" (marked with a yellow vignette in the figure) or "Project Topic" or "Area of Interest", another box could be added, labelled as "Risk addressed by the project", to inquire whether the initiative aims at targeting a problem which can be framed as *a risk*. This could enable a search for project using the key "projects addressing risks". The risk box could also be filled with information on how serious is the risk. This box could be connected to the "outcome" box (also marked with the yellow vignette) that could be filled with information on whether the risk has been mitigated or removed. The box "outcome" could also be filled with information illustrating eventual forms of *policy uptake*.[68]

I also engaged in a discussion on inserting the element of *grassroots* and *distrust* of the specific citizen sensing group/individual within the part of the ontology on participants, as noted by the yellow vignettes in Figure 2-9. To spot community-driven projects, I indicated the possibility to add filters under "participation tasks", which could be filled with information indicating to what extent the initiative is primarily led by citizens.[69]

67. The JRC model takes inspiration from the model suggested at the U.S./international level by the Data and Metadata Working Group of the U.S. CSA ('Public Participation in Scientific Research – PPSR CORE Data set Metadata Model 2015'). The JRC is also suggesting extensions to this model. In addition, other international actors (such as a representative of the Australian CSA) have submitted extensions for consideration to the PPSR-Core Governance Committee.

68. That is, output in terms of information creating public awareness; information used to inspire policy; information used to launch compliance assurance interventions or to ground investigations in courts and law enforcement actions etc.

69. With questions such as "Do the citizens build their own tools? Do the citizens finance themselves?" etc.

Moreover, within the box "person", I imagined a possible box to be filled with an assessment of distrust, although I acknowledge that the distrust attribute is harder to measure. However, adding to the questionnaire functional to compiling the inventory a question aimed at assessing distrust levels could be conceivable. In alternative, such distrust levels to be indicated in that box could be extracted from statistical data based on the country/region of origin of the project (yet, this measure may be too generalized). The distrust information could be *useful to policy-makers* for having them 'come prepared' to the encounter with the sensing community in the sense that they know they will find confrontational citizens not necessarily open to talk. Yet this could also have the unintended effect of policy makers mostly avoiding projects with high distrust. I consider this an important aspect requiring further research. Also, the JRC recognizes the benefit of assessing distrust at the project/participant's level. However, for time constraints distrust could not be assessed in the study and inventory (Bio Innovation Service 2018). Further developments of the study may go in this direction.

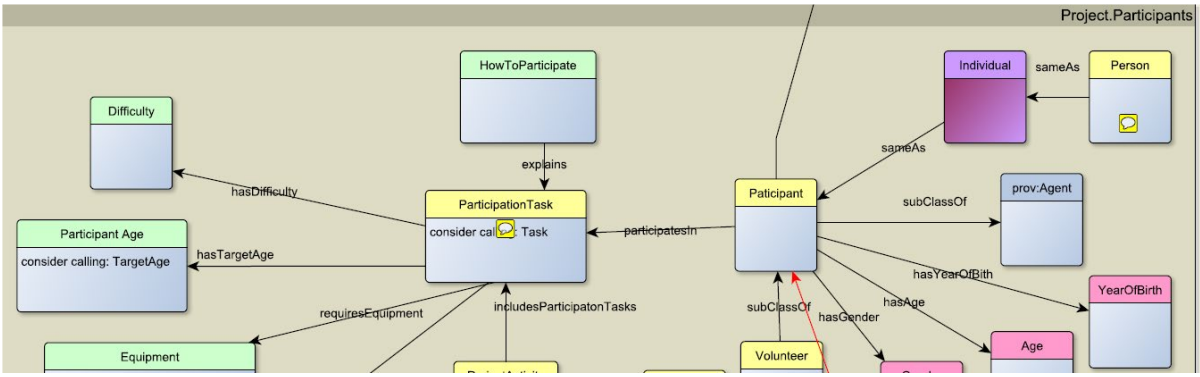
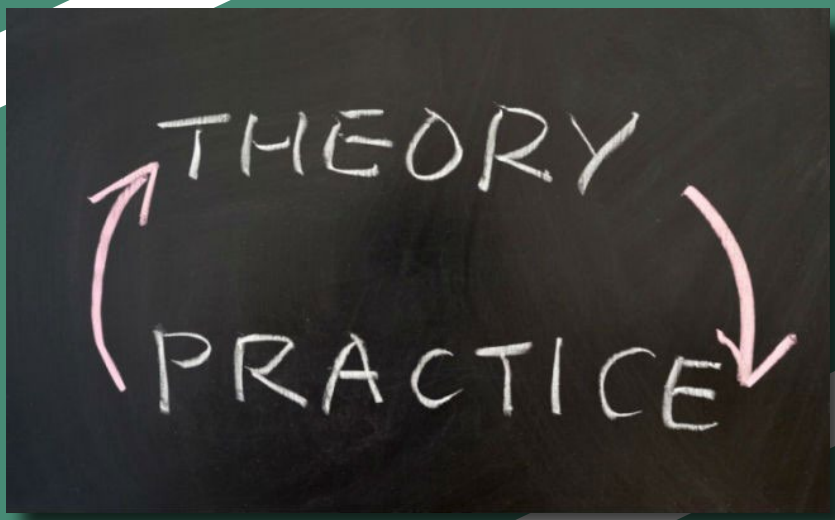


Figure 2-9 - Proposed ontology of a citizen science participant (readapted from Ceccaroni et al. 2018)

This effort of integration of my theoretical frame (illustrated in Figure 2-3 above) within the JRC and other frames is particularly functional to design the integrative framework as my design gets complemented by insights from other theoretical reflections. At the same time, through this work, I suggest to existing frameworks and data structures elements that in my view deserve attention, as resulting from my own research's findings. I indeed argue that future research should inspect how risk and distrust, grassroots elements and forms of policy uptake can be represented in existing metadata models. In addition, the described evolving models could and should be comparable with and take inspiration from analogous modelling in adjacent fields.[70] Aware of these underpinning theoretical reflections supporting and facilitating the

70. See for example the work of De Moor 2017, on a "Community Network Ontology for Participatory Collaboration Mapping", and the work done on environmental modelling by Kanala 2018.

integration of citizen sensing into institutional risk governance, next chapter will first identify challenges to the integration and – from there – develop an integrative framework that takes into account both such reflections and the identified challenges.



Chapter 3

Chapter 3 - *Overcoming challenges towards integration; the framework*

1. Introduction

In my doctoral research and in Berti Suman 2021, I discussed *inhibitors to the policy uptake* (preventing it altogether), and I categorized them as structural, punctual and contextual barriers. These barriers have been analysed as elements hindering the adoption by policy-makers of citizen sensing initiatives, as Figure 3-1 shows. In this chapter, I investigate possible political, legal, technical and socio-ethical *challenges of the integration process*, also in light of the European legal panorama for environmental monitoring and reporting,[1] and of the barriers to policy uptake identified earlier. I then proceed with a proposal for the actual framework and with a discussion on relativity of its application due to context-dependency.

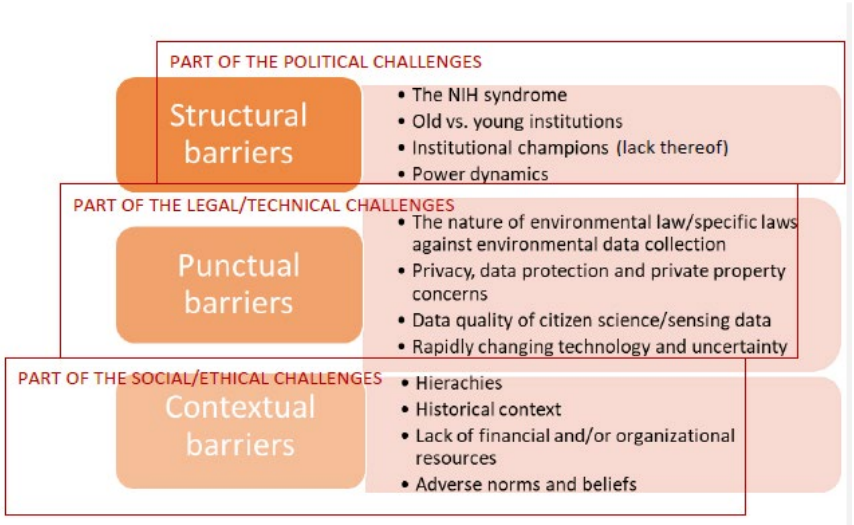


Figure 3-1 - Structural, punctual and contextual barriers to the policy uptake (re-adapted from Berti Suman 2021)

These barriers form part of the obstacles that will have to be removed or that citizen sensing will have to compromise with to obtain a successful integration of the practice into environmental risk governance. However, more barriers to the integration process are identified here, which are not really inhibitors *preventing the uptake* as those discussed in Berti Suman 2021, but rather *challenges* arising once the institution intends to adopt the citizen sensing initiative. The challenges discussed here differ to those discussed in Berti Suman 2021, first, because they regard *the integration process*, not

1. An illustration of this framework is discussed in Berti Suman, A. 2020b. "Citizen sensing from a legal standpoint: legitimizing the practice under the Aarhus framework". *The Journal for European Environmental & Planning Law*.

the policy uptake as such, as they can intervene when uptake has already happened. Second, they are not (only) obstacles but also *opportunities* for improvement. Lastly, whereas an inhibitor stops the uptake process with scarce chance to change that outcome, it is possible to overcome challenges through adaptation strategies.

The structural barriers to policy uptake identified in Berti Suman 2021 can trigger some of the *political challenges to integration* discussed later on in this chapter. It should be noted that – especially the responses to political challenges – can inspire broader reflections on and be a lesson for participatory government and governance, even beyond the narrow application to citizen sensing adopted in this booklet. The punctual barriers are partially *legal* and partially *technical challenges*. The contextual barriers partially belong to *social* and *ethical challenges*.[2]

Overall, the discussion on challenges that will follow is by no means exhaustive. Many more barriers could have been analysed but only a few, more relevant have been selected here for discussion again following the key theoretical aspects (strengthened by the empirical analysis) outlined above, i.e. the risk dimension, the technology dimension, the trust/distrust dimension and the grassroots element. Additional, thorough discussions of challenges from similar or other perspectives can be found in Science Communication Unit, University of the West of England (2013); Brett (2017); Haklay (2018); Bio Innovation Service (2018); the EPA (2018b); Wyeth et al. (2019); Van Oudheusden et al. (2019); the JEG (2020).

Furthermore, in this direction, taking the perspective of the citizen, goes the citizen-addressed 'manual' for environmental citizen monitoring recently released by Harvard Law School, Emmett Environmental Law and Policy Clinic (2019a and 2019b). A relevant contribution to the inquiry, especially on ethical and legal issues associated with citizen science and sensing projects is expected to come from the research work of PANELFIT,[3] a European Commission research project, (also) aimed at facilitating citizens' compliance with EU's regulations regarding ICT-based research and innovation. As part of its mission, PANELFIT will develop a citizens' information pack as a guidance for citizens in addressing ethical and legal issues related to data protection and security.[4]

2. I will not dive again in the discussion of these barriers but the mechanisms suggested here to remove the identified political, legal, technical and socio-ethical challenges or adapt citizen sensing to them should be considered as also targeted to the barriers illustrated in Berti Suman 2021, in a way that makes the two analyses complementary.

3. 'PANELFIT project - Participatory Approaches to a New Ethical and Legal Framework for ICT'. See https://www.panelfit.eu/. Accessed November 12, 2019.

4. Stakeholders' and experts' input for this deliverable was gathered during the Workshop "Creating a citizens' information pack on ethical and legal issues around ICTs: what should be included?" 9-10 March, 2020, Museum für Naturkunde Berlin, Germany, to which I (virtually) contributed. The workshop was organized with the ECSA, COST Action 15212 and the EU-Citizen.Science project. See https://www.panelfit.eu/ and https://cs-eu.net/events/internal/workshop-wg5-creating-citizens%E2%80%99-information-pack-ethical-and-legal-issues-around. Accessed March 15, 2020.

2. Political, legal, technical and socio-ethical challenges of the integration process; proposed strategies

2.1. Political challenges to the integration

Part of the political barriers to the integration can be found in Figure 3-1 above, acting as inhibitors, i.e. gate-keeping elements preventing the adoption itself. To stimulate removal of these first barriers, I stressed the role that institutional champions may play in spotting or responding to a citizen sensing initiative and opening a channel for dialogue (Berti Suman 2021). Also the point highlighted in the previous chapter on creating 'spaces of encounter' between sensing and officials can promote this first exchange in a 'trusted environment'. Yet, to be realistic, I should note that often policy-makers with overload of work might not find time to join these spaces of encounter. An option thus may be to introduce (as done in the Municipality of Koriyama, Fukushima Prefecture, Japan, see Berti Suman 2021) *a member of the personnel in charge of 'community engagement and outreach'*,[5] having the task of spotting fitting sensing projects and the power to leverage for its adoption. However, the institution should be sufficiently resourced to introduce such personnel. Furthermore, resources for identifying relevant policy linkages, especially if complex and indirect, should be promoted, for example by sending *bulletin feeds* to competent authorities spotting suitable sensing projects for specific policy purposes.[6]

Once the institution is convinced of the adoption (not an easy step…), another set of challenges come into play. Among these, worth mentioning are *design and organization*-related barriers (as identified by the JEG, EC 2020, 11). The institution will have to create a stable *network of interest* supporting the initiative which will need *sustained motivation and resources*. This is very difficult in practice as support in terms of dedicated time and financial resources may be limited. I suggest that integration is a *selective process* (integration of only those projects that can be sustained) inquiring beforehand whether such *mid-term/long-term maintenance* for a project can be provided by the institution, to avoid depletion of resources later. As noted by the U.S. National Research Council (2008, 227) "when government agencies engage in public participation processes without careful prior planning, adequate resources, and [...] commitment, the results may fall short of the potential of public participation."

Despite the existence of institutional champions and sufficient resources, resistance from public authorities can come out at any point of the process. Thus, it seems necessary to find mechanisms to not only *demonstrate to the involved policy-makers the benefit of citizen science* to the handling of the specific environmental issue but also *reward* them. A mechanism tracking and rewarding successes of the integration could

5. To be noted that italics in this and the following sections is used to isolate and highlight key suggestions that will form part of the framework and of my recommendations.

6. A similar approach is also suggested by the JEG, EC 2020.

enhance trust in the process from the policy-makers side and increase the incentive to engage in citizen science. For example, authorities successfully engaged in adoption of citizen sensing projects may get from the (E)CSA *rewards* in terms of e.g. visibility through prizes, free training and citizen science kits. Competition and best practices may also be stimulated by introducing *a 'best integration example' challenge* in the citizen sensing-authority interface. In addition, *streams of funding* could be provided e.g. from the Ministry of the Environment to those authorities that managed to solve, mitigate or better handle an environmental issue through citizen science, in order to further support cooperation. However, along with rewarding successful adoptions, an open discussion on limitations, possible conflict of interests, biases and failures should also be stimulated. Furthermore, the risk of financial compensation or other rewards is that money interests rather than true willingness to cooperate will then prevail.

Resistance to citizen sensing can also derive from the fact that such practices may be seen by policy-makers as "inherently confrontational, [when] the community collects information to oppose or challenge local industrial facilities or future plans by local authorities" (Haklay 2015, 58). The 'Not In My Back Yard' and 'Not In My Term of Office' syndromes discussed in Berti Suman 2021 can also pose substantial challenges to the integration. Efforts to foster dialogue even through adoption of *environmental mediation technique* should be undertaken, to show that citizen sensing can be "a potential tool to calm discussions" which can move the debate "to the realm of factual information which can be tested" (Haklay 2015, 58). On this aspect, Reed et al. (2018, S15) provide an analysis worth exploring in future research on *public engagement* (in environmental decision-making) *as a form of mediation.* Exploratory interactions that I had with experts of environmental mediation shared with me a positive attitude with regards to the potential of using citizen sensing as a tool within environmental mediation processes.[7] Also here a system of rewards for officials and institutions that successfully used citizen sensing to deal with the conflict could be promoted.

Overall, *adaptation* to changing policy landscapes seems key for integration. Adapting to changing contexts (and scales) is crucial, as "contextual factors can create difficulties for achieving principles of good [participatory] practice[s]" (The U.S. National Research Council 2008, 230). Furthermore, "upscaling or integrating a successful local initiative to an EU-wide level" can be an opportunity but also a challenge (JEG, EC 2020, 11). Thus, policy-makers dealing with these additional level(s) of coordination/

7. On June 14, 2019, I attended a seminar on *"La mediazione dei conflitti ambientali"* ("The mediation of environmental conflicts") where a project on environmental mediation was presented. The project was launched in 2015 by environmental lawyer Veronica Dini, president of Systasis - Research Centre for the Prevention and the Management of Environmental Conflicts, in cooperation with the Milan Chamber of Arbitration, the University of Milan and other partners. The project is aimed at reopening or opening the channels of communication between all the various stakeholders (businesses, citizens, public administration etc.) involved in an environmental conflict. I engaged in a number of follow-up discussions with Dini and she shared the interest from the project on including citizen sensing as a tool to facilitate the mediation process.

governance will have to *be trained appropriately* (e.g. through free courses offered by the (E)CSA). Understanding *changing priorities* between the local level and the regional/national/pan-European is central to integration.[8]

Especially in high-risk contexts where environmental assessments and decisions have substantial scientific content, citizen sensing should be constantly connected and harmonized with scientific analysis. *Iterative processes between participatory and traditional scientific assessment* have "the greatest chance of being effective in linking participation and scientific analysis. In contrast, processes that treat analysis and deliberation in isolation from each other impede both analysis and deliberation" (The U.S. National Research Council 2008, 233-234). A practical suggestion could be that of *having policy-makers and appointed experts* joining citizen sensing monitoring activities that they will have to consider in their decision-making and having *the sensing citizens* participate in the official monitoring to which the sensing initiative will contribute. This way policy-makers can familiarize with citizen sensing practices and citizens can get acquainted with the way of working of authorities. However, to avoid risk of capture, an oversight from the (E)CSA may be needed.

Lastly, attention should be devoted to *mitigating power unbalances*. As noted by Van Oudheusden et al. (2019, 5), "asymmetries in the relations between formal institutions and citizen science groups" have to be removed. Policy-makers should be ready to renounce some of their power and not expect to 'control' the citizen sensing community. Allocation of responsibilities and power in the integration process should be done in a way that mitigate risks of capture and control from the policy side to the initiative. Clearly, here again the integration dilemma emerges: integration comes at a cost. Yet the cost should be 'reasonable' in the sense that the balance among actors involved from the policy and the civic sides should not mostly tilted in favour of the authority. As the sensing communities may be the 'weaker party' in the discussion, *a stewardship role of the (E)CSA* in checking that the independence of the initiative is respected and that the sensing citizens receive appropriate decisional power is central.

8. Contextual differences include different demography, political environment, social ecosystem, climatic and environmental conditions etc. (JEG, EC 2020).

Suggestions to overcome (some of the) political challenges:

- having dedicated 'community engagement and outreach' officials with the task of spotting citizen initiatives and leveraging for its adoption;
- ensuring that mid/long-term maintenance for a project can be provided by the institution;
- showing to the involved policy-makers the added value of citizen science to the specific environmental issue (e.g. through a mechanism tracking successes; open discussions on failures; reward mechanisms such as prizes);
- fostering dialogue through e.g. environmental mediators showing that citizen sensing can be a tool to calm discussions and reward cases of successful adoption with funding (but adopting appropriate safeguards to avoid prevailing of financial interests);
- constantly identifying evolving policy linkages of the citizen initiative e.g. with bulletins directed to competent authorities and adapting to changing contexts (and scales);
- offering free training e.g. by the (E)CSA to policy-makers dealing with additional level(s) of coordination for scaling up/integrating an initiative into a wider political dimension;
- especially in high-risk contexts, iterative processes between participatory and traditional scientific assessment should be implemented also by having experts and policy-makers joining the sensing activities and having the citizens joining official monitoring with the oversight of the (E)CSA;
- having the (E)CSA playing a stewardship role in checking that the independence of the initiative is maintained and that the sensing citizens retain decisional power.

Text Box 1 - Summary of suggestions to overcome political challenges to the integration

2.2. Legal challenges to the integration

The legal obstacles to policy uptake have been identified in Berti Suman 2021 as either related to the nature of environmental law itself not promoting innovation, or specifically associated with punctual legal provisions (e.g. prohibition of trespass; privacy/data protection concerns etc.) that prevent or make it more problematic to adopt citizen sensing in policy-making. A study from Wyeth et al. (2019) also addressed the topic of legal barriers to citizen science's policy uptake. Although the authors did not find legal provisions to be a major impediment for citizen science, they still noted that *unnecessary legal obstacles have to be removed.* The point is to avoid that laws making special interests prevail on larger public interest (such as in the Wyoming

case of "criminalization" of the citizen scientists[9]) prevent citizen science to be used for the greater good of environmental protection. Differently, reasonable laws raising issue of privacy and trespass, for example, may require an act of balancing of interests and citizen science may have to adjust to it. Citizen scientists could benefit from the *support of (volunteer) legal professionals* helping them to navigate the legislative panorama of the allowed and the forbidden. Such professionals could dedicate some volunteer legal advice through the institution of *law clinics open to citizen sensing communities* (on the blueprint of the Emmett Environmental Law and Policy Clinic[10] and of the CSA Law and Policy Working Group "Ask a Legal Question" tool[11]).

My research cannot provide an analysis of specific laws and regulations posing challenges to citizen sensing due to the country-relativity of the legislative panorama.[12] Here the discussion will be limited to suggesting a response to these barriers, while promoting integration. Inspired by the study of Wyeth et al. (2019), I here suggest two main approaches: the default approach, that is *citizen sensing should comply with existing laws and regulations*, and *the removal of unnecessary obstacles-approach* which means that when a provision is considered irrational and too demanding for citizen sensing (see e.g. the discussion on the Wyoming dispute), removal or adjustments should be considered.

An example of legal barriers that citizen sensing has to face, which can eventually make the integration process more burdensome for policy-makers, is that citizen sensing should comply with the EU's General Data Protection Regulation (GDPR).[13] The regulation applies to those citizen science projects handling personal data, which are the majority of the projects in the health and medical domain (Berti Suman and Pierce 2018). Yet, in this category are also included those projects (researched here) in the environmental health domain requesting to participants to tag specific environmental issues with e.g. location and information on personal health complaints associated with the environmental problem, but also all citizen science projects collecting email addresses, phone numbers or IP addresses of the volunteers. Despite the GDPR

9. As stated in a press release from the non-profit environmental conservation group Western Watersheds Project. See https://www.publicjustice.net/wp-content/uploads/2018/10/Wyoming-Ag-Gag-Victory-Press-Release.pdf. Information about the Western Watersheds Project available at https://www.westernwatersheds.org/about/. Accessed November 6, 2018. Case available at: U.S. Court of Appeals for the Tenth Circuit, *Western Watersheds Project v Michael* [2018] 15-CV-169-SWS.

10. See https://hls.harvard.edu/dept/clinical/clinics/emmett-environmental-law-and-policy-clinic/. Accessed August 22, 2019.

11. See https://www.citizenscience.org/get-involved/working-groups/law-policy/ask-a-legal-question/. Accessed March 22, 2020.

12. Yet Berti Suman 2020b contains a reflection on the overarching legal framework relevant to citizen sensing, such as applicable international and EU provisions.

13. Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

applicability, "citizen science (and other) communities are still coming to terms with the implications" of the Regulation (JEG, EC 2020, 20).

In another context, with my co-author Pierce, I explored *conceivable challenges* for citizen science and the EU open science agenda under the GDPR and made recommendations on how citizen science should be adjusted to comply with the GDPR (Berti Suman and Pierce 2018). Although the study was more narrowly focused on health-related citizen science, we suggested *possible legal interventions* needed to mitigate the hindrance effect that the GDPR could have on citizen science projects. Under this aspect, the JEG (EC 2020), among other points,[14] suggest to develop a *data sharing framework* for citizen science at the EU level, enhancing data protection and preserving privacy of participants. The PANELFIT research initiative mentioned above is going in this direction. The enactment of *an annex to the GDPR* regulating specific instances of data shared within the framework of citizen science projects may be particularly helpful to this aim. However, this may sound a bit unrealistic as no move in that direction is currently ongoing. Another avenue would be that of resorting to *volunteer legal advice* (such as the experience of the Emmett Environmental Law and Policy Clinic) in terms of supporting projects in revising their data management plans in compliance with the GDPR.

Yet another approach could be that of having the (E)CSA playing a leading role in ensuring that citizen science initiatives are legally compliant. Within the (E) CSA, a committee dedicated to performing free 'legal check-ups' to projects could be envisaged. Such committee should composed by both scientific experts and representatives of the citizen sensing community. The fact that a project passed the legal check-ups (possibly open to update controls every e.g. 2 years as the legal panorama and relevant technology may change) could reassure policy-makers that a project can be integrated into institutional policies without risk of e.g. data protection/ privacy harms and other legal incompliances. Similar committees could also be set up by national competent authorities in each nation state, performing check-ups with regards to specific national legal provisions, in addition to those provided at a supra-national level.

The option to introduce a 'GDPR/legally compliant certification' (e.g. inspired by Art. 42 GDPR on the establishment of data protection certification mechanisms) is rather excluded as, first, certification mechanisms can be very expensive and not affordable to citizen science authorities. Second, a cross-national certification could go against the principle of legal sovereignty of each member state and be inconsistent with the relativity of each country's legislative panorama. The preferred approach is instead that of *promoting best practices* and examples through literature resources, and providing *legal guidance* though clinics open to citizen sensing projects that want to

14. A number of other useful reflections on the topic are contained in the dedicated section of the JEG.

check their legal compliance. An additional opportunity could be that of calling for *a European Data Protection Board's opinion on citizen science* which could serve as benchmark for projects striving to be GDPR compliant. This latter avenue appears to me a particularly interesting opportunity.

For what concerns non-personal data, instead, it is expected that integration of citizen science will be facilitated by the increasing push to a free flow of such data, at least in the European context. Indeed, recently, the EU Parliament approved a framework[15] for the free flow of non-personal data in the EU. This free flow is considered as the EU's fifth freedom, entailing a whole new set of rules aimed at removing obstacles in each Member State. Environmental data from citizen science could fall into this category. Their potential to be interoperable and used for big data analytics and for regulatory control purposes, such as for inspection and audit, could be enhanced by such provisions. However, it is still to be verified how the EU Parliament's statement will be concretely transposed in regulatory measures and how such measures will be balanced with the GDPR, in the case of data sets composed of both personal and non-personal data. Citizen sensing communities will have to explore opportunities provided by this potential framework and consider *adapting their data repositories in a way that excludes GDPR application* (only non-personal, environmental data), to the extent that this is possible and does not undermine the aims of the project. When, for example, reporting of health data of participants is needed for assessing a specific environmental health issue, they will still have to comply with the GDPR's provisions.

The reflections so far are clearly mostly relevant for EU-based projects or international projects partially operating with EU participants or on the EU territory. For the U.S. context, in the impossibility to perform an in-depth legal review here, I can refer to a study from the Wilson Center (McElfish, Pendergrass and Fox 2016) inspecting the legal challenges to the use of citizen science in public decision-making.[16] Also the study by Brett (2017) provides a useful roadmaps on sources of scepticism preventing agencies from using citizen science and -sensed data. Existing such resources for the U.S. context, project leaders and policy-makers in the U.S. could refer and adjust to this and other studies that already performed a legal review of citizen science's legal compliance. EU-based researchers may draw on this literature in performing similar reviews in the European context.

15. Regulation (EU) 2018/1807 of the European Parliament and of the Council of 14 November 2018 on a framework for the free flow of non-personal data in the European Union.

16. Especially of interest of McElfish, Pendergrass and Fox 2016 are Sections 16 and 17 on legal issues, constraints and opportunities; Section 29 on the laws that instead facilitate this use; and Appendix 3 on "Legal constraints affecting citizen science in federal, state and local public decisions".

Suggestions to overcome (some of the) legal barriers:

Overall:

- default approach (citizen sensing should comply with existing laws and regulations) but removal of unnecessary obstacles;
- country-relativity: screening of each country's legal panorama needed;

Specific:

- for the EU context/international cases with an EU application, citizen sensing should be GDPR compliant and preserve privacy of participants; an opinion from the European Data Protection Board may be useful to verify the relationship between the GDPR and citizen science;
- for the EU context, citizen sensing will have to comply with and likely explore benefits from the EU regulation on a framework for the free flow of non-personal data in the EU;
- law clinics open to citizen science projects may help initiatives to perform a regular check-ups of legal compliance, both at national level with regards to specific national legal provisions, and at a supra-national level, with the support to the (E)CSA;
- for the U.S. context, projects and policy-makers should refer to McElfish, Pendergrass and Fox 2016, and other resources that already performed a legal review of citizen science's legal compliance.

Text Box 2 - Summary of suggestions to overcome legal barriers to the integration

2.3. Technical challenges to the integration

In the previous sections, I underlined the importance of strong technology and quality assurance mechanisms. I could engage in an endless analysis of all the possible technical challenges that could hinder a successful integration. However, I will focus only on a selected number of them, also in light of the literature already discussed.

A key obstacle to the integration are perceived data quality concerns and fears of data biases recurring in institutional setting (JEG, EC 2020). In addition, a barrier is also posed by the trade-off between ensuring sufficient data quality and encouraging civic engagement (JEG, EC 2020). To address this challenge I suggest (in line with the JEG, EC 2020), that *standardized quality assurance screening mechanisms* are provided by supra-national bodies (e.g. the (E)CSA) through the set-up of *committees including both scientists and citizen sensing communities*. Taking inspiration from the U.S. approach, a project may be required to file *a Quality Assurance Project Plan* (QAPP) to undergo through this quality screening. On the side of the recipient authorities, particularly remarkable are the efforts coordinated by the U.S. Association of Public Health Laboratories (APHL), in collaboration with the U.S. EPA, to realize "A Guide for Governmental

Agencies to Support Citizen Science", which will be released in September 2020. On top of this, the authorities interested in the integration could provide *additional training to citizen scientists and project managers* and support with data quality and validation processes as well as with communication and information on data quality required *for a specific policy purpose*.

Another challenge to the integration could be that of achieving appropriate data scalability (as also noted in the JEG, EC 2020).[17] Institutions willing to adopt the project should provide support with training, tools and resources to facilitate the replication of the monitoring in other needed locations. However, in cases of a citizen sensing initiatives designed for a policy purpose from the beginning (yet, as I said, this is unlikely for projects having a strong grassroots component), the project can already be designed in a way that include multiple data collection locations considering the level at which the problem must be solved (e.g. possibly over the whole country if the problem entails a national policy).

A further issue can be related to ensuring *interoperability and integration of official and unofficial data* in a context of high *data heterogeneity* (JEG, EC 2020, 12). The absence of commonly agreed standards in the citizen sensing community on how to present data and metadata does not help. The discussed efforts for defining common metadata structures could tackle this problem.

A barrier to policy uptake discussed in Berti Suman 2021 is that of the evolving nature of citizen sensing technologies (and platforms) and the possible difficulty for policy-makers to follow their pace. As innovation in citizen science could be faster than in related official processes (JEG, EC 2020), *a work of coordination* should be performed between institutional interventions and civic initiatives to ensure that unofficial data can still be integrated with official data and complement them. In addition, such *technological changes should be properly communicated to and understood by policy-makers*. Again, the role of institutional champions that are often ahead of the process can be crucial here. Free training to policy-makers provided by e.g. the (E)CSA, can also help.

17. Citizen sensing project by definition operates at a local level but the policy intervention could have to be performed at a higher administrative level. Consequently, the issue should be monitored at multiple locations to ensure that the policy intervention is sufficiently backed up with evidence. Thus, difficulties may arise in readapting data and methods to different local contexts.

Suggestions to overcome (some of the) technical barriers:

- standardized quality assurance screening mechanisms should be introduced;
- this screening could be provided by supra-national authorities e.g. the (E)CSA through the set-up of committees including both scientists and citizen sensing actors;
- a project may be required to submit a QAPP to undergo the quality screening;
- authorities interested in the integration could provide additional training to citizen scientists and project managers and provide information on data quality and validation processes;
- to facilitate data scalability, authorities may have to provide technical/financial support to projects;
- to enhance interoperability and integration of official and unofficial data in a context of high data heterogeneity, metadata structures should be agreed and communicated;
- for the evolving nature of citizen sensing technologies (and platforms), a work of coordination should be performed to ensure that unofficial data can still complement official data and that technological changes are properly communicated;
- a work of adaptation of data license schemes and data access/use protocols should be performed both by authorities and by citizen sensing communities, with the support of the ECSA/CSA.

Text Box 3 - Summary of suggestions to overcome technical challenges to the integration

Lastly, and making a bridge to the legal dimension, "different data policies and data management principles" (JEG, EC 2020, 20) between institutions and citizen sensing communities may undermine the integration. Ideally, shared data license schemes and data access/use protocols should be developed jointly by the competent authority adopting the civic initiative and by the citizens' group. However, this can be quite unrealistic as it presumes an even excessive integration of the initiative in the institutional setting. In addition, this could bring about the risk of the authority imposing its schemes and protocols on the initiative. More appropriately, citizen sensing projects could have their schemes and protocols checked by the (E)CSA and see how these can be *adapted* to the existing institutional ones. The institutions too may have to adapt their protocols and schemes for welcoming the initiative.[18]

18. Reusable schemes that the institution can apply to multiple projects without having to engage in a negotiation of the conditions on a case-by-case basis would allow a saving of resources and a stimulus to further uptake (JEG, EC 2020).

2.4. Socio-ethical challenges to the integration

In the process of integrating citizen sensing into institutional patterns of environmental (risk) governance a number of challenges related to socio-ethical concerns may arise. Those aspects related to e.g. demography or ethics of citizen sensing do not fall into my main scope of analysis, despite recognizing their importance and, at instance, dealing with them when appropriate. Here a brief overview of conceivable socio-ethical obstacles to the integration is provided. I wish to add that these considerations could – and should – be extended to broader participatory government and governance interventions, as I noted earlier for the political challenges.

The first socio-ethical issue relates to *inclusivity* of citizen sensing, which becomes central especially when the practice is structurally integrated into official decision-making. Are marginalized and poor communities, who are also likely to suffer more from environmental issues, properly represented in these projects?[19] Which mechanisms can ensure that unrepresented communities have the chance to engage in citizen sensing? Enthusiastic project leaders, developers and participants often do not come from these communities.

However, before answering these questions, a preliminary one should be put forward: why does inclusivity matter for citizen sensing? Arguments to answer such an inquiry can be found from the literature on ethical Technology Assessment (eTA) (Boenink, Tsjalling and Stemerding 2010). eTA assesses the potential impact of new or emerging technologies on human identities, relations, and values. It complements traditional forms of technology assessment by inspecting *the moral desirability* of new technologies (Boenink, Tsjalling and Stemerding 2010). The assessment has to be included in the design process in order that the technology developers (in this case citizen science projects' creators) include moral considerations in their choices. It works with a checklist of issues that may raise ethical problems in new technologies. The list is based on past ethical debates about new technologies and should be neutral with regard to ethical theories (Boenink, Tsjalling and Stemerding 2010).

A number of criticisms to the eTA have been raised, for example as it considers morality as a static notion and for its inability to capture rapid technological changes. In response to these drawbacks, Kiran, Oudshoorn and Verbeek (2015) suggested a different approach, i.e. *an ethical Constructive Technology Assessment* (eCTA), aimed at developing answers to the question 'how' a technology could get a desirable moral outcome in society. The authors, taking a strong position, argue that the users of technologies (in my case, citizen science participants) have *a moral obligation* to take *an active part* in the shaping of society by technologies, and designers and technology developers (in this case, sensing projects' launchers) have too the obligation to take into account such an impact of technology. I defend that, before launching a citizen

19. See https://www.agu.org/Learn-About-AGU/About-AGU/Ethics. Accessed September 10, 2020.

sensing project, as this can be considered in a way 'a new technology', projects' founders have to wonder whether their project is morally acceptable and whether unethical consequences may derive from it, performing an eCTA. For example, a project monitoring a pollution issue affecting an indigenous community and set up in a working language that the indigenous group does not speak seems quite unacceptable. Here the criterion is that of representativeness: does the project *really* represent the community whose claims it says to voice?

In brief, citizen sensing should be inclusive as its intrinsic purpose is to represent issues perceived by individuals and communities exposed to environmental issues. If it fails to represent such views as it excludes some perspectives creating barriers to an even access, it misses its potential. I argue that it is the primary responsibility of the projects' leaders and then of the participants to ensure that the sensing community represents all – or at least a representative majority – of those affected. In case of uptake, however, this responsibility is shared with and primarily bears on policy-makers, as explained below. Beyond the design of the initiative, no matter how inclusive it is, targeted communities may still struggle to join. In these cases, *incentives should be provided by institutions* (e.g. adopting authorities; the (E)CSA) to ensure that *less privileged sectors of society* – lacking the financial resources and capacities to engage in participation – nonetheless *get included into citizen sensing* (e.g. providing tools through public libraries; time-off from work when joining a citizen sensing initiative etc.). Attention should be paid to whether the 'usual suspects' (middle-class, middle-age white men) only form the initiative.

From my analysis, it resulted[20] that women are often a minority in citizen sensing projects. *A deeper scrutiny* of the reasons underpinning this fact should be performed and support from institutions to improve outreach should be provided. Immigrants' communities and ethnic minorities are also less visible in citizen sensing projects. Institutions should take a *proactive approach to ensure that diverse communities are represented* in the projects adopted and that measures facilitating engagement thereof are taken (e.g. translation of the project's platform in the language of the specific community to be engaged). In addition, competent authorities should adopt *a welcoming attitude* accepting diverse people, voices, perspectives, religious values and epistemologies, especially in cases of contested scientific beliefs and uncertain science. In the certification committees described above, for example, it should be avoided that all committee members are white, middle class, men and hold a PhD.

Overall, attention should be paid to *performativity* in the rhetoric of the institutions engaging the public. Going beyond a sort of "enthusiasm, a normativity, a happy hypothesis of change through the involvement of more people", a *realistic, authentic*

20. In some occasions, I often asked participants about the (gender) diversity of the project and frequently they pointed out to the scant representation of women in their project.

and critical approach to participation should be adopted (Kelty 2017, S87). This attitude should be considered as a way to ensure that participation does not become "false, phony, exploitative" (Kelty 2017, S87). Emblematically, Kelty (2017, S88) raises the problem of "too much democracy in all the wrong places" referring to participation as becoming "more temporary and fragile". The enthusiasm for participation has stimulated a "quicker, faster, more flexible implementation of participation" which may have benefits but often entails institutional structures that are too weak to sustain participation (here considered as integration of a citizen sensing project into policy) over time. Participatory mechanisms should be well 'metabolized' by institutions in their functioning to ensure that the integration is built on solid grounds, among which I insert also diverse representation.

In addition, another socio-ethical consideration worth of attention is how contemporary participation through citizen sensing is more focused on the individual participant, almost in a challenge among who feeds more data points on a platform, rather than on a sense of belonging to a collectivity. As noted by Kelty (2017, S88), the "'wisdom of crowds' presumes an emergent collectivity but no necessary sense of belonging." The author stresses (referring generally to participation) that "even the focus on 'teams' is simply a way to make individual characteristics complementary with each other rather than some attempt at solidarity of a cointerested collective" (Kelty 2017, S88). This sense of belonging should be promoted by the authorities that adopt a citizen science initiative, for example stimulating encounters and teamwork.

A more social concern relates to the risk of losing attention from the public over time, if the institutions adopt all sensing projects on a specific environmental issue. According to Irwin (2018), the public is getting 'tired' of all the options for participation, which no longer appears as an exceptional process but rather an 'institutionalized' approach. Integration of citizen sensing into institutional risk governance should not be viewed as an ordinary process but, as stressed earlier, *a resort to be explored only when governmental failures call for this inclusion.* However, this risk seems not to subsist here as, as stressed earlier, policy uptake of citizen sensing at present is still rare.

A mostly ethical issue could be related to funding. As noted above, a citizen sensing community may oppose to be funded by a (private/public) actor having a conflict of interest towards the issue that has to be measured. Under this perspective, attention should be paid to ensuring that integration of citizen sensing within institutional settings remains sustainable for the authority but leaving to the sensing community the possibility to oppose unethical or unacceptable funding. A preferred approach is that of *keeping a crowd-funding structure* when the project was so designed, although this may be hard if the financial expenditure of the project increases substantially after the integration.

In terms of more strictly ethical issues, Haklay (2017, 58) discusses the issue of "opening up of local and indigenous knowledge across the world, through its

integration in citizen science." When institutions support citizen sensing and integrate it into policy process, they should consider possible adverse effects, such as the release of sensitive information on the location of endangered species by an openly accessible citizen science platform. Especially when indigenous knowledge is at stake, authorities should check that the citizen sensing project provides acceptable mechanisms for *"ownership and control over local knowledge"* and for granting *"consent to participate, protection of information, [of] intellectual property rights,* [...] in accordance with international best practices, such as the International Labour Organization Indigenous and Tribal Peoples Convention or the ethics guidelines of the International Society of Ethnobiology" [emphasis added] (Haklay 2015, 58). These mechanisms safeguarding ethics of the project are crucial also because the institution, in case of policy uptake, will be the ultimate *responsible* for eventual harms caused by the initiative.

Similarly, the authority proceeding into the uptake should *check that the citizen sensing project does not expose the participants to (unnecessary) risks*. Haklay (2018, 58) note that, for example, in 'Do It Yourself' (DIY) Science, which can be considered adjacent to citizen sensing, "participants are repurposing a range of materials and tools to build laboratories, [and] there are risks associated with them." Analogous issues can emerge in the area of bio-hacking (performing of biological experiments in public laboratories by laypersons) and in nuclear radiations-citizen science. Although the citizen sensing community appears to be aware of these issues (Haklay 2018, 59), the institution adopting the project should still *check compliance with ethical standards* in terms of risk exposure during scientific research. In addition*, referral to existing citizen sensing communities' codes of ethics* (Haklay 2018, 59) adopted to govern informal science may be beneficial.[21]

Suggestions to overcome (some of the) socio-ethical barriers:

- citizen sensing projects' launchers should perform an ethical Constructive Technological Assessment (eCTA) when designing their initiatives;
- projects' leaders and participants, and in case of adoption also the adopting authorities should ensure that the sensing initiative is representative of the sensing community;
- incentives should be provided by authorities/(E)CSA to include less privileged communities into citizen sensing and to promote engagement of women, immigrants and ethnic minorities;
- competent authorities should adopt a welcoming attitude accepting diversity also in terms of religious values and epistemologies, especially in cases of contested science;

21. Other ethical aspects relate to the topics discussed under legal barriers in terms of respecting privacy of the participants and confidentiality of the information, ensuring safe storage and transmission of the data while granting open access to such data etc. (more in Strum et al. 2017).

- a realistic, authentic and critical approach to participation should be adopted to ensure that participation does not become false, exploitative and performative;
- participation through citizen sensing should stimulate a sense of belonging to a collectivity in addressing a shared environmental issue; adopting authorities should promote this;
- participatory mechanisms should be well planned and 'metabolized' by institutions;
- mechanisms should in place to avoid losing over time support from the public when participation no longer appears as an exceptional process but rather a default approach;
- attention should be paid to ensuring that integration remains sustainable for the authority but leaving to the sensing community the possibility to oppose unethical or unacceptable funding; preferring crowd-funding;
- when institutions support citizen sensing and integrate it into policy process, they should consider possible adverse socio-ethical effects, such as the release of sensitive indigenous knowledge or the exposure of participants to unnecessary risks;
- international best practices in terms of ethics should be followed in addition to referral to existing citizen sensing communities' codes of ethics.

(Other ethical aspects are discussed under legal barriers e.g. in terms of respecting privacy of the participants and confidentiality of the information; ensuring safe data storage and transmission).

Text Box 4 - Summary of suggestions to overcome socio-ethical barriers to the integration

3. Towards a framework for environmental risk governance complemented by citizen sensing

3.1. Framework building; the premises for application

After the analysis of conceivable challenges which can make the integration a demanding process, it seems now appropriate to start the actual framework-building work. The purpose of the framework is that of guiding the integration of citizen sensing into environmental risk governance through meaningful policy uptake, that is, not only 'consulting' the people but expressly acting upon the citizen-sensed evidence and basing deliberations on it. As a result, the integration can help mitigating, removing or better handling the risk, this stage – however – not being under analysis here. What happens after the project is adopted (e.g. implementation of a new policy) goes beyond my scope of analysis, as I 'just' focus on the adoption stage and on what precedes it.

The approach of drafting an *integrative framework* has been preferred to a *guidelines approach* as the idea is to provide an actual mechanism for facilitating the integration process, rather than a set of recommendations. Yet recommendations have been offered earlier in this chapter under the form of suggestions to remove challenges to integration (Section 2 and in short Text Boxes 1-4) and will be provided also in my conclusive remarks for specific sets of stakeholders. I consider a framework different from guidelines inasmuch as guidelines are a list of not necessarily connected recommendations, whereas a framework is a *systematic, connected strategy* also including a number of recommendations. The framework is mostly a legal framework (in the broad sense of 'legal' illustrated earlier), aimed at regulating how citizen sensing can be embedded in the risk governance system if certain conditions are met. Under this perspective, it includes more abstract provisions (for example on which rights the integration should be grounded) from which concrete obligations can be derived and implementation measures can be suggested. In addition, there are very practical recommendations in the framework that can be viewed as a 'toolkit' for practitioners in the sector, especially directed to those actors within the citizen sensing community. Talking about 'a' framework can be misleading because, as I will stress after, from my suggestions several ways of possible integration can be extracted. Yet a broad enough framework will be outlined including in itself *various levels of integration* and mechanisms to adapt to context-dependency.

With regards to existing integrative efforts, such as the JEG discussed earlier, my framework stands in a relationship, in part, of genus and species, to the extent that my framework draws on these insights but focusing only on the key aspects relevant to this research (the '*Riskness*', '*Sensorness*', '*Grassrootness*' and '*Distrust*'). In part, however, my framework differentiates itself from these mentioned resources, for example inasmuch as it takes mostly the perspective of the sensing citizens rather than of policy-makers. The framework in fact is not only functional to the policy uptake and thus to integration, but also envisages the hypothesis of initiatives that *do not want* such a policy uptake (with the exception of the public interest described above). Yet, even when citizens do not want to cooperate with the institutions in terms of having the initiative adopted by the competent authority and jointly performing the measurements, *they may still want (and often do) to be heard by institutions*, that is having the authority use the knowledge they create. I will show that in such cases a less pervasive, yet meaningful contribution can be conceived.

That said, I can now move to the principles for integration that I developed throughout this chapter. First, recalling Figure 2-4 above, the framework applies *only if the basic conditions for integration holds*, that is that there is a governmental failure and a willingness from the civic side to cooperate with institutions to address this failure (unless, explained before, the civic will is outplayed by a public interest in having the initiative adopted). As stressed in Berti Suman 2020b, having the institutions *using the citizen sensing data* may even be considered an 'obligation' of the institution

in certain instances. It may be more difficult to justify *appropriation of the initiative* from the authority against the civic will but, in extreme public interest situations, this could eventually happen. Another, overarching principle that I stressed is that of "Integration: yes, but not too much". I will suggest measures aimed at balancing the desirability of integration with the need of preserving (to the extent possible) the grassroots nature and independence of the sensing project. I will bear in mind that an excessive integration could *de facto* lead to an initiative controlled by the institution adopting it, which does no longer perform its tasks but rather becomes an outsourcing of governmental action.

In Figure 3-2, the integrative flow with different levels of pervasiveness is illustrated. The first part of Figure 3-2 recalls the four independent variables illustrated in the introduction and assessed in Berti Suman 2021 in their influence on the policy uptake of citizen sensing. The figure also recalls Figure 2-3 above, where the successful ingredients for policy uptake are displayed. In the first part of Figure 3-2, the distrust element is not represented as it is not a precondition in the research design (as instead where the other three elements, see extensively Berti Suman 2021), yet being an element often present in sensing initiatives' discourses and likely to be found in the lower line (initiatives not wanting policy uptake). However, it is also conceivable that, over time, the dialogue between the citizen sensing community and the institutions can mitigate such a distrusting attitude the more the process proceeds towards integration and the challenges to this integration are addressed.

Depending on whether the citizen sensing initiative wants or not policy uptake, two options are envisaged. In the *highly integrative model*, policy-makers take ownership of the sensing initiative by adopting its data and/or methods and getting support from participants for their policy purposes. Recalling the definition of 'meaningful policy uptake', in this case occurs "the adoption by institutional actors of (some component of) the initiative", often associated with the performing of policy, regulatory or even factual interventions. It should be noted that this definition entails an *appropriation* from the institutional actors of (part of the) initiative, whereas the other form of policy uptake discussed after does not, just regarding the data, not the project. In this adoption, a number of challenges may arise (those discussed in Section 2) that will have to be addressed following the suggestions contained in the Text Boxes 1-4.

In the case the initiative does not want to be integrated within an institutional system for the reasons explained in this chapter, I suggest an *alternative scenario*. I wish to note here that the fact that the citizens do not want their initiative to be adopted by institutions can be considered an exception (although in certain socio-cultural context this attitude may be predominant). Differently, the dominant trend from the empirical analysis resulted to be institutions that do not (want to) use the citizens' initiative to solve a government failure. Taking in this booklet the sensing citizens' perspective, I argue that, when governments do not want policy uptake but the civic

initiative is sound and could effectively contribute to risk handling, then this obstacle *should be removed* as a barrier ('inhibitor'). Taking instead the policy-makers' perspective, I would have probably argued otherwise.

In the 'non-adoption' scenario, the initiative can still *serve policy but without appropriation*. This may be considered a 'light' form of policy uptake, entailing just early warning (the initiative serves just as a data source alerting policy-makers on an issue) or problem-definition (the initiative contributes through its data to the framing of a problem) but without the community losing ownership on the initiative and the authority taking control on it. In this case, again using the definition of 'meaningful policy uptake', the initiative – through its data – influences the authority to perform policy, regulatory or factual interventions expressly demanded by the initiative or stimulated by it.

In this scenario, especially when the citizens' initiative fears the loss of social support from the affected community and other societal fringes (reputation issues), it may be particularly crucial *not to have* the project appropriated by governmental actors. Under this instance, the role of mediators as conveyers of information and enablers of dialogue between the societal group(s) on one side and the institutions on the other side may be useful. These mediators can foster the understanding in the citizen sensing community that cooperation with the government may be beneficial to the handling of the risk. This enhanced dialogue may also stimulate mutual *trust* and acceptance from the affected community that the citizen sensing initiative can cooperate with the government without necessarily being controlled by it.

The two avenues are illustrated in Figure 3-2. The arrow on the right linking the upper to the lower flows indicates that challenges can arise also in the second scenario (light integration) and that mediation techniques could be useful also in the first scenario (full integration). The discussion on complementing specific phases of the risk governance cycle as discussed in Chapter 2 (e.g. risk-problem framing, monitoring and control) is illustrated with the yellow box. Hints to the suggestions made in this chapter's previous section are also included (red box). Mechanisms to adjust the framework to the mentioned context-dependency will instead be explained in the following sub-section. Overall, I wish to stress that most of the lessons illustrated here for the integration of citizen sensing initiatives in government and governance structures may well be of inspiration and learning for *broader participatory experiences and integrative interventions* of such experiences into policy.

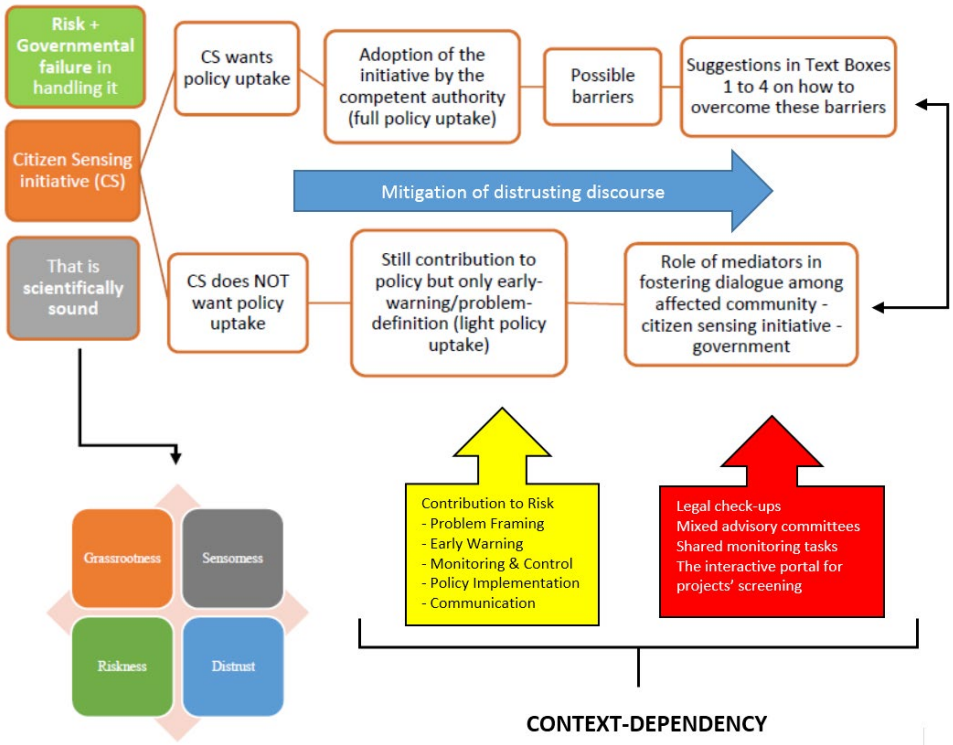


Figure 3-2 - Two avenues for an initiative wanting integration or not

Considering Figure 2-3 above and Figure 3-2, a number of regulatory measures and policy interventions are suggested in the following lines to facilitate the integration. The process of drafting these suggestions have been inspired by "The Tilburg Institute for Law, Technology, and Society - TILT's triangle" (Figure 3-3) illustrating the "mutual-shaping" and "fundamental interdependence between social, technological, and normative transformations, in an ongoing process of [dynamic] socio-technological change" (TILT Research Programme 2014-2019, 5). The triangle is regarded as fitting here as citizen sensing is inherently both a technology and a social phenomenon. In addition, it is fundamentally embedded in and

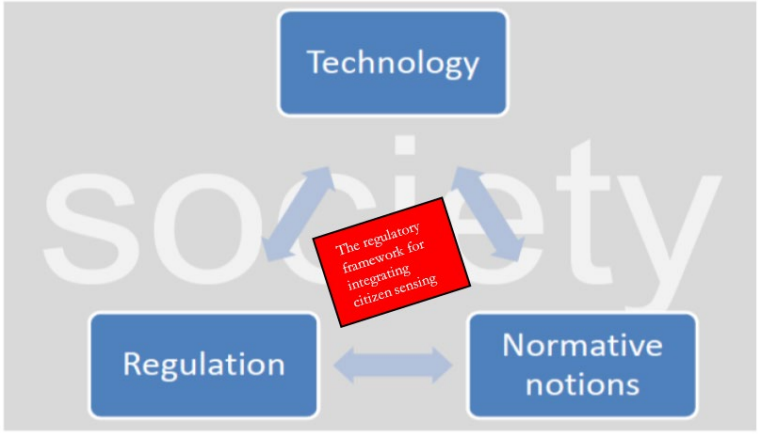


Figure 3-3 - Modification to the TILT triangle (from TILT Research Programme 2014-2019, 5)

responds to normative values and claims, such as the right to access environmental information and the value of environmental protection. Furthermore, some of the recommendations that will follow target regulatory aspects of citizen sensing, other entail more technical interventions, and other instead make normative statements. My framework for integration of citizen sensing can thus be placed exactly in the middle of the triangle: it addresses an emerging technology (citizen sensing) through regulatory measures, also bearing in mind norms and values.

Risk in the framework is considered both as the phenomenon addressed by the sensing technology (and at instances caused by a technology, such as in the case of a nuclear disaster) and as object of specific regulations which embed normative notions (such as views on how the risk should be addressed). On the policy/regulatory side, authorities that wish to make use of citizen sensing should indicate types of citizen sensing initiatives that they consider apt to address specific risk types/scenarios/at specific points of the policy cycle. On the (E)CSA side, a *data set of existing projects that effectively responded to specific risks* (e.g. the experience of Safecast could be reported there to be used by future authorities in search for initiatives responding to nuclear radiations-associated risks) should be compiled. This data set could also be an interactive portal or interface where the authorities can publicise their data or other knowledge needs, and citizen science communities can respond. Ideally, the platform operates as *a screening system* for policy-makers to search projects according to their policy needs (*purpose-specific search* for projects). On the database, information on each project should be easily found through filters to be applied depending on the specific subject of interest. In addition, the database should be an evolving resource where further developments of projects can be added by individual or group end users. Lastly, on such a portal citizen sensing projects can learn from the experience of other cases that managed to be integrated into a policy process. Thus, if a project contributed to risk policy, such a result should be published.

At the EU level, a similar platform could be *integrated into the ERCC's portal and also connected to the GDACS*[22] to reach the international level. On the platform, reference to Twitter and other pages of the projects effectively responding to specific risks could enhance their *visibility* to interested institutional actors. The portal should also clearly indicate which data quality screening mechanisms have been adopted by which projects, and which institutions are already making use of these data. A system of *policy uptake traceability* through use of DOIs referring to citizen sensing data sets in policy products seems fitting here. In addition, different labels should be assigned in case the published information includes local data from various locations or data from elsewhere.

22. See Chapter 2 on the Global Disaster Alerting Coordination System at the JRC.

Taking the normative element and the societal overarching aspect from the TILT's triangle, attention should be paid to ensuring that communication of subjective risk perception is facilitated. The (E)CSA but also adopting authorities should ensure that safe *channels* (both online and on physical places 'of interest') are created to *facilitate exchange of information* between the citizen sensing communities (perceiving the risk) and the authority (handling the risk) especially in high risk situations. To facilitate communications, a contact point within the responsible authority (i.e. the 'institutional champion', often at the municipal level) and within the sensing project taking care of the initiative-authority interface should be identified, with oversight mechanisms to avoid capture.

Despite it seems crucial that the sensing initiative fills institutional data gaps (a 'gaps-oriented matching'), a certain *independence* of the initiative in choosing what to measure, when and how should be ensured. These decisions should not be dictated by the adopting authority but still be in the full control of the initiative's leaders and participants. Otherwise, one runs the risk of making the sensing project a sort of (unpaid) mechanism just to outsource governmental tasks. This independence should be preserved through e.g. oversight of the (E)CSA on the whole process. Also the role of an (environmental) mediator could help checking that the cooperation proceeds in a fair way, in the respect of the citizens' will.

Another 'cost' of adoption has been identified in the loss of social support. In order to mitigate the trade-off between governmental engagement in the initiative and maintaining social support, governments should not only not do that altogether, but also refrain from showing to the broader public that they appropriated and control the initiative. They should rather describe the winning cooperation on public media in a nuanced way. *Protocols and best practices* on how to *present to the public the integration* could be defined by the (E)CSA.

Another crucial element for the integration is that the initiative can meet the data quality requirements for the specific purpose of a certain risk governance process. In order to facilitate integration and avoid a case-by-case quality assessment to be performed by the authority, I suggest the introduction of a single, standardized (but adjustable) template for data quality and documentation of the initiative, which is recognized and provided by the competent authority to citizen sensing projects interested in contributing to a policy process. As this is highly dependent on the type of environmental factors studied, it is advisable that such single data quality templates are introduced per type of the risk measured (e.g. one for nuclear radiations; one for air pollution).

Concretely, I suggest that European networks of environmental protection authorities (such as IMPEL) agree on *standardized templates for quality assurance and documentation* per environmental sector, on the blueprint of the QAPP proposed by the U.S. EPA. Using such a template would be the first step for the citizen sensing initiative to then enter

into quality screening mechanisms. An important measure to avoid risk of capture and control entails not having such screening committees set-up within institutional settings, but ideally hosted by 'neutral' or more grassroots-oriented bodies such as the (E)CSA. These committees should be composed by both scientific and lay members, and by invited policy-makers.

In order to further facilitate the integration, an overview (eventually under the form of a regulatory tool) of *which citizen sensing quality standards provide data that are appropriate for which specific policy purposes* should be introduced by citizen science associations, better if supranational (e.g. the (E)CSA), in consultation with competent authorities (e.g. the EPAs Network; the U.S. EPA). The policy purposes could be defined taking inspiration from the pyramid of policy uptake purposes that I develop in Berti Suman 2021. Moreover, such an overview could provide guidelines on interoperability between typologies of citizen sensing data sets and between official and unofficial citizen-sensed data. Possibilities to reuse and scale up to different levels specific types of data for different policy purposes should also be stressed and facilitated by the set-up of an adequate infrastructure (for example, requiring that citizen sensing projects publish their data on the European Open Science Cloud). Interoperability and reusability will be facilitated by the adoption of a standardized data structure to refer to citizen sensing data and metadata, as discussed above.

An important measure to preserve independence of the initiative, once adoption is in course, is to have 'third parties' (in a stewardship role) providing oversight on the actual performing of the monitoring tasks. For example, it is advisable that citizens in their measurements are flanked by volunteer and independent academics, professional scientists and/or members of the (E)CSA, as this reassures the agency in terms of respect of quality standards but they can also check that the participants are free to perform their measurements with no impingement from the government's side. A *register of academics and scientists willing to perform these* (voluntary) *flanking tasks could be compiled* and published on the portal mentioned above.[23]

Another relevant point is the need to ensure beforehand that the initiative is 'legally compliant' and does not incur in legal issues for its operations. The screening committees mentioned above play a key role here. In addition, a system of (volunteer) *legal professionals helping citizen sensing projects to handle eventual legislative barriers* could be set up.[24] Such professionals could advice the community from routine checks related to e.g. privacy of participants, to more serious concerns such as criminalization of the sensing citizens in contexts of public censorship. These professionals could be included in the afore-mentioned register.

23. In addition, from this register environmental mediators could be selected.

24. See the example of https://www.citizenscience.org/working-groups/law-policy-working-group/ask-a-legal-question/. Accessed November 6, 2019.

When the initiative starts the actual data collection for the sought policy purpose, the Bristol Approach could be followed in terms of *framing* the problem i.e. identification stage (including identifying data gaps), defining how the measurements will be *deployed* in agreement with the competent institution i.e. design stage, and discussing the wanted *outcome,* i.e. orchestration stage (KWMC 2015, 3). Especially the design stage should also take place *on the site* of the environmental issue and engage the affected actors (eventually, a 'perception mapping' approach and the 'diagnostic questions' could be used, as illustrated above). Following an evidence-informed process, the flow should be iterative as new evidence can require the adjustment of the design. In addition, the process could also take inspiration from the representation of "citizen science impact in the policy cycle" (Figure 1, Bio Innovation Service 2018, 10) and follow the relevant steps.[25]

As an additional remark, to ensure that the integration is financially sustainable over time, (ethical and acceptable) financial schemes should be defined in a way that preserves independence and scientific integrity of the sensing activities. The initiative should be supported in terms of resources by the adopting authorities but oversight mechanisms (e.g. by the (E)CSA) should check that this financial stream does not corrupt the initiative, through requesting e.g. strict accounting documents. Also crowd-funding options will have to be explored, in order to guarantee that the integrated sensing initiative can continue its operations in line with its values.

To facilitate the act of balancing between some legal interests (e.g. privacy of the participants; limits to trespassing on private lands) and citizen sensing (bringing interests embedded in specific rights), the strategy adopted by the U.S. could be enlightening for Europe, namely that of enacting a dedicated Crowdsourcing and Citizen Science Act.[26] The U.S. Act of 2016 indeed deals with a number of aspects raised here and explicitly envisages hypotheses of cooperation with competent agencies. Other supportive legal provisions in the U.S. context can be found in the relevant study of the Wilson Center (McElfish, Pendergrass and Fox 2016, Section 29).

I suggest that, in order to have an overarching instrument regulating the allocation of power and roles in the integration, a *legal provision recognizing and supporting citizen science and sensing* should be introduced by means of a directive at the EU level, preferred as allowing Member States to transpose it according to their national specificities.

25. First, the sensing initiative and the competent authority go through the "Innovation in data gathering" stage; then they engage in the "Validation and quality control" and in the "Analysis and data management of the data gathered from new data sources". Subsequently, they enter the crucial step of the "Integration of new knowledge in established decision-making processes". Also important are the following steps, which are "Communicating policy-related reactions to this knowledge" and "Monitoring policy impacts of these reactions".

26. 15 U.S. Code § 3724 (2016) - The Crowdsourcing and Citizen Science Act.

This scenario seems not too far from reality, considering the JEG and the EC's communications on citizen science and its use in environmental monitoring and reporting.[27] Yet, further research should assess and compare options to decide what would be the preferable form, considering also the administrative level (e.g. local or national) and cross-country aspects (e.g. an EU-wide provision or per country). Future analysis should also define whether this legal instrument would create just the 'possibility' for authorities to use data from citizen sensing or rather whether – as a result of this legal intervention – they would be under a legally binding 'obligation' to recur to such data, when certain conditions are met (e.g. information is inadequate from the official side). From the present analysis, however, I can state already here that such a legal provision should at least provide for the following elements:

- Regulate *different conceivable forms* (from less to more pervasive) of integrating citizen sensing into institutional settings depending on the will of the citizens and on the needs of the institution;
- Set *under which conditions* institutions are obliged/strongly recommended/advised to adopt the initiative/make use of their data, eventually even against the citizens' will;
- Define *which rights 'justify' the action of the sensing citizens* and thus protect their actions from adverse legal consequences;[28]
- Possibly, include an analysis of under which conditions the sensing citizens *have a 'right to contribute to environmental information' and the institutions an obligation to listen* to the citizens and use their evidence/methods/tools to take action.[29]

The overall aim of such a legal intervention should be to ensure that, if certain conditions are met, authorities are stimulated to (or even obliged to) use citizen sensing for their actions. Such a legal instrument could take as a model for integration the experience of 'advisory boards' that provide input to governments but maintaining their independence. Yet, a problem may arise: what if the government disregards such an advice, as often occurs with advisory bodies? Having a 'right to contribute' (and consequent duty to listen) may help by making it compulsory for the government to consider citizen-sensed evidence under certain conditions.

27. Such as Communication on 'EU actions to improve environmental compliance and governance', COM/2018/10 and Staff Working Document SWD(2018)10, which provides details of each action.

28. On this and the previous aspect, see Berti Suman 2020b.

29. On this aspect, see Balestrini, M. 2018. "Beyond the transparency portal: citizen data and the right to contribute". ICT4D Blog. http://ictlogy.net/20181004-mara-balestrini-beyond-the-transparency-portal-citizen-data-and-the-right-to-contribute/. Accessed December 23, 2018. See also the discussion during a dedicated webinar and captured in a blog post: Berti Suman, A. 2020c. "Citizen Sensing: towards a right to contribute to environmental information". *Environmental Law Blog, Tilburg University*. https://blog.uvt.nl/environmentallaw/?p=443. Accessed July 10, 2020.

A specific source for inspiration could be found in the Dutch environmental law panorama and, in particular, in the Environmental Management Act (*Wet milieubeheer*).[30] The Act at Art. 2.17 provides for an Environmental Impact Assessment Commission ("the Netherlands Commission for Environmental Assessment")[31] with the task of advising the competent authority with respect to environmental impact reports. The body is composed of members who are experts in the field of environmental protection (e.g. degradation, pollution), but may also be assisted *by experts who are not members of the commission* (Art. 2.21). One could envisage a bridge there to the inclusion of citizen sensing 'experts'. By analogy, this part of the act could also be useful to regulate inclusion of evidence from a sensing initiative in institutional decisional processes. Yet, it could be argued that they are not 'expert' (but see discussions on 'experiential experts' in Berti Suman 2021). An inquiry should be performed on whether citizen scientists are already at instances involved or could be approached to become a member of the commission on a certain project or issue, and whether citizen science/sensed data are being already used by the Commission in specific instances.

In alternative, as it exists an Environmental Impact Assessment Commission, ideally *an independent 'Citizen Sensing Commission'* could be set up *ad-hoc* when the specific environmental issue, associated with governmental failures, so requires. In designing such a commission, the insights from the study of Bijker, Bal and Hendriks (2009) on the role of scientific advice in democracies, could be especially enlightening. The authors, studying the functioning of the *Gezondheidsraad* (the Health Council of the Netherlands), an independent advisory body providing solicited and unsolicited advice to the Dutch ministers and Parliament on matters of public health, provide precious insights on the actual independency of these committees and the role that they can play in steering governmental actions.

3.2. A flexible framework, adaptive to context-dependency

An important point should be added to Figure 3-2 above, i.e. the element of *context-dependency*. The findings from the empirical analysis suggest that the framework should be *flexible* enough to be readjusted on the basis of specific contextual conditions. The context-dependency of the framework should be borne in mind especially when transposing an integrative experience from an initiative to another and from a social/cultural/geographical/political/legal context to another. In the impossibility to make a per-country framework, the most viable solution seems that of making a framework that is broad enough that can be adapted to context specificities, as also suggested by

30. *Wet milieubeheer* van 13 juni 1979, geldend van 01-07-2019 t/m heden. Act available at (in Dutch) at https://wetten.overheid.nl/BWBR0003245/2019-07-01. See also https://tinyurl.com/y5wvuz9b (in English). Accessed August 23, 2019.

31. See https://www.commissiemer.nl/english/our-services/advise-on-eia-and-sea. Accessed August 23, 2019.

the U.S. National Research Council (2008, 236-237), broadly with regards to public participation.

More generally in relation to the understanding of what "makes democracies vibrant and successful over the long term", Berman (1997, 562) stressed the importance of combining an analysis of "economic, political, or institutional factors" with "societal and cultural variables" (Berman 1997, 562). Even more remarkably, the author stated that "to know *whether civil society activity will have positive or negative consequences* for democratic development, we need to marry an analysis of societal and cultural factors to the study of political institutions." Again, this seems to stress the need for an inquiry of institution-specific aspects, in addition to traits inherent to the sensing initiative. The U.S. National Research Council (2008, 236) lists contextual factors to be considered, such as "attributes of the environmental issue, the state of knowledge, the agency and its environment, and the participants" which can pose challenges in achieving good public participation. They also suggest that "choices made in the design of a public participation process can compensate for the difficulties that specific attributes of the context may pose" (The U.S. National Research Council 2008, 236). Lastly, it is "counterproductive to define best practice in terms of any specific techniques to be routinely used" and thus no one-specific-framework approach is here suggested (The U.S. National Research Council 2008, 237). Instead of struggling to define a best framework, an effort of *carefully diagnosing the context*, a constant *monitoring of the process* to see how well the framework applied is working, and *changing tools and techniques* accordingly are advisable (The U.S. National Research Council 2008, 237). Hopefully, the framework and regulatory measures that I suggest are broad and flexible enough to be adjusted to varying contexts (and thus power dynamics, cultures etc.), for example by using the 'diagnostic questions' discussed above as preliminary stage.

Reed et al. (2018, S7), also referring to general public participation, proposed a theory to explain the *variation in outcomes* from different types of engagement. They suggest that socioeconomic, cultural, and institutional contextual factors can heavily influence the outcomes of engagement, thus no standard best practices really hold. Yet some "*process design factors* [...] can increase the likelihood that engagement leads to desired outcomes, across a wide range of sociocultural, political, economic, and biophysical contexts" [emphasis added]. Aspects such as "power dynamics, the values of participants, and their epistemologies, [...] and which types of knowledge they consider valid" should be considered in defining the process. Moreover, these engagement processes work differently depending on the spatial and temporal scales and contexts in which they operate. Concretely, this means that the ultimate choice on *where, when and how* to measure a certain environmental issue should be retained in the hands of the sensing citizens, who will embed in the monitoring their values, expectations and perceptions. For this importance of local context-dependency, all actors involved in the initiative and its uptake should discuss "the appropriate type

of engagement approach [and policy uptake] and adapt its design to the context" (Reed et al. 2018, S15). All affected parties should also have an equal opportunity to contribute to feed in the process their goals that reflect their values (that may be at the root of a conflict)" (Reed et al. 2018, S15). This should be ensured by independent scientists flanking the process and (E)CSA members overseeing it.

Worth quoting is the final sentence of the study of Reed et al. (2018, S15): "whether success means achieving beneficial environmental outcomes [such as risk removal/ mitigation] or whether it simply leads to an increase in *trust* [...], a theoretically informed approach to stakeholder and public engagement has the potential to markedly *improve the outcomes of decision-making processes*" [emphasis added] (Reed et al. 2018, S15). Hopefully, the analysis of the present chapter contributed to build such a theoretically (and empirically) informed approach. A deeper analysis of this approach can be found in Reed et al. 2018. Furthermore, I wish to add that most of these lessons with regards context-dependency can be enlightening for informing broader experiences of participatory government and governance, which too will have to adapt to contextual factors.

In light of these reflections, the analysis can now move to the conclusion section where the answer to the question "How can citizen sensing be integrated in environmental risk governance framework(s)?" will be summarized. I will do so developing accessible guiding lines that could help policy-makers and interested communities in shaping citizen sensing initiatives that manage to get integrated in the risk governance system or, at least, meaningfully contribute to it even without being integrated.


AREAS
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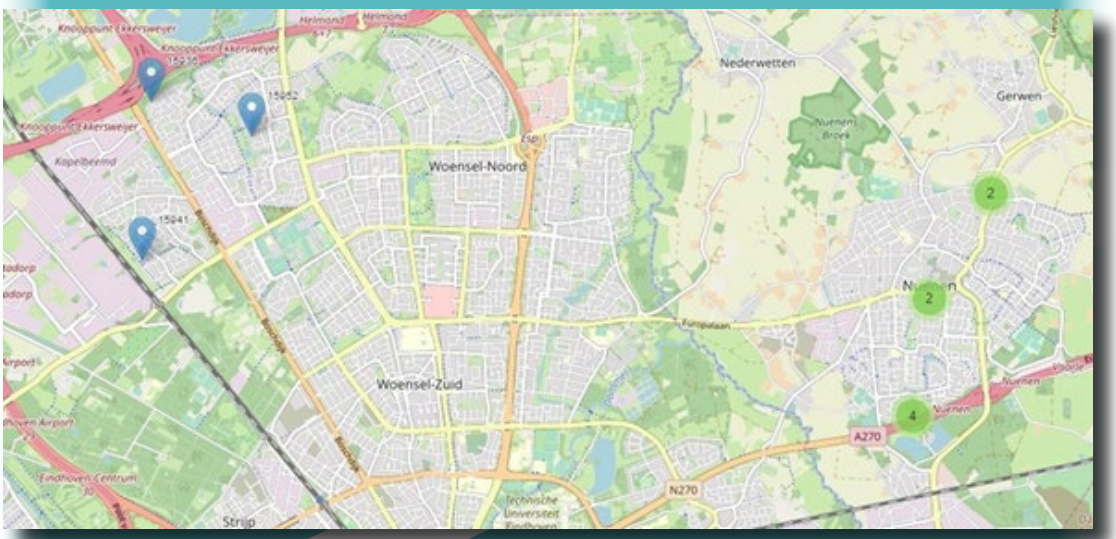
Chapter 4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Chapter 4 - *Conclusion*

1. An answer to the key question on integration

In this booklet, I developed an answer to the question "How can citizen sensing be integrated in environmental risk governance framework(s)?" wondering which interventions are needed for citizen sensing to result in a contribution to risk governance. This analysis is complementary to the research developed in Berti Suman 2021 on the factors influencing the uptake of citizen sensing in environmental risk policies.

In providing an answer to this question, I developed a model for designing citizen sensing projects that manage to be influential on policy-making. Furthermore, I provided to institutions interested in citizen sensing a structure to integrate citizen sensing practices into existing institutional risk governance frameworks. Lastly, I suggested a series of interventions to facilitate such an integration and to remove eventual barriers. The main lessons from this study can be summarized as follows:

- As a premise, I wondered whether citizen should be structurally integrated in institutional risk governance. I concluded that citizen sensing is an advisable complementation to risk governance *under certain conditions*. Only if governmental failures subsist and the initiative wants the policy uptake, the integration is advisable. As not all citizen sensing initiatives want to be integrated in the system, I ideated an alternative for these types of initiatives that still manages to be contributory to risk governance processes. When the initiative wants the policy uptake, a whole set of *adoption measures* are suggested, aimed at having the initiative structurally included in the institutional risk governance cycle. When this is not the case, I suggest that the initiative can still contribute to *problem-definition and early-warning, without being appropriated* by the authority. In certain cases, however, I indicated that policy uptake and integration should be pursued by the institutions even against the initiative's will.
- In drafting the integrating framework, I could realize the importance of building on and complement existing theories that share my integrative aim. I also stressed the need to take inspiration and insights from previous empirical analyses. In particular, I shaped the framework that I suggest here on the model of a successful experience of citizen sensing initiative that effectively challenges the system but also reaches the policy uptake stage (developed on the basis of empirical research performed within my doctoral project, Berti Suman 2020a). In this working model, my three preconditions and dependent variables are reflected, together with social uptake and distrust that gets transformed over the process.
- I engaged in the identification and definition of a number of challenges that will have to be removed or that citizen sensing will have to compromise with

to ensure integration. I advanced a number of practical suggestions to engage in this *adaptation* or *barriers' removal*, including the creation of an interactive portal operating as a screening system for policy-makers in search of fitting citizen sensing projects; the introduction of the figure of an (environmental) mediator to facilitate communication between the sensing citizens and the institution; the development of a standardized template for quality assurance and documentation including quality screening mechanisms; and the definition of standards on which citizen sensing data are appropriate for which specific policy purposes. At a more abstract legal level, I suggested the enacting of a legal provision recognizing and supporting citizen science and sensing at the EU level and the development of new rights such as the 'right to contribute to environmental information'.

- Aware of the importance of contextual factors in determining the success of the integration, I proposed the rule of 'context-dependency' as fundamental for any effort of framework drafting. Consequently, I tried to make my framework broad enough that can be adapted to contextual specificities. I also stressed the importance of carefully diagnosing the context and constantly monitoring and readapting the process when proceeding with the integration.

2. The integrative framework in a nutshell

In answering my question, I had to wonder whether citizen sensing should be integrated into institutional risk governance in first place. I concluded that, when the initiative *effectively targets and fills governance failures* and *the sensing citizens wish so*, integration should be a sought outcome. Moreover, when the citizens do not want integration but the initiative seems essential to protect wider public interests, policy-makers may still need to proceed with adopting the initiative or at least consider its evidence.

From my empirical insights and the review of literature on integration of citizen science and sensing into institutional settings, selected on the basis of its relevance for my variables, I extracted an integrative framework. I defined various levels of integration, depending on the needs and on the extent to which the citizens are willing to have their initiative adopted and the policy-makers ready to cooperate with/integrate the initiative. I designed the framework in a way to tackle possible inhibitors and challenges to the integration. I also advocated for the adoption of specific, targeted measures to remove political, technical, legal and socio-ethical barriers, yet bearing in mind the context-dependency aspect. Lastly, I stressed as particularly useful the development of a legal instrument regulating citizen sensing and including a legitimate base for it, eventually to be grounded on a still-under-construction 'right to contribute to environmental information'.

In the Text Box 5 below, I provide a summary of my main recommendations as deriving from my framework. I differentiate from suggestions addressed to citizen

sensing communities and to policy-makers. My recommendations to academics are instead primarily contained in my reflections on a future research agenda.

Recommendations for citizen sensing communities:

- Citizen sensing initiatives should aim at addressing governmental failures and data gaps; use scientifically strong technologies and methods and show that they are properly providing a complementary risk monitoring system;
- Sensing projects need to seek for social support and mobilization, as achieving a critical mass can either contribute to address the problem through behavioural changes or activate policy-makers;
- Citizen sensing should identify policy-linkages of their initiatives and look for institutional champions if they wish their projects to influence policy actors;
- Citizen sensing communities aimed at integration within institutional structures could benefit from the oversight of the (E)CSA on the whole process to preserve their independence;
- These communities should strive for integration, but 'not too much', keeping an eye on maintaining a critical distance from the authority;
- In case the community does not want their project to be integrated within an institutional system, they can still serve or influence policy, e.g. through early-warning or problem-definition.

Recommendations for policy-makers:

- Policy-makers should consider integrating a citizen sensing initiative in institutional governance structures only provided that there is willingness from the civic side to cooperate, unless the civic will is outplayed by a public interest which could even make consideration of the citizen-sensed data/adoption of the initiative an 'obligation';
- Policy-makers may consider setting up an interactive portal or interface where they can publicise their data/knowledge needs and citizen science communities can respond; the platform can also operate as a screening system for purpose-specific search for projects in line with quality standards;
- Policy-makers that proceed in adopting citizen sensing projects should refrain from (giving the impression that they are) appropriating and controlling the initiative, paying attention to a fair allocation of roles and responsibilities in the process;

- Policy-makers (and especially European networks of EPAs) should support the introduction of a single, standardized but adjustable template for data quality and documentation of citizen sensing initiatives, depending on the type of the environmental risk addressed and the policy needs; a role of oversight by the (E)CSA is advisable to avoid an excessive burden for the citizen sensing community and the 'imposition' of governmental will;
- Policy-makers may consider enacting a legal provision (e.g. by means of a directive at the EU level) recognizing and supporting citizen sensing, and promoting its eventual integration into policy processes (e.g. based on the model of 'advisory boards'), and laying grounds that can legitimize the action of the sensing citizens (e.g. including a 'right to contribute to environmental information') but also legal requirements that citizen sensing will have to comply with.

Text Box 5 - Recommendations for citizen sensing communities and policy-makers

3. Acknowledging an integration dilemma

Despite my efforts in conceiving various levels of integration and suggesting mechanisms to target barriers, I could not solve an essential dilemma, that is what I framed as 'the dilemma of integration', which already emerged in assessing the role of the grassroots' element for policy uptake. At the end of this trajectory, I have to acknowledge that, no matter how many (good) measures are adopted to preserve the independence of the initiative, integration may in the end be incompatible with strongly community-led and anti-system projects. Such initiatives may lose their power if integrated. In particular, the need for 'independent' citizens that 'watch over' the government's action may be outplayed by integration. This does not mean that integration should not happen but that the sensing citizens should bear in mind that 'integration does not come without costs'. However, strategies aimed at preserving a 'healthy' distance between the sensing citizens and the adopting institutions could be a way to mitigate the risk of loss of independence.

Another dilemma that reinforced my previous argument is that integration can come at the cost of loss of social support and this is also something that the initiative should bear in mind. In brief, some initiatives may just decide not to push for policy uptake altogether. This way, they may have less chance to influence policy-making 'from the inside' but more chance to steer it to a more accountable and transparent risk governance by watching over it 'from the outside', activating and mobilizing social actors beyond the policy walls. Over the course of this research, I discovered that there are dilemmas that cannot be solved in the attempt to integrate into governmental action a practice that is, by nature, grassroots-driven. I do not consider

this as a failure of my research. Rather, I see it as a discovery and, hopefully, a fertile ground for future research.

4. Limitations of this study

The integrative framework I suggest has several limitations, as it is non-exhaustive (leaving out possibly relevant aspects) and unapt to capture (key) contextual factors. Furthermore, it is relative and partial inasmuch as it mainly takes the perspective of the citizen sensing actors rather than that of the policy-makers, for example striving for inclusivity and independence, and for respecting the citizens' will of not integration, at least in principle. In addition, the framework leaves open questions such as that on how to engage with strongly grassroots-driven citizen science, although the alternative scenario partially targets this demand. The framework could not solve completely the integration dilemma, though it suggests mechanisms to mitigate it.

Despite proposing strategies to balance integration and independence, I have to ultimately acknowledge that integration may occur at the *unavoidable cost* of compromising the grassroots nature of the project. Lastly, the integrative framework provides a number of strategies to foster dialogue, trust and acceptance between the affected community, the citizen sensing actors and the institutions. However, despite supporting the need for an integrative framework, I stressed that *the 'conflictive element'* between citizens and competent authorities and *a bit of distrust* should not be completely eliminated as these warrant a 'healthy' system.

5. Towards a future research agenda

Throughout this research project, I could gather and understand the views of experts that have been researching citizen sensing, the expectations and doubts of policy-makers confronted with the practice, and the feelings and claims of the sensing citizens and of those individuals affected by environmental risks who saw in the sensing initiatives a spark of hope. I learned from them, struggled with them at times, and often got challenged by what I discovered. I could not have reached the point where I arrived without their voices, reason why I see this project as an endless discovery. Future researchers may consider reflecting on some of the aspects that, over the course of the inquiry, I flagged as sparks for future research which I could not address.

Such ideas for future research span from political sciences and study on social movements, law, behavioural sciences, sociology, STS, history and philosophy of science. I will concentrate here on three main directions that I think researchers working at the intersection of (environmental) law and citizen sensing should explore. In order to *boost* the potential of citizen sensing for environmental risk governance and policy, future research should explore:

- Whether a need for *a legal instrument regulating citizen sensing*[1] indeed exists in the first place or whether other possible non-legal instruments are conceivable and advisable; if such a legal instrument is needed, what would be the preferable form, considering also the administrative level (e.g. local or national) and cross-country aspects (e.g. an EU-wide provision or per country); whether this legal instrument would create just the 'possibility' for authorities to use data from citizen sensing or rather whether – as a result of this legal intervention – they would be under a legally binding 'obligation' to resort to such data, when certain conditions are met (e.g. information is inadequate from the official side);[2]
- Whether *a 'right to contribute to environmental information'* can be extracted from existing legal provisions and a consequent obligation for the competent institutions derived[3]; how this new right could, on one side, 'legitimize'[4] citizen sensing and facilitate policy uptake and, on the other side, also shield participants from possible (legal) risks associated with the exercise of the practice; whether this right could be considered a new human right and, thus, what would be its relationship to the existing procedural human right to access to environmental information; lastly, how this new right could be implemented and enforced;
- Broadly, what is *the potential of citizen sensing in terms of being used for law enforcement and compliance assurance actions and, more broadly, for (environmental) justice*; more specifically, on which grounds and under which conditions citizen-sensed data can be used in courts in environmental litigation, to be inspected adopting as lens an U.S.-EU comparative case law and legislation analysis. Furthermore, it is worth exploring whether citizen sensing can be used as a tool to facilitate environmental mediation and thus to avoid the court stage.[5]

Beyond environmental law and policy, other fields of study may wish to build on my research along the following lines. Risk governance scholars could engage in an analysis on the risk as a motivator and as a *catalyst* for accelerating policy uptake especially by those authorities competent for managing disaster response protocols. Moreover, an interesting field of analysis could be the study of whether distrust

1. On this point see also Berti Suman 2020b.
2. Discussions on the topic have been advanced by the contribution of dr. F. Sindico, as member of my doctoral committee, and of lawyer V. Dini, both captured in Berti Suman 2020c.
3. Engaging discussions on the topic occurred during a dedicated webinar on May 7, 2020, and are captured in Berti Suman 2020c.
4. This aspect is currently under discussion in a forthcoming publication Berti Suman, A., S. Schade and Y. Abe. 2020. "Exploring legitimization strategies for contested uses of citizen-generated data for policy". *Journal of Human Rights and the Environment.*
5. Especially these last two points are being addressed within my postdoctoral research project titled *"SENSJUS - Citizen Sensing as a source of evidence in environmental justice litigation and as a tool for environmental mediation"* deployed at the JRC in cooperation with the Milan Arbitration Chamber and Systasis - Research Centre for Environmental Conflicts Prevention and Management, Milan. See the project's website at https://sensingforjustice.webnode.it/. Accessed September 16, 2020.

levels towards institutions often associated with environmental disasters and crises could be mitigated or rather worsened by citizen sensing practices. Political sciences researcher may want to investigate the different typologies of policy uptake and the factors that may influence the occurrence of one type of uptake rather than another. More broadly, the implications of this research not only for (environmental risk) governance but also *for governments' and law-makers* (dealing with environmental risk but also beyond that) could be explored.

Sociologists may consider exploring the *invisibility* of certain actors in citizen sensing (e.g. minorities) and of certain types of initiatives (e.g. strongly community-led, 'distrusters' projects). STS but also legal scholars should pay close attention to possible *adverse effects of citizen sensing*, such as issues of surveillance, network dependencies, and harms to privacy and data protection. It may also be worth exploring citizen sensing for policy in connection with emerging 'bottom-up' models of data governance (Micheli et al. 2020). Furthermore, the implications of my findings for scholarship *on social movements,* especially on ongoing, strongly grassroots-driven environmental protests (such as the Extinction Rebellion movement)[6] that challenge the current legal and political *status quo*,[7] could be explored. Such reflections could take inspiration from Gutiérrez's (2018) work on 'proactive data activism' and from Rajagopal's (2003) analysis of social movements as triggers for the evolution of international law 'from below'. My research could also stimulate discussion among scholars working on the history and philosophy of science, for example in relation to discourses on *democratising epistemologies and disputing scientific hegemonies*, along the lines of the work of Kimura and Kinchy (2019) in relation to citizen science.

Moreover, behavioural scientists could explore *behavioural adaptations* that are triggered by the rise of a sensing project and the dynamics deriving from the confrontation between sensing citizens and policy-makers, ideally to be assessed making use of experimental methods from psychology and behavioural sciences. Also behavioural changes stimulated by taking part in a citizen science project versus policy-induced behavioural changes can be worth inspecting in a comparative light, for example in relation to the effect that citizen sensing could have in pushing people to adopt (more) environmentally friendly behaviours or to take (more) environmentally safe decisions (i.e. *'nudging' through citizen sensing*).[8]

6. See https://rebellion.earth/. Accessed March 15, 2020.
7. This aspect is currently under discussion in the forthcoming publication Berti Suman, Schade and Abe 2020.
8. Part readapted from Berti Suman 2021.

Figure 4-1 - ph.: ITV/PA; protestors against air pollution, UK.

6. Concluding remarks

At the conclusion of this investigation, I acknowledge that the findings discussed here – on which, I hope, future research will develop – are substantially and methodologically novel. At a *substantial level*, actors engaging in and with citizen sensing could learn from my analysis the need to care for scientific strength and to target risk governance failures, if they wish to have citizen sensing ultimately influence policy with their monitoring (see Chapter 2 of this booklet and more in-depth Berti Suman 2021). I also made a case for why integration of citizen sensing within institutional risk governance is a particularly complex process and can have drawbacks, as independence of the sensing citizens and their critical distance are maybe even more essential than cooperation between civic and policy actors (see Chapter 3 of this booklet).

At a *methodological level*, only grounding this research on solid theoretical reflections and on previous empirical analysis (extensively illustrated in Berti Suman 2021), learning to compare and combine methods, I could reach my conclusions. Over this process, I often had to refine my choices and accept limitations due to the nature of the specific methods, but also to contextual and feasibility barriers, and to my own background of a legal scholar learning how to engage with social sciences research methods. These adaptations and iterative processes, however, ultimately strengthened this project allowing me to discover findings that I could not reach otherwise. The

context-dependency aspect and the integration dilemma, for example, came out only by engaging with my ethnographic data, whereas the unquestionable role of scientific strength of the citizen sensing initiative for policy uptake could be demonstrated only scaling-up the analysis to a larger data set (as discussed in Berti Suman 2021).

Now that some three years passed since I started engaging with this research and I look backwards, I realize that a number of transformations drastically changed the scene. Indeed, at the time of finishing my booklet, citizen sensing has become object of increased attention from policy-makers, risk governors and even more civil society actors. The European Commission just released guidelines[9] that represent a first step towards a regulatory instrument for stimulating the use of citizen science for European environmental policy. Furthermore, on the Joint Research Centre data catalogue an expanded version[10] of the inventory of environmental citizen science projects has been released, giving new momentum to the data set and related discussions.

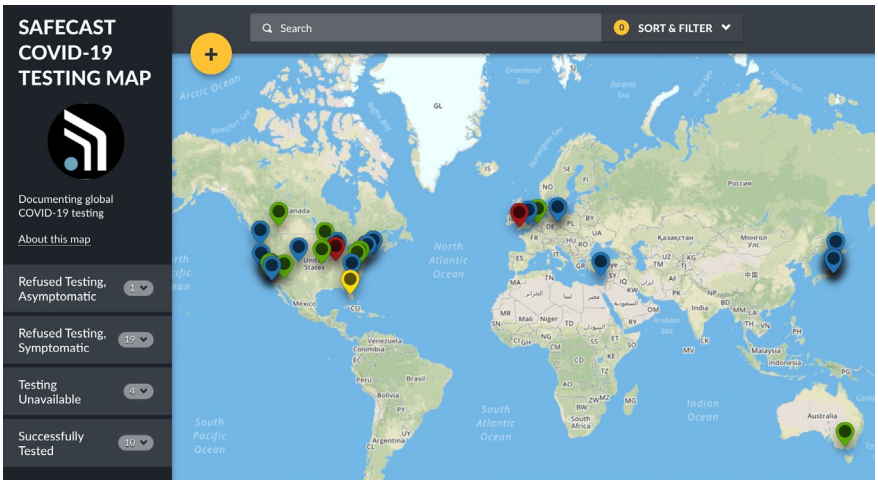

Figure 4-2 - Covid-19 testing map by Safecast [credit: Safecast]

Risk governors around the world are turning to citizen sensing initiatives as a potential source of precious evidence, especially in disaster and crisis scenarios. While I am finalizing this reflection, almost all countries around the world are witnessing the emergency associated with a massive, *systemic* risk, i.e. the Coronavirus (COVID-19) pandemic. Citizen science and sensing initiatives are multiplying in response to the crisis both to offer relief to affected people and to provide resources to policy-

9. European Commission. 2020. Best Practices in Citizen Science for Environmental Monitoring, SWD(2020) 149 final.

10. See https://data.jrc.ec.europa.eu/dataset/jrc-citsci-10004. Accessed April 2, 2020.

makers and scientists.[11] The perception that the risk is not (always) being properly handled and communicated by competent authorities is making citizens respond to uncertainty and fear with creative initiatives, which ultimately are a demonstration that people wish to retain *agency* in times of emergency.[12]

Citizen sensing communities are also having their data recognized in environmental litigation, as observed in the Formosa case decided on June 2019.[13] A new Citizen Science Law and Policy Working Group[14] is mobilizing researchers around the world to inspect legal and policy-questions associated with citizen sensing. Lawyers are gradually joining the debate too.[15] Conceivably, discussions in the years to come will lead to the elaboration and, hopefully, recognition of a right to contribute to environmental information and a duty of the State to listen to citizen-sensed evidence.[16]

11. Numerous initiatives are spreading around the world. See for a collection of ongoing projects https://www.citizenscience.org/covid-19/ (from the U.S.); https://eu-citizen.science/blog/2020/03/31/citizen-science-resources-related-covid19-pandemic/ (from the EU). Accessed March 26, 2020. For example, in Italy, which was particularly hit by the pandemic, an initiative 'from below', the project "Covid19italia.help", was launched as a citizen initiative to 'sense' and collect information related to the virus, in order to make it easily accessible for people in need and competent institutions. https://www.covid19italia.help/about/. Accessed March 15, 2020.

12. Intervention by Prof. Renn, Institute for Advanced Sustainability Studies, IAAS Postdam, Germany, at SHARE Webinar: "Lessons we are learning from the COVID-19 pandemic for radiological risk communication", March 16, 2020. See https://www.ssh-share.eu/webinar/. Accessed March 26, 2020.

13. U.S. District Court, Southern District of Texas, *San Antonio Bay Estuarine Waterkeeper et al. v. Formosa Plastics Corporation et al.* [2019] No. 6:17-cv-00047.

14. See https://www.citizenscience.org/working-groups/law-policy-working-group/. Accessed March 15, 2020.

15. For example, within the framework of the recently launched 'PANELFIT project - Participatory Approaches to a New Ethical and Legal Framework for ICT', targeting also citizen science and sensing. See https://www.panelfit.eu/. Accessed March 15, 2020.

16. I trust to be able to contribute to these discussions through my postdoctoral research project titled *'SENSJUS - Citizen Sensing as a source of evidence in environmental justice litigation and as a tool for environmental mediation'*. See the project's website at https://sensingforjustice.webnode.it/. Accessed September 16, 2020.

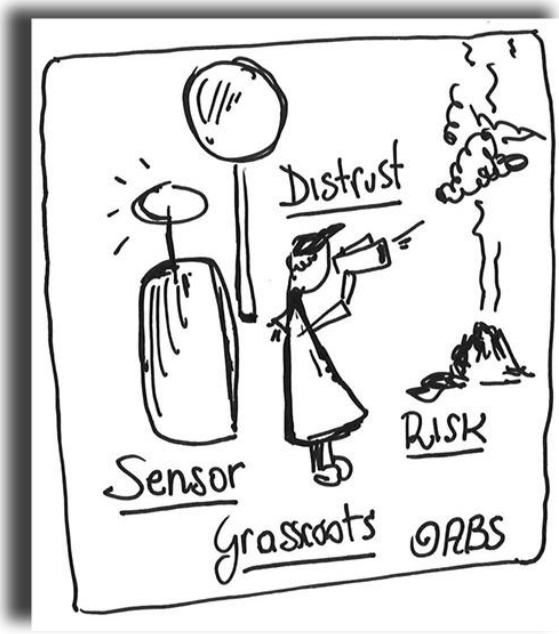

Figure 4-3 - Sensing citizen in action [credit: own drawing]

As a researcher, I hope that this booklet will turn to be a useful resource for interested communities and policy-makers that wish to integrate citizen sensing into institutional risk governance. As a passionate environmental lawyer, and convinced supporter of scientifically strong citizen sensing initiatives addressing governmental failures, I hope that this research will (contribute to) legitimize actions, ground claims and inspire further discoveries. As a citizen, I hope that more citizens will mobilize to care about and act in defence of their environment, also making use of citizen sensing. Against a rampant trend of scepticism towards political engagement and loss of trust in science, citizen sensing can be an avenue to meaningfully *engage* in identifying and targeting (environmental) governance problems and respond to complex scientific and policy questions.

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'Citizen sensing', framed as grassroots-driven monitoring initiatives based on sensor technology, is increasingly entering the debate on environmental risk governance. Although through a possible initial conflict, citizen sensing may ultimately have the potential to contribute to institutional risk governance. Building on previous empirical research based on a combination of methods, including ethnographical research, descriptive analysis and fuzzy-set Qualitative Comparative Analysis, Berti Suman designs an accessible 'toolbox' for interested communities, policy-makers and researchers that wish to shape citizen sensing initiatives in a way to contribute to risk governance.

Sensing citizen in action
[credit: own drawing]