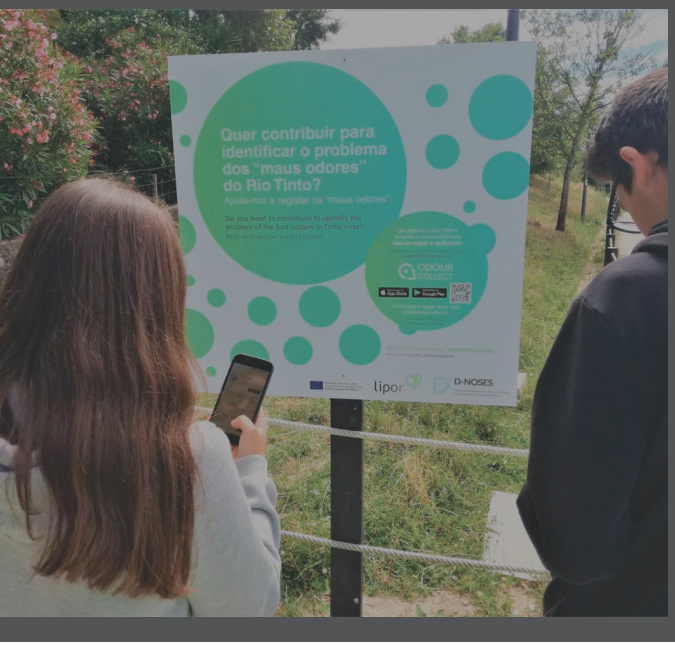
D-NOSES

Distributed Network for Odour Sensing, Empowerment and Sustainability

DIY guidelines

for citizen science projects in odour-conflicted communities



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Main author

Tim Woods, European Citizen Science Association (ECSA)

Main reviewers

Rosa Arias and **Nora Salas Seoane** (Ibercivis)
Miguel Hernández and **Johana Burbano**, Science for Change (SfC)
Laura Capelli, Politecnico di Milano (POLIMI)
Gerhard Schleenstein, ECOTEC / ECSA
Lucía Paz Errandonea, Ideas for Change (IFC)
María Alonso-Roldán and **Louise Francis**, Mapping for Change (MFC)

Contributors

Rosa Arias and **Nora Salas Seoane** (Ibercivis)
Miguel Hernández and **Johana Burbano**, Science for Change (SfC)
Gerhard Schleenstein, ECOTEC / ECSA
Lucía Paz Errandonea, Ideas for Change (IFC)
María Alonso-Roldán and **Louise Francis**, Mapping for Change (MFC)
Stavros G. Vlachos, Envirometrics
ECSA European Citizen Science Association, ecsa-admin@mfn.berlin

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DIY guidelines

for citizen science projects in odour-conflicted communities

Summary

These guidelines aim to support citizen science projects operating in odour-conflicted communities. They are DIY guidelines - helping you to 'do it yourself' - and offer tested tools and practical tips for running projects and adapting them to different contexts.

Drawing on real-life experiences from the D-NOSES project (see Box 1), these guidelines outline the approach and methodologies used in the project's pilot case studies to tackle odour pollution in affected communities. As such, they are based on the direct experience of people involved in the project - notably the odour-conflicted communities in the pilot studies and the project team. They also draw on numerous D-NOSES reports and resources, especially the Odour Observatory and project evaluations of the pilot case studies.

The main target audience are citizens living in odour-conflicted regions who wish to take steps to address odour problems. However, they can be used by anyone interested in or affected by odour pollution. They are also helpful for other stakeholders in odour-conflicted situations: policy-makers, local authorities and those responsible for the source of the pollution, including the odour emitting activities.

Although focused on odour pollution, these guidelines can be adapted for use by projects addressing other environmental problems, such as noise pollution, illegal dumping, chemical emissions, air quality monitoring and greenhouse gases. Citizen science projects aiming to tackle odour issues should use these guidelines alongside other publicly available documents from the D-NOSES project, including:

- the Green Paper on Odour Pollution[1]
- the Strategic Roadmap for Governance in Odour Pollution[2]
- the review on odour pollution, odour measurement and abatement techniques[3]
- the compilation of good practices in odour pollution[4]
- the analysis of existing regulations in odour pollution and odour impact criteria[5]
- the Odour Observatory's Guidance For Communities[6]
- the Multilevel engagement plan for stakeholders and communities[7]
- the MOOC on Odour Pollution[8]
- other tools available on the Odour Observatory website.[9]

Box 1:

The D-NOSES project

The Distributed Network for Odour Sensing, Empowerment and Sustainability (D-NOSES) project, which ran from April 2018 to September 2021, aimed to:

- **empower citizens** to become a driving force for change through responsible research and innovation (RRI), citizen science and co-creation tools
- **reverse the way** in which odour pollution is commonly tackled - from a private process with no citizen involvement and poor access to data and information, to a **holistic approach** based on citizen science to monitor odour pollution in real time from the receptor point of view
- **advocate** to **introduce odour pollution in the policy agendas** and to contribute to build **appropriate regulatory frameworks** at local, regional, national and European level to act as a basis for odour-control efforts

The project launched the **International Odour Observatory (https://odourobservatory.org/)**, where relevant data and information on odour pollution is gathered, mapped and made available to contribute to the compliance of Principle 10 of Río Declaration[10] regarding odour pollution. By using citizen science as the basis of the methodology this project goes one step further by allowing citizens not only to access the data, but to contribute to its generation. It also produced a **Green Paper on Odour Pollution** and a **Strategic Roadmap for Governance in Odour Pollution**, which set out the basis for future odour regulations.

D-NOSES was funded by the European Union's Horizon 2020 Science with & for Society (SwafS) call, under grant agreement 789315. For more information, see: https://dnoses.eu

1 https://dnoses.eu/wp-content/uploads/2021/12/DNOSES.GreenPaper.pdf
2 https://dnoses.eu/wp-content/uploads/2021/12/DNOSES.StrategicRoadmap.pdf
3 https://odourobservatory.org/wp-content/uploads/sites/2/2021/09/D2.1_Review-on-odour-pollution-measurement-abatement_v3.2.pdf
4 https://odourobservatory.org/wp-content/uploads/sites/2/2021/09/D2.3_Good-practices_v3.1.pdf
5 https://odourobservatory.org/wp-content/uploads/sites/2/2021/09/D2.2-Analysis-of-existing-regulation-in-odour-pollution-odour-impact-criteria-1.pdf
6 https://odourobservatory.org/wp-content/uploads/sites/2/2019/10/Guidance-for-communities.pdf
7 https://odourobservatory.org/wp-content/uploads/sites/2/2021/09/D4.1-Map-of-Odour-Issues.pdf
8 https://dnoses.envirolearning.net/catalog/index
9 https://odourobservatory.org/toolkits-and-guidance
10 https://www.unep.org/civil-society-engagement/partnerships/principle-10

These guidelines are structured into the following sections.

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What is an odour-conflicted community?

This chapter identifies the common characteristics of odour-conflicted communities, using examples from the D-NOSES project.

1.1. What is an odour?

Smell, or olfaction, is one of our major senses. It is one of the most important ways in which the environment communicates with all animals - including humans - and enables us to identify food, mates and predators. For humans, it also provides sensual pleasure, such as the smell of flowers and perfume, and warnings of danger, for example spoiled food or chemical dangers.

Odour is a property of a mixture of substances capable of sufficiently stimulating the sense of smell to trigger a sensation of odour. Odour perception starts in the nasal cavity and ends up with the transmission of a stimulus to the brain, where it may cause pleasant or unpleasant sensations, or even originate physical reactions, due to the involvement of the trigeminal nerve and of other higher brain functions.

However, when speaking about 'odour pollution', the term 'odour' is generally used to refer to unpleasant or unwelcome smells. Box 2 lists common odour sources that were identified during the D-NOSES project for use in the OdourCollect app. The Odour Observatory provides a more detailed explanation of these, along with additional educational resources.[11]

1.2. Common sources of odour

The sources that generate odours in communities are numerous and diverse; in many cases the same community is exposed to more than one odour source. Industrial activities, waste management and wastewater treatment facilities represent the main challenges regarding odour emissions in many European countries, while in Chile the main source is the swine industry[12]. To address this, D-NOSES odour experts proposed six main categories of odour types (waste, wastewater treatment, agriculture/livestock, food industries, industrial and urban odours), each of which comprises different odour-emitting activities. This list was then broken down into sub-types of odour frequently associated with different activities, and categorised in OdourCollect, the app used in D-NOSES to co-create collaborative odour maps; these are listed in Box 2. It is important to note that, even though our sense of smell is able to recognise millions of odour types, it is not always easy to classify the type of smell that we perceive. As we will see in the following sections, the D-NOSES methodology includes the training of the olfactory vocabulary of the population involved, as the odour observations collected are based on the recognition of the perceived smell.

These categories should not be considered an exhaustive list, and in OdourCollect there is always the possibility to include 'other odour' or 'I do not know', in case the subtype category is not clear. Based on a co-creation exercise with affected communities in the D-NOSES pilots in Barcelona (Spain) and Los Álamos (Chile), two new categories were added: 'Nice odours' and 'no odour'. This last one was added in order to have more technical details on the frequency of the odour observations and the duration of odour episodes.

1.3. What is an odour-conflicted community?

An odour conflicted community occurs when people are continuously exposed to environmental odours that they can perceive in their living environment (home, work, recreation). Usually, the perception of the smell is negative and occurs repeatedly, even though continuous exposure to nice odours can also cause complaints. In other words, annoyance odour is the complex of human reactions that occurs as a result of an immediate exposure to an ambient stressor (odour) that, once perceived, causes

Information booth at a waste incineration plant in Barcelona. Source: Mapping for Change

11 https://odourobservatory.org/about-odours

12 Distribution of odour sources in European D-NOSES partner countries, based on >220 odour complaints from the last 8 years. Source: https://odourobservatory.org/wp-content/uploads/sites/2/2021/09/D4.1-Map-of-Odour-Issues.pdf

Box 2:

Types and sub-types of odour used in the OdourCollect app

<table>
<tr>
<td>
Waste

• Fresh waste
• Decomposed waste
• Leachate
• Biogas
• Biofilter
• Ammonia
• Amines</td>
<td>
Wastewater treatment

• Waste water
• Rotten eggs
• Sludge
• Chlorine</td>
<td>
Agriculture / livestock

• Dead animals
• Cooked meat
• Organic fertilizers (manure/slurry)
• Animal feed
• Cabbage soup
• Rotten eggs
• Amines
• Ammonia</td>
<td rowspan="2">
Food industries

• Fat/oil
• Coffee
• Cocoa
• Milk/dairy
• Animal food
• Ammonia
• Malt/hops
• Fish
• Bakeries
• Raw meat
• Ammines
• Cabbage soup
• Rotten eggs
• Bread/cookies
• Alcohol
• Aromas/flavours</td>
</tr>
<tr>
<td>
Industrial

• Asphalt / rubber
• Chemical
• Ammonia
• Leather
• Metal
• Plastic
• Oil / petrochemical
• Cabbage soup
• Sulphur
• Alcohol
• Ketone / ester / acetate / ether
• Amines
• Glue / Adhesive</td>
<td>
Urban odours

• Urine
• Sewage system
• Waste bin
• Waste truck
• Sweat
• Fresh grass
• Humidity / Wet soil
• Traffic / Tyres
• Food
• Flowers
• Chimney (burnt wood)
• Paint
• Fuel</td>
<td>
Nice odours

• Fruit
• Fresh grass
• Forest / Trees / Nature
• Mint / Rosemary / Lavander
• Sea
• Perfume
• Chimney (burnt wood)
• Wood
• New book
• Flowers
• Food
• Bread / Cookies</td>
</tr>
</table>

negative cognitive appraisal[13]. These can come from a range of different sources, such as those outlined in Box 2.

Few of these industries, activities or service providers set out to cause odour problems. Sometimes, however, odour is an unavoidable by-product of an essential process that benefits society; for example, agriculture or livestock are common sources of odours - but we cannot live without these activities. Similarly, we are all jointly responsible for the treatment of waste and wastewater that we generate, which also generates odours.

Emitting activity in the Forum Area of Barcelona

Unfortunately, the continuous emission of odours diminishes the quality of life of nearby communities, and it is not just a nuisance (Box 3). This is why it is important that the public sector takes into account the potential emission of odours from emitting activities when issuing permits or for urban planning to avoid their impact on the population. In some instances, it can affect people's health, for example causing headache, stress, anxiety, lack of concentration, insomnia, or increased respiratory problems. Even if there is a gap in the literature on the relationship between odours and health[14], we can find examples of studies in affected communities, as the one in Finland regarding people affected by odours nearby waste treatment facilities[15]. Another example is more recent and it is about odour nuisance in the south-eastern part of Kraków (Płaszów) and the related quality of life of its inhabitants[16]. The D-NOSES consortium has addressed this issue on the D2.6 Review on odour pollution and its relationship with chemical compounds and health issues[17]. You can find further examples and case studies of how odours affect communities on the Odour Observatory[18], and even better, you can contribute and add new cases to the map.

When communities decide to address the problem - which almost always means tackling the source of the odour - they often place themselves in conflict with the polluters and/or the municipalities or environmental authorities in charge of the issue. This is why we describe them as 'odour-conflicted communities'.

If your neighbourhood or local area is affected by an odour, the first step should be to **identify others who share your concerns**. The Odour Observatory's 'Guide For Communities' explains how to do this[19]. You can also map your problem on our open and collaborative map of affected communities[20] to show the world what is happening.

13 Capelli L., Bax C., Diaz C., Izquierdo C., Arias R., Salas Seoane N. (2019)
14 Literature about odours and their relationship to health can be found here: *https://www.olores.org/en/content/565-the-european-environment-agency-believes-that-the-odours-do-not-affect-the-air-quality-in-europe#references*
15 Marjaleena Aatamila et al. (2010)
16 Magdalena Wojnarowska et al. (2020)
17 https://dnoses.eu/wp-content/uploads/2021/12/D2.6-Review-on-odour-pollution-and-its-relationship-with-chemical-compounds-and-health-issues.pdf
18 https://dnoses.communitymaps.org.uk/project/odours-affecting-communities
19 https://odourobservatory.org/wp-content/uploads/sites/2/2019/10/Guidance-for-communities.pdf
20 https://dnoses.communitymaps.org.uk/project/odours-affecting-communities

Box 3:

An odour-conflicted community in Thessaloniki

Thessaloniki is located in the Greek region of Central Macedonia, which is vital for the country's economic development. One industry based here is Hellenic Petroleum, which has a refinery very close to Thessaloniki. When the refinery was established in 1966, the municipality's population was around 5,000 people. Today, this has risen to over 100,000, and this growth means that some people live less than 500m from the refinery.

Complaints about odours from the refinery have been documented for over a decade. However, the owners state that they follow the requirements of its environmental permits, and participate in major corporate social responsibility initiatives. The refinery has also been involved in public panels to explain its operational processes.

Finding a long-term solution to the problem is difficult. The refinement process, which is an odour source, cannot be significantly altered. Furthermore, most refineries operate continuously and have a high number of fugitive emissions[21], meaning mitigation options are difficult to implement.

The issue is further complicated by a large industrial area close to the refinery, which is home to numerous potential sources of odour. This makes it hard to identify the exact source of odours, and potentially leads to the refinery being unfairly blamed. Furthermore, untreated municipal wastewater from several suburbs in the western part of Thessaloniki are discharged into a river south of the refinery. There have been several complaints about this, and local authorities are trying to map the issue and resolve it.

A refinery in Thessaloniki. Source: Envirometrics

21 Fugitive emissions are gases or vapours released from pressurised equipment, due to leaks and other unintended or irregular releases of gases. They come mostly from industrial activities.

Phase One:

Identify the issues

To address an odour-related problem, the first step is to identify exactly what the problem is. This chapter describes how odour-conflicted communities can do this.

To solve any problem, the first step is to identify it. This is especially important with odour problems, where the causes can be multiple and complex (see Box 4), and which may affect people differently.

Yet odour pollution is an under-reported and under-regulated environmental issue, and there is consequently a lack of knowledge about many odour problems: both the causes and the impacts it has on people's lives. To address this, and establish a shared understanding of the problem, the first step is to get to know the affected area, and then those who know the odour issue best: the people affected by it.

It is important to allocate sufficient time for this first phase, to allow for 'hidden' issues to come to the surface. In the D-NOSES pilot in Spain, for example, new potential odour-emitting activities were only identified at a later phase. And in Uganda, it became clear during Phase One that odour problems are caused by both industry (e.g. uncollected waste) and individuals (e.g. waste burning by households).

2.1. Get to know the local area

As a first step, it is highly recommended for project organisers to get a 'feel' for the affected area. Even for projects initiated by affected communities, taking time to understand the area and its social realities fully will provide useful background for the rest of the project. Not only does it deepen people's understanding of the odour issues, it also helps project organisers to broaden their knowledge about other aspects of the area: the social realities and cultural dynamics of the people to be involved in the project, its geography, demography, places where people usually gather, communities, etc. These aspects will be crucial to design the engagement strategies to gather participants for your project.

The leaders of the D-NOSES pilot projects identified several ways to improve their knowledge of odour-affected areas.

- **Ethnographic fieldwork** is very helpful in terms of deepening the social understanding of the local area. This means research methods that look at people's behaviour in certain social situations, and understanding their own interpretations of this behaviour. It often uses qualitative research methods, such as observing participants and/or

Box 4:

A sensory walk in Kampala

A sensory walk is a guided walk with an interested party to analyse how people use and sense space. They can be arranged through other engagement activities, or when working with an existing group. Participants follow a predefined route, which allows them to focus on sensory information and to collect qualitative and quantitative data. The group stops at specific points for discussions about the experience.

In the D-NOSES project, Mapping for Change used a sensory walk to practice odour reporting with 60 students in Kampala, Uganda. In pairs, and with support from their teachers, the students walked around a defined part of the Kampala Capital City Authority (KCCA) campus for half an hour, recognising distinct odours, marking their location on a paper map and describing them using a 'smell diary'.

Sensory walks can take longer, and be more detailed, depending on the needs of the project and the community. In addition, they can be performed in different seasons or weather conditions to better understand the dispersion of environmental odours.

Kampala students use smell diaries and maps around the KCCA facilities.
Source: Mapping for Change

documenting their social interactions and perspectives. Such methods help all participants to gain a deeper understanding of other people's contexts in relation to the odour issue, as well as insights into their first-hand experience of the problem.

- **Field visits**, such as sensory walks (see Box 4), are an effective way to identify the different odour sources in the area, and also to learn to differentiate, name and map the odours perceived in an affected community.
- It is useful to seek out people who have **previously worked in the affected area**, or those who have previous knowledge of the odour issue, to learn from their experiences and invite them to take part in the project.

2.2. Collect people's stories

One way to gather concerns about an odour is to collect stories about how the odour is affecting the everyday lives of people living or working in the polluted area. This can be done in a number of ways:

- **Rapid appraisals**, which are a good way to get an overview of the problem: visit the region, choose a suitable location and talk to people and businesses to get a sense of the situation.
- **Informal conversations,** to get to know people's stories going to where they are.
- **Surveys and questionnaires** are a cheap, easy and fast approach to ask communities about the problem. Check if this approach is suitable assessing the social context first.
- **Interviews** with members of the affected community can provide in-depth personal insights and are a more sensitive approach that can provide great inputs to get to know the issue.
- A **sensory walk** with communities allows them to reflect on their experience with the odour issue and to recognise and map ambient odours (see Box 4).
- **Group discussions**, for example in a community venue or public meeting place, can also help, especially when different stakeholders are involved.

To stimulate discussions and encourage people to share their stories, project organisers can ask the following questions:

- Where is the odour coming from?
- Is more than one source of odour causing a problem?
- How many types of smells are contributing to the problem?
- When do you perceive the smell with a higher frequency - along the day and along the year?
- How is it affecting your life, and the lives of others?

Project organisers should make an effort to give all members of an odour-conflicted community the chance to share their stories, especially those whose voices are often overlooked in such matters - such as disadvantaged groups (e.g. women, children, groups with low literacy levels, homeless people, etc.) and ensure inclusiveness[22].

However, this is not always easy to achieve in practice and extra measures might be needed. For example, it may be necessary to organise several public activities, at different times (when people are available to attend, after work or during weekends) and in different locations adhering to the social context (see Box 5). Also, be aware that more engaging activities, such as group discussions, might generate higher expectations among participants - for example, that the issue will be resolved quickly, so avoiding raising false expectations is an ethics aspect that should always need to be taken into account.

You should aim to reach people across the affected area, including the worst-affected and less-affected parts. When conducting a survey, you should even go beyond the affected area (i.e. to a 'blank zone') to provide a comparison.

2.3. Consider the problem from all perspectives

As well as asking affected communities their views, other stakeholders - especially **local and environmental authorities, affected municipalities** and **odour-emitting industries** - should be asked for their perspectives on the problem during the first phase of a project. They can share important information (if publicly available) that will contribute to understanding the issue from the scientific and/or the social perspectives.

22 This chapter on Inclusiveness and Diversity includes the D-NOSES inclusive engagement framework: Carole Paleco et al. (2021).

However, this step may prove more difficult. While communities affected by odour problems are often prepared to dedicate their time and energy to addressing it, other stakeholders may be less enthusiastic. The D-NOSES pilot projects came across numerous barriers when first making contact with such stakeholders:

- Local authorities may lack **data on odour issues**; not all municipalities collect complaints about odours, for example, or the mechanism for collecting complaints is not straightforward.
- Industries may be reluctant to share **confidential or operational data** about their odour-generating activities and/or industrial operations.
- All stakeholders may **lack the capacity** - time, staff and money - to support the project actively.
- It is key to **gain trust** from all stakeholders involved in the issue, one by one.

Even if it is not possible to engage deeply with such stakeholders during this first phase, project organisers should at least attempt to do so. This will establish initial contact with such groups for later in the project, and demonstrate your transparency and neutrality within the project. It will also counter any later claims from these stakeholders that they did not have a chance to help identify the issues and thus did not have the opportunity to contribute to the co-creation of actions towards reducing the impact on the affected community.

Box 5:

"Fish where the fish are"

Identifying locations where communities and families from the project area gather can be a way to inform them about your project and engage them in different activities. In La Mina, a neighbourhood in Sant Adrià del Besòs, closeby Barcelona, families gather outside the local swimming pool, in a local bar, from 17:00-18:00 while their children attend swimming classes. These families proved to be quite sensitive to odour pollution issues, as they were living in the affected area, and this proved a useful opportunity for telling them about the D-NOSES project. By contrast, handing out leaflets in La Mina was not as effective as attending community events or hanging out in places where people gathered. The message is: depending on the local context, one may follow one strategy or the other, and that is crucial for the D-NOSES model. So, undertaking ethnographic research is a must.

This example is taken from the D-NOSES workshop 'You've got the buzzwords, have you got the people? A highly inclusive engagement model to tackle socio-environmental issues using citizen science', held at the ECSA 2020 conference. A recording is available at: www.youtube.com/watch?v=7gfsHmPqw8g

Expected outcomes from Phase One - Identify the Issues

- A defined set of issues that the odour is causing, largely from the perspective of the affected communities
- A clear understanding of which communities are affected, how long the odour problem has been occurring, and how far it has spread
- An initial approach to key stakeholders for a wider overview of the issue

Phase Two:

Stakeholder mapping

To resolve an odour problem effectively, it is important that all the key players are involved in identifying potential improvements or solutions. This chapter explains how to map all the stakeholders involved in odour pollution issues.

During Phase Two, the focus should be on considering as many stakeholders as possible. The more people involved in the project, the greater the chances of finding a compromise to reduce odour impact that is workable - and acceptable to people on all sides of the issue. Stakeholder mapping is also a good way to engage with people involved in the project for later phases.

3.1. Identify your stakeholders

Identifying the stakeholders in a project might seem like a simple step, and starting this process off can be quite straightforward. In many instances, the project organisers will sit together with a large sheet of paper, some marker pens, and ask each other: who needs to be involved in this project?

However, ensuring that you create a **comprehensive and inclusive map** of all stakeholders takes time and dedication, for a variety of reasons:

- Some stakeholder groups, or the relevant actors within these groups, only arise later in the process, not at the beginning - and may only become apparent during later phases of the project, meaning that this should be an iterative phase.
- By spending time with odour-conflicted communities, you may identify further - and unexpected - stakeholders through their informal networks.
- If the project is taking place in a new or unfamiliar location, the project team will also need to conduct desk-based research (this is also recommended even if you know the area).
- It is not a one-off task: your stakeholder map should be constantly updated throughout the project, as new stakeholders come into play.

Stakeholder mapping can be enhanced through ethnographic field work in the affected area. In the D-NOSES pilots, this helped to identify some overlooked social groups. It also helped the project organisers adopt a fully inclusive approach to stakeholder mapping, by moving beyond the established 'formal' structures applied to different groups, to consider 'informal' structures in more detail.

To achieve a truly inclusive approach, as many different people should be involved in the mapping process as possible. At this stage of the project, this may include members of affected communities. It could also include local authorities, odour experts, and industries or other odour-emitting activities - although some of these stakeholders might be harder to engage (see Section 3.3). Time spent with these stakeholders can also build trust and strengthen relationships with them early in the project and get them on board.

3.2. Map out their motivations

Once the individuals, groups and businesses with an interest in the odour issue have been identified, the next step is to consider how to involve them in efforts to resolve the issue. What are their motivations for participating?

Ethnographic methods are useful at this point.

For citizen-led projects, one of the easiest ways to do this is to talk to people. Organising a series of meetings, interviews and conversations with local stakeholders will help everyone involved to better understand the issue at stake, and the varying perspectives on this issue. Figure 1 identifies some of the benefits for different stakeholder groups. It is important to adapt the language and send the right message to each of the stakeholder groups to foster their involvement.

Fig. 1:
Potential benefits to participating in odour-pollution projects for different stakeholders

Source: D-NOSES consortium

3.3. Barriers and mitigation strategies

While some stakeholders will be keen to get involved in resolving an odour issue, **others may be reluctant**. Several of the D-NOSES pilots experienced this problem (see Box 6). In some cases, it was the regional authorities; in others, the industries responsible for odours; while in some, the affected communities were not willing to participate due to an initial lack of trust.

There could be a number of different reasons for this lack of interest, such as:

- a lack of time to engage with the issue, or more urgent priorities
- apathy among communities who see odour problems as a long-term issue and feel nothing will ever change
- invested interests in the cause of the odour, such as commercial interests for the polluting industry or citizens affected working at the emitting activity
- fear or apprehension about whether the proposed mitigation actions might affect their livelihoods, or be expensive to implement
- general mistrust in the project, the team or the potential results

As well as mapping out stakeholders' motivations, it is therefore also important to anticipate and document their potential concerns. This can be done by asking: What are the possible barriers to different stakeholders taking part in the project? How can these be overcome?

An important decision at this stage is **which stakeholder group we should address first**. For example, affected communities may be reluctant to participate if environmental authorities or odour emitting industries are approached first. In other cases, such as the case in Thessaloniki and Barcelona, approaching the regional authority proved effective to increase trust in the rest of stakeholders to get on board. A strategy should be defined based on the understanding of the issue.

Box 6:

How to reach reluctant stakeholders

During the D-NOSES pilots, the project organisers learned that communication is key in reaching reluctant stakeholder groups. In some cases, this will mean working within their communications systems. For example, local authorities may be more likely to respond to official, top-down requests for help, such as a letter or formally submitted communication, as this is how they usually work. Direct meetings to present the project are also key.

At other times, the medium chosen for communication may help you to contact hard-to-reach groups. In Uganda, the pilot organisers switched from emails to WhatsApp messages because this is what their target groups used to communicate.

The trick is to build on the communications channels people are already using, rather than trying to impose your preferred channel on them. It may take more time - especially if different stakeholder groups prefer different approaches and channels - but it will yield better project outcomes if everyone gets on board early on.

And finally: do not forget to adapt your language and your message to your target audience! And avoid raising false expectations to increase trust.

Expected outcomes from Phase Two

- A map of all stakeholders with an interest in the issue
- A clear idea of their motivations and concerns
- Agreed strategies to overcome these concerns
- A clear strategy on the stakeholder group to be approached first

Phase Three:

Frame the problem

Once an affected community has been identified, it is important to frame the problem clearly. This chapter outlines how to reach a shared understanding of the problem among all stakeholders - and some of the challenges that may arise.

Framing an odour problem means giving it 'shape': using facts and figures to turn people's stories and experiences into a clear problem that can be tackled.

Odour problems can be difficult to define, however. There may be different odour sources to consider, and conflicting views on the severity of each. Odour problems can also be emotional issues as those affect people's well-being directly, and communities living with them may feel exasperated, while those causing them may act defensively when the issue is raised.

It is therefore essential to frame the problem carefully and accurately: to establish exactly what it is and how it affects people. Establishing a clear picture helps to take emotion out of discussions, and data will show the facts, enabling all stakeholders to focus on co-designing actions to reduce the impact over the population.

4.1. How to frame an odour problem

To frame an odour problem, there are a number of activities that can be done. Odour experts may start doing desk research, investigating all available public information on the issue. This may include all available documents, such as:

- previous odour complaints;
- existing studies on odour impact assessment;
- information on the environmental permit of the emitting activities, to understand the odour emitting process, the main odour sources and the associated odour types, and to see if they are obliged to carry out any kind of analysis regarding odour emissions;
- news in the press. It is also important to talk with the emitting activities and, if possible, visit them. Having the environmental authorities, the municipalities and the odour emitting activities on board will help gather further information than what is publicly available to analyse the project from a scientific point of view.

Phase Three will be most successful if all of the stakeholders mapped in Phase Two contribute to framing the problem. Bringing together this broad spectrum of interested parties will help to identify the full range of issues around the odour problem, and the key contributory factors. It can also be useful when

Box 7:

How to frame an odour issue collaboratively

Framing an odour issue, and involving all the relevant stakeholders, is not always simple. Experiences from the D-NOSES pilot projects suggest that the following principles are vital to success.

- **Be flexible.** You may need to adapt the timing of engagement activities for different stakeholder groups, according to their availability and other priorities.
- **Describe the problem in the right way.** An odour problem should be described as it is perceived by citizens. In the UK, for example, the D-NOSES pilot team reframed their project as being about 'air quality' rather than 'odour pollution', as that is how local people described it.
- **Use people's knowledge**. Make sure everyone's inputs are included and valued; this is essential for increasing understanding of the issue (e.g. how far an odour extends) and also motivates people to stay involved, as they feel their voice counts.

Another key lesson from the D-NOSES pilots is that projects work best when they build on strong local foundations. Rather than starting from scratch, project organisers should identify the networks and infrastructure that already exist in the odour-affected community - and work with these, rather than trying to replace or compete with them. For example:

- **Go where people go.** Run workshops and community events in places that people already use, such as community centres, churches or informal meetings spots (see also Box 5).
- **Involve local facilitators that can become the community champions of your project.** Collaborate with local leaders, such as the leaders of formal neighbourhood organisations.
- **Contact schools.** Many of the pilot projects successfully worked with local schools, incorporating citizen science approaches into broader science and education activities. Children, in the same way as the community champions, can act as project multipliers.

Sensory walk in Barcelona. Source: Mapping for Change

Odour emitting activity at Los Álamos. Source: Ecotec

prioritising which issues should be tackled first, and who should play a role in this. Organising public meetings, sensory walks, visits to the odour emitting activities or round tables with all stakeholders will help to frame the issue from a broader perspective.

However, a by-now familiar problem may hinder this in practice: a lack of engagement by one or more stakeholder groups. In some of the D-NOSES pilot projects, the organisers found that while they were able to establish contact with odour-conflicted communities, the social realities of people's lives made it difficult to engage them fully. Fortunately, they also identified some useful tips to address this and bring everyone together to frame the problem collaboratively (Box 7).

4.2. Technology, data and information

During Phase Three, it is important to start considering how technology and data can help with tackling the issue. In particular, it is useful to find out what existing resources can be drawn on, such as:

- **publicly available information** on sources of pollution
- **existing data** on local odour issues
- **technical data** and **environmental permits** of odour emitting activities
- **media reports** about the issue, either locally or similar cases from other regions
- existing tools for **measuring and recording the type of odour** that is causing a problem

This will not only identify existing resources, but also highlight major gaps in resources and knowledge - an important preparation for Phase Four.

Expected outcomes from Phase Three

- A scientific understanding of the project based on available information
- A common understanding of the problem, created and shared by all stakeholders
- A log of existing technology, data and useful information

Phase Four:

Project design

This is a critical stage in tackling odour pollution: designing the project. While every project will be different - depending on the type(s) of odour, the stakeholders involved, and the local context - we suggest some common factors to consider.

Project design should be undertaken using a co-design approach - with all stakeholders included. By involving everyone at this stage, and ensuring their views are considered and represented, it will become easier to act on the data gathered later in the project, and to agree the way forward.

5.1. The research question

All scientific projects, whether led by professionals or citizens, need a clear research question that the project aims to answer. This question will depend on the context for each project, and the views of all stakeholders. For example, which aspect(s) of the odour problem do citizens want to understand better (e.g. the source, impact area, health effects)? What information do policy-makers need to inform their decisions? What information is key for the odour emitting activities to adjust their industrial operations and reduce the impact over the population?

If possible, project organisers should aim to get all stakeholders together - in the same place at the same time. This will allow you to use the policy-society dialogue approach (Box 8), which the D-NOSES pilots implemented at this stage.

Box 8:
Policy-society dialogues

Policy-society dialogues are a powerful tool to encourage multi-sided communication between citizens, scientists and policy-makers; they can also include other stakeholders, as appropriate (e.g. industry). They provide a forum in which citizens can meet with representatives from different stakeholder groups to share ideas around a common problem.

Policy-society dialogues are inclusive by nature. They allow all stakeholders – regardless of their level of knowledge, their socio-economic background, religious affiliation, cultural background or gender - to have their say on an issue and make their voice count. They also help to establish commitment among stakeholders, and can lead to a more accurate and widely supported definition of the problem at hand (Bulkeley and Mol, 2003).

The D-NOSES pilots used policy-society dialogues to initiate contact between groups and forge improvements to odour problems, as well as to consider research questions. However, our experiences suggest that they should only be arranged once the project organisers have a good understanding of the issue at hand and the networks in place. If you bring everybody together too early (i.e. before the problem is well understood), it may trigger conflicts that you are not (yet) able to resolve.

5.2. The data-collection strategy

Once the research question has been agreed, the next step is to establish how to collect the data needed to answer it. Some data sources may already exist (identified during Phase Three), but the D-NOSES approach involves citizens actively collecting data on the odour problem, using citizen science approaches, to **understand the problem from the receptor point of view** and account for **real time monitoring of the perceived impact**.

The exact nature of the data needed will depend on the specific odour problem being addressed. It may be important to involve an odour expert at this stage to ensure that the strategy has the right focus. However, communities can discuss and agree upon many aspects of data collection, such as the means for collecting the data. Project organisers can use the following questions to guide these discussions.

Timing (when?)

- How often will you need to collect the data (e.g. daily, weekly, monthly)?
- How long will you need to collect data for (e.g. six months, one year)?
- At what times of day does the data need to be collected?

Location (where?)

- Where does data collection need to take place?
- Do citizen scientists need permission to gather data there?

People (who?)

- Who will do the collecting?
- What skills and training will they need?
- How do we plan to train the citizens involved?
- What is their knowledge of the local issue?
- Do they have any potential conflict of interest that may introduce bias in the collected data?

Students from São João da Madeira (Portugal) learning how to conduct dynamic olfactometry

Data (what?)

- What are the main odour types and subtypes that we want to monitor?
- What are the main attributes of an odour observation?
- Is the intensity and the hedonic tone of the perceived odours important to be measured?
- How can we account for the duration of the odours perceived?
- Do experts need to check and/or verify the data?
- Is it safe for citizens to collect this data (e.g. if the odour comes from chemical sources)?
- Will we need to add further data retrospectively (i.e. after the data-collection process)?
- Do we need to create a bespoke odour list for this location?
- Do we need to correlate the odour observation data with other types of data (e.g. weather data, industrial operations data, sensor data, etc.)?
- How will we verify the plausibility of the data?
- Do we need to complement the methodology with traditional odour monitoring techniques, such as dynamic olfactometry?[23]

5.3. Tools and approaches for data collection

As well as deciding **which** data will be collected, project organisers and participants will need to think about **how** data will be collected. A number of different tools and approaches are used to gather data on odour pollution. These include apps dedicated to odour monitoring, and paper-based methods such as questionnaires or 'smell diaries', which can be used when technology is not available or to avoid the digital gap to guarantee inclusivity.

To identify the best tool or approach, communities should seek expert advice on how to measure the odour. Communities should also consider the following questions before making a final decision on which tools to use. These include:

- What are the objectives of data collection?
- Which data do we need to collect?
- Which tool or strategy can help us collect the data?
- Does the community have access to technology? Is there a digital gap?
- How expensive is it, and who will pay for this?
- What other costs are involved in data collection (e.g. data analysis, reporting)?
- How time consuming is the data collection activity?

It is important not just to identify which is the 'best' tool or approach from a scientific or technical perspective, but also which are the **most appropriate for your project**. Project organisers need to assess the suitability of the different options in relation to:

- the project's budget
- participants' time
- participants' digital literacy (i.e. whether they can use the tools properly)
- the languages in which the tool is available
- internet connectivity (e.g. is there good connectivity to gather real-time data? Is it affordable and reliable?)
- access to technology - especially if working with young people.

Another important aspect to consider is the **openness of the data** and the **recognition of the ownership of the data** collected. Being this data collected by the affected communities, i.e. by the citizens involved, the property of the data belongs to the citizens and the corresponding recognition should be given in any scientific publication or alike derived by the project, following the

23 The Odour Observatory identifies several 'traditional' tools and approaches for measuring odours that can complement the D-NOSES methodology: https://odourobservatory.org/measuring-odour

10 principles of citizen science by ECSA[24]. Also, **ethics aspects** should be ensured at all times in relation to data collection, including the protection of personal data according to the General Data Protection Regulation (GDPR[25]Box 12), the signature of informed consent forms by all participants or the anonymisation of all data collected. Finally, the chosen tool needs to provide access to the data collected by the citizens at all times in an open format, so that everybody can access the odour observations collected - contributing to the compliance of **Principle 10 of Rio Declaration** (Box 9) regarding the access to environmental information.

5.4. Data validation

When scientific standards are observed, citizen science allows to create large datasets and introduce innovative ideas, fosters acceptance through transparent procedures and verifies practical applicability in the field. It is an effective instrument to deal with complex social issues and strengthen the research methodology. Still, citizen science is a scientific method with advantages and limitations, like every other approach. The inclusion of citizens in research can be difficult when the methods require special training or strenuous work. In addition, individual accuracies can vary, depending on the difficulty of the tasks. The element of variation in data collection and analysis done by citizens needs to be carefully incorporated into the final analysis and interpretation of the data/project.[26]

Quality assurance and quality control are commonly thought of as procedures used in the laboratory to ensure that all analytical measurements made are accurate. Yet both extend beyond the laboratory and are essential components of all phases and all activities of an odour monitoring project. You can find useful recommendations in the Handbook for Citizen Science Quality Assurance and Documentation[27] published by the United States Environmental Protection Agency.

Data plausibility checks and data validation should be considered within your projects. In the case of odour pollution, a typical plausibility check compares odour observations with the wind direction (see Section 7). Depending on the wind speed and the current wind direction, the position of the measurement point can allow for correlating potential odour sources according to the perceived odour type. For example, if one takes as reference the European standard for field inspections[28], for wind speeds above 1 m/s, a measurement can be considered plausible if the measurement point is located in the current wind direction within an angle of +/-60° from the source. More complex plausibility checks consider the calculation of retrotrajectories, using reverse dispersion modelling, which may be useful in multi-source settings for activities emitting different types of odours.

Box 9:
Principle 10 of Rio Declaration

Principle 10 was adopted in 1992 as a part of the Rio Declaration, stating that:

"Environmental issues are best handled with participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided. "

Principle 10 sets out three fundamental rights: access to information, access to public participation and access to justice, as key pillars of sound environmental governance. Citizen science not only allows compliance to Principle 10, but goes one step beyond by making the citizens active contributors to environmental data. D-NOSES advocates for the "right to contribute to data" of citizens in environmental matters of their concern.

24 https://zenodo.org/record/5127534#.YVIpArgzZPZ
25 Regulation (EU) 2016/679 of the European Parliament and the Council of 27 April 2016 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02016R0679-20160504
26 https://odourobservatory.org/measuring-odour/citizen-science
27 https://www.epa.gov/citizen-science/quality-assurance-handbook-and-guidance-documents-citizen-science-projects
28 EN 16841-1 Ambient air - Determination of odour in ambient air by using field inspection - Part 1: Grid method. https://www.en-standard.eu/csn-en-16841-1-ambient-air-determination-of-odour-in-ambient-air-by-using-field-inspection-part-1-grid-method

5.5. Training and support materials

One important element of citizen science is that everyone should have the opportunity to take part. To achieve this in practice, it may be necessary to provide training and support materials, so that everyone is able to collect data and odour observations.

To identify training needs, it may be necessary to map the skills that participants need to use tools or to recognise ambient odours, followed by the skills they already have - and then identify the gaps between these two. Once the requirements are clear, training can be organised in a number of ways, such as:

- training sessions or workshops held within the community
- sniffing sticks and odour samples to learn describe odours, their intensity and hedonic tone
- videos about how to collect odour-related data
- sensory walks to practice the data collection methods together and learn how to recognise ambient odours, give them a name and map them in a consistent manner
- training manuals and other educational materials; such as the D-NOSES MOOCs[29] (currently available in Spanish and Greek) or the didactic unit of OdourCollect[30]. The EU-Citizen.Science platform[31] is also a good place to look for additional materials.

5.6. Communications channels

Another important decision during Phase Four is to establish how stakeholders want to be kept up to date. This could be by email or other communication via Apps, social media, Slack or through regular meetings. In keeping with the ethos of building on local foundations, these communications channels should reflect what people are using already, rather than seeking to introduce a completely new approach.

Once the preferred system of communication has been agreed, this should be noted in the project's data-collection strategy, or a separate project communication plan if necessary. As a minimum, a communications plan should include:

- agreed channels for **internal communication** between participants and the different stakeholder groups, such as an email list or regular stakeholder meetings.
- agreed channels for **external communication** to tell the wider world about the project, such as a project website or social media accounts (e.g. a Facebook group).

The channels used should be agreed by all project stakeholders, and match the time, skills and resources available within the project team - and it is up to the project organisers to make sure this is acted upon.

Expected outcomes from Phase Four

A project plan that includes:

- A clear and agreed research question
- A data-collection strategy that lists the data-gathering tools and approaches to be used, including the training of the participants, ethics aspects and data validation strategies
- Agreed communications channels

29 D-NOSES has produced two Massive Open Online Courses: one for educators and one for the public. They can be found here: https://dnoses-mio.talentlms.com/catalog

30 OdourCollect has two didactic units to introduce the issue of odour pollution in secondary schools, one for teachers (https://zenodo.org/communities/odourcollect-escuelas/?page=1&size=20) and one for students (https://zenodo.org/record/4581130#.YVIymLgzZPY), currently available in Spanish and Catalan.

31 https://eu-citizen.science/

Phase Five:

Data collection

Data-collection methods will vary from project to project, depending on the local context and the source of odour pollution being studied. Rather than describing such methods in detail, this chapter sets out some common principles to apply when collecting data in a citizen science project.

Phase Five will draw heavily on the outcomes of Phase Four, notably the data-collection strategy. However, it is important to review this strategy once data collection is under way, and ask: Is it generating the data we need and/or want? Is everyone able to take part? Are there any problems with the approaches selected, or gaps in the data we need to address? How can we ensure the quality of the data?

The focus in this chapter is on citizen-generated data, but remember that you may also be able to use publicly available data from other sources; this should also be obtained during Phase 5.

6.1. Duration of data collection

In general, odour impact depends on the variability of the odour emissions, together with the weather conditions and the related dispersion of the emitted odours. Data about odour pollution should be collected for at least three months - and ideally during a year in all four seasons, if you want to account for seasonal variability, depending on your project objective. This will ensure that the odour observations are made during different weather conditions. Dispersion is a significant factor influencing the impact of odours, determining where the odour drifts to, the overall impact area and the perceived odour concentration. Some sources of odour will only be emitted at certain moments during the year, such as agricultural odours (e.g. muck-spreading on fields before sowing). Industrial processes may also be discontinuous, thus causing variable odour emissions. Some punctual industrial operations may also increase the odour flow released into the atmosphere and cause odour episodes.

However, gathering such long-term data is not always achievable in practice. The costs (e.g. for technology, or transport to the site, for maintaining citizen engagement), may add up over time. In other places, a lack of resources for local communities to collect data (e.g. smartphones) could be an issue, as well as a lack of local staff (or staff time) to oversee a project.

Participants may also find it difficult to maintain their time commitments, due to competing pressures such as family or work commitments. Many citizen science projects also find that motivation levels drop over time, as the initial enthusiasm wanes or participants feel they are not making any progress. Data-collection processes may also be interrupted by factors beyond the project's control (see Box 10).

An alternative, psychometric approach for monitoring and assessing annoying odours, set out in VDI 3883[32] Part 2, recommends that citizens use short-term observation periods (2-3 months, with daily observations) or long-term observation periods (12-14 months, with one observation per week) - although the amount of data collected with this method is rather low.

Box 10:
Dealing with the unexpected

No matter how well you plan your project, events beyond your control can disrupt things. During the D-NOSES pilots, the COVID-19 pandemic caused a major problem for all pilots during the data-collection phase. In Italy, for example, lockdown restrictions put in place due to the pandemic made it difficult to complete the training for citizens on how to collect data.

In response to this, the pilot team held the later training sessions online, to ensure their participants had access to the full process. This shift did affect citizens' participation, however, with fewer people attending online meetings compared to face-to-face sessions. One possible reason for this was that the project's volunteers were mostly older, and therefore less familiar with some online technologies.

6.2. Support for data collectors

As Section 6.1 notes, the data-collection process doesn't always run smoothly. Fortunately, there are several different

32 This is a German technical standard, 'Effects and assessment of odours; determination of annoyance parameters by questioning; repeated brief questioning of neighbour panellists', produced by the Verein Deutscher Ingenieure e.V. (VDI, 1993). See: https://www.vdi.de/richtlinien/details/vdi-3883-blatt-2-wirkung-und-bewertung-von-geruechen-ermittlung-von-belaestigungsparametern-durch-befragungen-wiederholte-kurzbefragung-von-ortsansaessigen-probanden

Box 11:

The OdourCollect App

OdourCollect is a free app that any citizen can use to report odours. It can be used as a citizen science tool to build odour maps collaboratively, based on odour observations - anywhere and at any time! It can also be used to report bad odours in affected communities, with the aim of co-creating improvements or potential solutions with all the stakeholders involved (local authorities, odour emitting industries, experts - and of course - citizens!).

OdourCollect is an open data App that allows the collection and validation of odour observations gathered by citizens in local communities affected by odour pollution. It is based on the concept of **"citizen-sensor"** and promotes **an inclusive engagement approach** to build **odour maps collaboratively** by anyone affected. All collected data can be visualised in the map without the need of registering. OdourCollect was conceptualised by Science for Change and further developed through the D-NOSES project. It was subsequently used in several of the project's pilot studies as a tool to **empower communities** affected by odour nuisance to monitor and demonstrate the problem.

How does OdourCollect work?

Citizens are the users who make simple reports, indicating the **type of odour perceived, the intensity level and the hedonic tone** (i.e. how much they like or dislike it). OdourCollect **geolocalises** the users, associating time and space stamps to each report. Its back office allows the validation of **individual and collective observations.** Only if the emitting industry is involved, the data can be correlated with industrial processes to co-design corrective measures and minimise the odour impact over the affected communities. Data can also be used to co-design **Odour Management Plans** for the odour emitting activities or to **evaluate the effect of mitigating measures** after their implementation.

OdourCollect's key features are:

- Calculation of the odour impact in real time in affected communities based on human perception, while existing methodologies are focused on the odour sources and only estimate a probable, average impact on those communities.
- Identification of sources of odour pollution affecting communities thanks to data correlation with industrial processes.
- Elaboration of Odour Management Plans for smarter decision-making to reduce odour impact over the population.
- Early alert of industrial incidents (odour episodes) thanks to the availability of real-time odour data.
- Verification of the effect of corrective measures for minimising odour impact after their implementation.
- Digital social innovation for addressing societal and environmental challenges.
- Increased transparency, platforms provide free and open data access.
- Improved relationships between industries, public authorities, environmental organisations and citizens. Increased trust.
- High potential for replicability to tackle other socio-environmental challenges.

Currently OdourCollect accounts for more than 10.000 reports from approximately 1.000 users around the globe. Now you know, so smell and share!

ODOUR COLLECT

You can access the web app: https://odourcollect.eu

strategies that project organisers can use to keep people engaged. For example, you could:

- identify **community champions**: these are usually the most dedicated participants, who can help to motivate others. They may be involved already in citizen associations (and can help communicate about your project through their networks) or other socio-environmental endeavours related to their neighborhoods.
- attract **new participants** to the project, for example by organising events, extra training sessions and participating in community events already in place: this provides a fresh impetus to the group and reduces the burden on each data collector.
- conduct **early analysis** on the data collected so far: this will reassure participants that their efforts are making a difference and provide feedback to their efforts in collecting data.
- provide participants with regular opportunities to **share their thoughts or concerns**: do they need any extra support during the data-collection phase?

Throughout the data-collection phase, it is essential for project organisers to be **flexible and open to feedback** - especially when volunteers say that something isn't working. It is better to make changes during a project, rather than only discuss problems at the end. To enable such adaptability, project organisers need to provide regular opportunities for volunteers - and other project stakeholders - to give their feedback.
In the D-NOSES pilots, several teams decided to tweak their data-collection strategy once the volunteers had started.

- One pilot team switched from using an app (OdourCollect, Box 11) to using less technical approaches, such as paper-based odour diaries during sensory walks, associated with a limited access to technology. Data collected through odour diaries was retrospectively uploaded into OdourCollect by the team.
- Another pilot project started to provide data plans and tablet devices to help volunteers with data collection.
- The Chilean pilot project decided to take a systematic approach to data collection due to the difficulties in engaging a high number of people in the affected communities.

6.3. Feedback for all stakeholders

While not all stakeholders will be involved in collecting data, it is important to keep them updated on progress, so that the agreed strategy can be reviewed and updated if necessary. Providing **regular feedback** also ensures that all stakeholders remain engaged with the project, even during phases they are not actively involved. Keeping up this engagement to fulfill the principles of citizen science can help to sustain relationships between stakeholders, making it easier to work together when necessary during later phases. Useful approaches include:

- providing intermediate reports on project progress, using the agreed communication channels.
- asking local champions to collect data with citizens: this can be a powerful motivator for citizens to continue with the project.
- organised sensory walks to motivate data collection.

As a minimum, we recommend organising a data analysis workshop, involving the data collectors and odour experts (if possible), after the **first month of data collection**. This will be an opportunity to review and (if necessary) refine the data-collection strategy, as well as to share with citizens the initial results of their efforts. Sensory walks or further odour trainings can be organised if needed.

Lastly, citizen science projects - at least, those operating in Europe - will need to consider how to ensure any personal data they collect is kept secure and private, in adherence with data-protection regulations (Box 12).

Box 12:
Data protection

Data on odour pollution can be sensitive, and citizen science projects often collect personal data on their participants (e.g. names, contact details) as well. To comply with European regulations on data protection - namely the General Data Protection Regulation, or GDPR - it is essential that such data is managed carefully. These regulations can be complex, but you can usually comply with them by following some basic principles.

- Data should only be used for the purpose for which is was collected
- You should only collect the data you need for the project, and nothing else
- Data collected should be accurate
- It should only be stored for as long as it is needed
- Data should be managed with integrity and treated as confidential
- The project organiser, or an appointed person, should be accountable for the data

One way to keep track of adherence to these principles is to prepare a **data management plan** for your project, setting out how all data will be collected, stored, shared and deleted.

Note that data-protection regulations are constantly being updated. If you are unsure about whether your data management complies with the rules, it is best to contact your national data regulator. To get the most up-to-date information about managing data in citizen science projects, we recommend searching on the EU-Citizen.Science platform[33]; for further information about the GDPR, you can read through the many resources from the PANELFIT project.[34]

Expected outcomes from Phase Five

- Citizen-collected data that monitors odours in the project area, from the selected period of time based on the project objectives
- Data provided by other stakeholders, such as data from odour-emitting industries, weather data and publicly available environmental data
- Feedback mechanisms and a data management plan set in place

33 https://eu-citizen.science/resources
34 https://www.panelfit.eu

Phase Six:

Data analysis

This chapter outlines some common issues to consider during data analysis, as well as tips to ensure the data can be accessed and understood by others.

You've collected data about your odour problem - congratulations! The next step is to analyse this data. This includes data plausibility and data visualisation, which should be done with the help of odour experts. However, it is important that the people who collected the data are actively involved in analysing it, as their local knowledge and direct experience of odour problems will add value to the results.

7.1. Data analysis

As with data collection, the analysis techniques you need to use will be determined by the type of odour pollution being investigated by the project and the type of data collected. Odour experts or local authorities - or, in some cases, the stakeholders responsible for the odour - will be able to advise citizens' groups on the most appropriate analysis techniques to use. However, there are certain questions that should be considered as a starting point for analysing any source of odour pollution.

- What does the data tell us?
- Are there any trends in the data?
- Are we gathering the right data?
- Do we need extra data?
- How can we correlate the observed data on odour perception with the daily operations at the odour emitting industries or the weather conditions at the time of perception?
- What are the main criteria to validate the collected data?

Remember, data analysis can begin while Phase Five (data collection) is still under way, so there is still time to adjust the data-collection approach if necessary.

The ultimate aim for the data analysis is to answer the research questions set at the start of the project (Phase Four). The analysis should therefore not just include data (i.e. facts and figures about the odour), but also some key conclusions based upon the data: Where is the odour coming from? What are the main types of odours perceived? What is the frequency of the perceived odours? Which particular activities or processes are responsible, and to what extent?

7.2. Data plausibility

At the same time as analysing the data, you will need to check its accuracy and quality to verify if data can be assigned to a certain event, which is known as a plausibility check. This is important, because inaccurate or poor-quality data can undermine later attempts to influence or change odour-related policies, or produce poor Odour Management Plans for the industries to adjust their industrial operations and reduce the related odour impact over the population. People will be reluctant to base any major decisions on data they do not trust.

One approach to data plausibility is to compare citizen generated (bottom-up) data with other "traditional" (top-down) techniques to assess odour impact. This will allow complementing the information collected and therefore having a broader approach to the odour problem. Therefore, in this stage it is important to ask an odour expert for advice on how to approach the type of data collected. Box 13 provides an example from the D-NOSES pilot project in Greece.

Box 13:

Checking the plausibility of citizen-generated data in Greece

The D-NOSES project in Greece used a three-step method to check the plausibility of the data it collected.

Step 1: take two sets of measurements with an in-field olfactometer for each area of interest - during an odorous day and a non-odorous day.

Step 2: validate all observations, through comparison with wind-direction data, for the entire data-collection period.

Step 3: hold a public consultation to confirm the nature of observations with key stakeholders.

Further examples of how to check data plausibility, from the D-NOSES projects in Chile and Italy, can be found here:
Chile (see Section 3 in particular, PDF): www.aidic.it/cet/21/85/024.pdf
Italy (PDF): www.aidic.it/cet/21/85/025.pdf

7.3. Data visualisation

Phase Six is not just about analysing the data collected; projects also need to share the results. One effective way to do this is through data visualisation. Different approaches to data visualisation - such as graphs, graphics, photos, maps and timelines - help people to make sense of the data collected and understand what it is showing.

All project participants, especially the data collectors from affected communities, should also be involved in this step. As representatives of a target audience for the data visualisations - i.e. citizens - they are perfectly placed to know what will work well, and what won't, as well as deciding what they want to see in the data.

Box **14**:

Visualising odour data in Barcelona

After data collection (Phase 5), the D-NOSES pilot team in Barcelona invited participants to join a collaborative data analysis session. This was organised to enrich the initial findings with their comments, experiences and additional interpretations of the data.

The session included a presentation of the key facts and figures, such as the total number of observations; the number of users and episodes that participants had reported; and the most reported types of odour, as well as their subtype, intensity and hedonic tone.

The initial results from this participant-led analysis were presented with a description of how the odour observations were analysed. This was then shared as a public presentation and sent to all participants by email, in order to keep gathering their feedback.

After these initial results, the pilot team of Barcelona created a variety of maps, using specific software for data visualisation, following requests from the citizens and the involved environmental authority (shown below). The data visualisation helped to identify the areas where the different sources of odour had more impact in an intuitive and straightforward manner.

Intensity of sludge subtype and number of observations in the Fòrum area. The peaks indicate the zones where more observations were recorded (squares of 100m x 100m).

Heat map of the hedonic tone in the Fòrum area.
Red areas represent more unpleasant odours.

Expected outcomes from Phase Six

- Definition of the data analysis, data plausibility and data visualisation strategies
- Identification of potential improvements in data-collection processes
- New insights and understanding of the odour problem under investigation, drawn from the data collected, to co-design Odour Management Plans, changes in daily operations, good practices, etc.
- Data visualisations, such as graphs, maps or timelines

Phase Seven:
Action

This chapter focuses on a major step on facing an odour problem: tackling it. Drawing on the experiences of the D-NOSES project, here we provide some suggestions about how to handle this critical phase.

During Phase Seven, the main task is to co-design possible actions that different stakeholders should take to mitigate the odour problem. These will be evidence-based actions, drawing on the results of the data collected and analysed (Phases Five and Six). As they are based on evidence, the co-designed actions should be more robust than simple complaints or demands to "do something". And, as the relevant stakeholders have (hopefully) been engaged throughout the project, the people who need to take these actions will help to co-design changes to reduce the impact over the population.

8.1. Form a plan of action

It is important to bring together all the different stakeholders involved in the project at this point: citizens (those involved in data collection and others in the affected area); local emitting activities that may be a source of odours; odour experts and professional scientists; policymakers and local authorities, and anyone else who has been involved. This can take the form of a further policy-society dialogue (see Box 8).

This may require some time, and a lot of **negotiation and compromise**. This is partly due to logistics; it can be difficult to get lots of busy people together! But, depending on the measures needed to mitigate the odour problem, there may be considerable resistance to the proposed actions. For example, it might be that the corrective measures identified are expensive and require significant investment from the odour-emitting activities, for example to contain and/or treat the source of the odour. Still, the odour emitting sources are protagonists in the solution of the problem and promotion of dialogue and their involvement is essential for success. It may also be the case that the public authorities or local municipalities do not want to publicise the project results or undertake public measures as they can worsen the image of the community as "a place that smells". Even affected citizens may prefer not to let people know about the odour issue due to the fear of a decrease in property prices.

In fact, you may find that not all the potential actions to solve the problem can be agreed upon.

However, many projects will find that there are some actions that are acceptable to everyone, and which will reduce the problem and improve the living conditions for the odour-conflicted community. It is important that all stakeholders reach an agreement on what these actions are.

To reach such an agreement, stakeholders should all answer the following questions:

- What are the feasible corrective measures or good practices that could be put in place to mitigate or reduce the problem?
- What time scales should they have: short, medium or long term?
- Who is responsible for acting?
- Who will monitor the impacts of these actions, once they have been taken?
- Could the outcomes of the project be used to form a new, community-led regulation to control odour pollution and protect affected citizens?

Once these questions have been answered, and the achievable actions have been agreed upon, this information should be complemented with an Odour Management Plan for the emitting activities[35]. The Plan should include good practices, recommendations, changes in industrial practices and more for the odour emitting activities to act upon the issue based on the collected evidence to reduce the impact over the affected community.

Expected outcomes from Phase Seven

- A co-designed plan for action agreed with all stakeholders to mitigate the odour problem, including short, medium and long term measures
- A technical Odour Management Plan for the odour emitting activities
- Information about any agreed new regulations / continuous odour monitoring to control odour pollution

35 A guide for writing an Odour Management Plan can be found at the Odour Observatory: https://odourobservatory.org/resource/odour-management-plan

Phase Eight:
Reflect on the outcomes

This chapter provides an overview of the final phase, one that is important in all citizen science projects: reflecting on lessons and achievements.

Reflecting on what has been learnt and achieved through an odour-pollution project should consider progress in terms of tackling the odour problem, and in establishing new regulations and controls on odour issues. More broadly, participants should reflect on the lessons learnt and how these can be fed into policy or shared with other odour-affected communities.

9.1. Reflect on the project

This reflection could be done in a number of ways: through a survey of participants, follow-up interviews with key stakeholders, or through further policy-society dialogues. The best way to organise this reflection will depend on the local context, and how willing all stakeholders are to take part (e.g. time commitments). To encourage their participation, it is helpful to hold any stakeholder meetings as soon as possible after the action plan has been agreed (Phase Seven), so that the project is still fresh in people's minds and high on their list of priorities.

Some important questions to ask during the reflection process include the following.

- What lessons were learnt during the project?
- How can they inform policies and odour regulations at local, regional and national levels (see Box 15)?
- How can the evidence collected inform odour emitting activities or environmental authorities?
- How can the monitoring continue in the future to assess the implementation of the agreed actions?
- What tools and data developed in the project can be made publicly available (e.g. for use in future projects)?

9.2. Capture and share the lessons

Once the project's stakeholders have shared their thoughts, both good and bad, on the project, the next step is to capture this information and make it available for other odour-conflicted communities to learn from. If time and resources allow - and the participants still have enough motivation - then such lessons could be captured in different formats, each tailored to different audiences.

- **Scientific guidelines** that describe the methods used to collect and analyse data on a particular type of odour will be useful for communities facing similar issues.
- A summary of your project's **tools, best practices and lessons** will be of interest to other communities looking to establish a citizen science project.
- **Policy recommendations**, presented as a policy brief or paper, can be a useful way to reach local policy-makers, as well as those tackling similar odour problems in other places.
- The project's **website and social media accounts** should be kept online after the project (if possible) to enable other odour-conflicted communities to contact you directly.
- Attending events, such as **conferences, business fairs, workshops** or similar, can help raise the issue of odour pollution more widely, and advocate for using citizen science as a way to address this.

9.3 Open access data

Think back to Phase Three, when your project was looking for existing data sources to inform its planning. Your project can now help others who are at this step! To do this, you need to make all verified datasets publicly available, if possible. You could do this through an existing open-access platform, such as data.europa.eu.[36] This will also add to the amount of data available globally on odour pollution, which remains an under-reported problem in most countries, and will contribute to Principle 10 of Rio Declaration.

Interaction with students in Kampala. Source: Mapping for Change.

36 https://data.europa.eu/en

Box 15:

How the D-NOSES pilots fed into policy processes

Over the course of the D-NOSES project, several pilots achieved significant policy impacts. This ranged from influencing new legislations and licencing activities, to highlighting the importance of public participation and citizen observations in odour pollution monitoring to policy-makers.

- The Chilean pilot team distributed the D-NOSES policy brief to the Environmental Ministry and its regional branches, at a time when national odour policies were being designed. We also produced a document to introduce the D-NOSES methodology based on citizen science to monitor odour pollution in the regulations under preparation[37].
- In Portugal, the national and regional policy-society dialogues helped to build a powerful network, the Portuguese high level policy group, with the participation of the Ministry of Environment (IGAMAOT) and the Portuguese Environmental Agency (APA), among other key actors, to walk towards a national regulation in odour pollution in the country.
- Odour experts from the D-NOSES consortium (AMIGO), alongside the Àrea Metropolitana de Barcelona and Science for Change, provided inputs relating to odour monitoring to a draft of Uganda's Air Quality Guidelines. Many of these were included in the subsequent Air Quality Regulations draft, published in April 2021.
- After taking part in policy dialogues, councillors and politicians in the UK advocated both citizen science and the OdourCollect app as new potential solutions to long-term odour issues, through social media and an open letter.

Expected outcomes from Phase Eight

- Communications outputs that share the key lessons and recommendations from the project
- Informing policy actions at the local, regional or national levels

37 The Chilean Ministry of Environment opened a process to receive suggestions of improvement of the proposed law on odour control for the pig sector. The D-NOSES statement can be found here (in Spanish): https://consultasciudadanas.mma.gob.cl/storage/citizen/6432/D-Noses%20Statement%20on%20Chilean%20Emissions%20Standard.pdf

Project replication

D-NOSES focused on odour pollution, but many of the phases described are applicable to other projects that aim to tackle pollution sources. This chapter provides a short overview of how and where the D-NOSES approach could be useful.

The D-NOSES project was initiated in response to the lack of a proper, unified response to the widespread problem of odour pollution, and the need to fill the subsequent lack of a regulatory framework to address this. It was therefore created to empower citizens to participate in decisions made about their environment.

The overall philosophy behind the D-NOSES project can be described as follows:

> *Co-creation processes, and balancing the interests of quadruple helix stakeholders,[38] can lead to 'win-win' interventions that improve the situation on all sides. Achieving this requires transparency, dialogue, knowledge, tools and guidance - and citizens, through citizen science, should be involved in decisions about their own environment.*

While D-NOSES focused on odour pollution, this overarching philosophy can be applied to other environmental problems. There are, however, certain characteristics of the problem that need to be in place for this approach to be the right one. These include:

- a community that is **severely affected by the source of pollution**, and is therefore motivated to do something about it
- one or more **identifiable sources of pollution**, rather than disparate or unidentifiable polluters
- a **lack of existing regulations and/or data**: a project is less likely to have a tangible impact if it repeats what is already out there.

Possible sources of pollution for which this approach is likely to be suitable include:

- **noise** pollution, such as from roads, building sites, pubs and nightclubs or industrial sites. This type of contamination is widely regulated, but there is not much data available due to the instrumentation used to monitor it.
- **pollution related to traffic and mobility** generates other environmental and social problems such as air pollution, noise pollution, generation of greenhouse gases, psychosomatic effects (stress and anxiety). This type of pollution needs to be measured in real-time and with a wide geographical distribution to know its behavior and generate clear and more forceful public policies.
- **local impacts of Climate Change** in communities have a high risk of vulnerability. It is difficult to identify the principal polluter, but it is possible to integrate many stakeholders interested to make changes. In addition, there is no extensive information on the impacts of climate change on humans and biology because climate research has focused mainly on remote sensing, with data from monitoring stations and satellite information.
- **illegal dumping** of litter or waste - although it may be difficult to identify the polluter, and harder still to engage them in the project.

The D-NOSES approach is less applicable for sources of pollution that are less localised, and/or for which it is difficult to identify individual polluters. For example greenhouse gas emissions may be better addressed by engaging concerned citizens at national and global scales, rather than focusing on locally affected communities. Similarly, marine litter is a major problem in many places, but does not always directly affect the lives of local communities - and nor is it simple to identify the many different polluters responsible. However, if local contexts are to be evaluated, the D-NOSES approach will be completely valid.

A series of factsheets from the D-NOSES project provides country-level guidance on how the D-NOSES pilot projects were conducted in a number of countries. You can find these in the D-NOSES Odour Observatory.[39]

Odour circuit in Portual. Source: LIPOR

38 Policy-makers, scientists, citizens and industry.
39 https://odourobservatory.org/case-studies-pilot-updates

Resources needed

Drawing from the D-NOSES pilot studies, this chapter lists some of the resources that will help your project be successful.

Each citizen science project is different, in terms of its scale, participants, location and focus. Likewise, the resources that each project can draw upon will vary. The trick for project organisers is to establish which resources are available, and decide how to make the best use of them.

Resources you will need for your project are likely to include the following:

- **Financial resources**. Your budget for the project will determine many aspects, such as the level of engagement of your stakeholders, tools and equipment you use for data collection, how you communicate the data and results, and even where you hold project meetings. You could see if there are small environmental grants available locally; alternatively, there may be a nearby university that conducts research on environmental issues, which may be able to support a citizen science project.
- **Time**. Running an odour-pollution project is likely to require a lot of time: for the project organisers and the participants. Early discussions with stakeholders should cover the amount of time they are willing or able to commit.
- **People.** A lot of people need to contribute to the project for it to be successful: policy-makers, industry players, professional scientists and local communities. It is important to make contact with them at an early stage - and continue this at regular intervals to keep them engaged throughout. Moreover, community engagement requires a lot of time and human resources to be successful!
- **Tools and equipment.** One way to save money is to borrow the equipment and tools you need to measure odours. Try asking the odour-emitting industry (if they have engaged with the project) or local sources of scientific equipment (e.g. universities, companies, research institutes).
- **Methodological resources**. There is no need to start from scratch with your project: instead, take stock of the many existing resources for running citizen science projects on odour pollution. Annex 1 contains several resources from the D-NOSES project.

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Appendix:

The D-NOSES engagement toolkit

In this section, you can find a selection of cards from the D-NOSES engagement toolkit that can be used for odour-related projects:

1. Conversation method card
2. Round table talk tool and activity card
3. Field activity method card
4. Sensory walk tool and activity card

These will be particularly useful in the early phases of your project. You can find many more useful resources for running an odour-related citizen science project at the Odour Observatory website.[40]

Odour emitting source in Schermbeck (Germany). Source: ECSA.

40 https://odourobservatory.org

MEC (Method Card)

CONVERSATION

Conversations are unstructured interviews aimed to understand the problem at stake from the point of view of different stakeholders. You want to know what they think about the odour problem and how it affects different aspects of their daily lives. You also aim to understand stakeholders' motivations about their potential involvement in the pilot study. This will allow you to manage expectations over the course of the pilot.

HOW TO DO IT

In the tools cards you will find a set of questions that can guide you during the conversations. Remember to take notes of your conversations during, or soon after, the interview.

POSSIBLE APPLICATIONS

- **Phase 1 - Frame**
- **Phase 6 - Reflection.**

TAC (Tool & Activity card)

1 2 3 4 5 6

FRAME

ROUND TABLE TALK

These are discussions in which all the participants are considered to have an equal standing on the topic. The circular shape refers to the fact that they contribute equally. A facilitator should open the discussion with questions to provoke a reflection and conversation.

KEEP IN MIND

- The facilitator should also be an expert on the topic
- External audience might be allowed
- It has to be a face-to-face activity

RESOURCES REQUIRED

- A moderator who knows about the topic
- Space with sufficient capacity to accommodate participants (and the audience, if any)
- Recording device (can be pen and paper)

OTHER POTENTIAL APPLICATIONS

- Phase 4 - Data analysis
- Phase 5 - Action

MEC (Method Card)

FIELD ACTIVITY

Field activities aim to collect information about the problem at stake by observing and acting in the area under study: in-situ. Field activities enable researchers to grasp the cultural dimension of the area and understand how culture and everyday practices influence the problem at stake.

HOW TO DO IT

Field research involves a wide range of activities, all of them conducted in-situ. Get inspiration from the tool cards about possible field activities you can conduct!

POSSIBLE APPLICATIONS

- Phase 1 - Frame the problem
- Phase 3 - Data collection.

TAC (Tool & Activity card)

1 2 3 4 5 6

FRAME

SENSORY WALK

A guided walk with an interested party, possibly assembled through other engagement work or working with an existing group to analyse how people use and sense space. The guided walks with participants in a predefined route allow them to focus on the sensory information and collecting qualitative data. Specific stopping points can facilitate discussion about the experience. A similar method (community walk) can be used to demonstrate the issues and the data collection methods available.

KEEP IN MIND

- Needs a great deal of local knowledge from the guide and sense of direction
- It may be difficult to collect qualitative data on the move
- Can only be done face-to-face

RESOURCES REQUIRED

- A suitable walking route
- Maps - paper and/or online
- A facilitator & a local guide
- Channels to access the target groups

OTHER POTENTIAL APPLICATIONS

- Phase 3 - Data collection

Project acronym	Grant agreement #	Project title
D-NOSES	789315	D-NOSES (Distributed Network for Odour Sensing, Empowerment and Sustainability)

D-NOSES project deliverable

D6.3 DIY guidelines for citizen science projects in odour-conflicted communities

Photos

Odour Observatory (https://odourobservatory.org/), PIXABAY and Shutterstock

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