D-NOSES

Distributed Network for Odour Sensing, Empowerment and Sustainability

Strategic Roadmap for governance in odour pollution

D6.5 v2.2

September 2021 (M42)

Deliverable

PROJECT ACRONYM
D-NOSES

GRANT AGREEMENT #
789315

PROJECT TITLE
Distributed Network for Odour Sensing, Empowerment and Sustainability

DELIVERABLE REFERENCE NUMBER AND TITLE

D6.5 Strategic Roadmap for governance in odour pollution

Revision: v2.2

AUTHORS

Rosa Arias
(Ibercivis, Science for Change)

Miguel Hernández
(Science for Change)

Johana Burbano
(Science for Change)

Carla Perucca Iannitelli
(Science for Change)

Nora Salas Seoane
(Ibercivis, Science for Change)

CONTRIBUTORS

José Uribe
(ISWA)

Laura Capelli
(POLIMI)

Stavros Vlachos
(ENVIROMETRICS)

Gerhard Schleenstein
(ECOTEC / ECSA)

Louise Francis
Maria Alonso
Hannah Stockwell
(MfC)

Anastasia Roniotes
(MIO-ECSDE)

Funded by the Horizon 2020 programme of the European Union

Grant Agreement No 789315

DISSEMINATION LEVEL

✔ **PU** **Public**

CO Confidential, only for members of the consortium and the Commission Services

Revision History

REVISION	DATE	AUTHOR	ORGANISATION	DESCRIPTION
v1.0	26.07.2021	Rosa Arias, Nora Salas Seoane Carla Perucca, Miguel Hernández, Johana Burbano Jose Uribe	(Ibercivis, Science for Change) (Science for Change) (ISWA)	Index proposal Revision of first draft
v1.1	13.08.2021	Rosa Arias	(Ibercivis, Science for Change)	Contents structure
v1.2	10.09.2021	Carla Perucca, Miguel Hernández, Johana Burbano	(Science for Change)	First draft for revision
v2.0	15.09.2021 29.09.2021	D-NOSES Partners Carla Perucca, Miguel Hernández, Johana Burbano	See list of contributors (Science for Change)	Contribution to the contents Revision of contents
v2.1	30.09.2021	Rosa Arias, Nora Salas Seoane	(Ibercivis, Science for Change)	Final revision
v2.2	27.10.2021	Rosa Arias Carla Perucca, Miguel Hernández, Johana Burbano Anastasia Roniotes	(Ibercivis, Science for Change) (Science for Change) (MIO-ECSDE)	Final revision for submission

STATEMENT OF ORIGINALITY

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

HOW TO CITE THIS REPORT

Arias R., Salas Seoane N., Hernandez M., Burbano J., Perucca C., Uribe J., Capelli L., Vlachos S., Schleenstein G., Francis L., Alonso M., Stockwell H., Roniotes A., (2021), Strategic Roadmap for governance in odour pollution, D-NOSES, H2020-SwafS-23-2017-789315.

Acronyms

Acronym	Description
AMB	Metropolitan Area of Barcelona
AMIGO	Environmental International Society of Odour Managers
APA	Portuguese Environmental Agency
APEA	Portuguese Association of Environmental Engineers
AQE	Air Quality in Europe
ASTM	American Society for Testing and Materials
BAT	Best Available Techniques
BAU	Business As Usual
BREF	Best Available Techniques Reference
CEN	European Committee for Standardization (in French: Comité Européen de Normalisation)
C_t	Threshold Concentration
CCDR-n	Norte Portugal Regional Coordination and Development Commission
D/T	Dilution-to-threshold units
D-NOSES	Distributed Network for Odour Sensing, Empowerment and Sustainability (H2020 European project)
EN	European Standard
EPR	Environmental Permitting Regulations in United Kingdom
EU	European Union
EXPtot	Total odour exposure
FIDOL	Frequency, Intensity, Duration, Offensiveness and Location
GOAA	Guideline on Odour in Ambient Air (Germany)
IED	Industrial Emission Directive
IGAMAOT	General Inspection of Agriculture, Sea, Environment and Spatial Planning in Portugal
IPPC	Integrated Pollution Prevention and Control directive in United Kingdom
KCCA	Kampala Capital City Authority

MEP	Member of the European Parliament
MfC	Mapping for Change
MIO-ECSDE	Mediterranean Information Office for the Environment, Culture and Sustainable Development
MOEW	Ministry of Environment and Water in Bulgaria
MOOC	Massive Open Online Course
NA	Not available
NEA	National Environment Act in Uganda
NEMA	National Environmental Agency in Uganda
NTC	Norma Technical Colombian
Oc	Odour Concentration
OIC	Odour Impact Criteria
ou	Odour Unit
ou_E/m^3	European odour unit per hour per cubic meter
OMP	Odour Management Plan
PRIO	Plan to Reduce the Impact of offensive Odour
RIEW	Regional Inspectorates for Environment and Water in Bulgaria
SfC	Science for Change
SJM	Municipio de Sao Joao Da Madeira
TRS	Total Reduced Sulphur
UNE	Spanish Standardization Body
VDI	Verein Deutscher Ingenieure (VDI) (in English: Association of German Engineers)
VOC	Volatile Organic Compounds
WWTP	WasteWater Treatment Plant

Executive Summary

The Roadmap for Governance in Odour Pollution positions objectives and strategies to pave the way for future regulations in odour pollution in the medium and long term.

Governments and environmental authorities have a complex task in the policy frame of odour regulations. There are as many approaches for regulating odour pollution as countries, leaving mostly citizens defenceless, but also industries and local authorities without a framework to act upon the issue - often leading to socio-environmental conflicts in the affected communities. In addition, common criteria to define impact odour thresholds, and determine the related level of annoyance have not been established, nor have clear definitions or terms been drawn up. The *Strategic Roadmap for Governance in Odour Pollution* aims to provide objectives and strategies in the medium to long term (5-10 years) to pave the way for a more inclusive and sustainable regulatory framework in odour pollution.

A multi-level strategy has been implemented during the EU Horizon 2020 D-NOSES project to impact the multi-level governance scenario that odour pollution has in most of the countries where pilot study cases took place. This strategy, based on a bottom-up approach has influenced key actors at all levels: from local municipalities to the European Union (EU). In each case study, the D-NOSES policy and its policy-society dialogues were an effective tool for involving different stakeholders, and establishing networks that could be drawn upon at later, more policy-oriented, stages. All results of D-NOSES pilots represented a significant step forward in advancing the process of policy action and, in empowering odour-afflicted communities to take action,

In parallel with the *Green Paper on Odour Pollution*, the present document has been prepared to inform policymakers about the context and situation of odour pollution in the different countries that have been part of the EU Horizon 2020 Project D-NOSES. The project's conclusions and findings come from the results of implementing participatory strategies, citizen science interventions, policy-society dialogues at national level, and the roundtables with all stakeholders. The advocacy actions that were developed also contributed to having a better understanding of the current situation in the different countries. Finally, community regulations will be encouraged to act as promoters of change.

The document is ordered in the following chapters:

Chapter 1. INTRODUCTION: starts with the scope of the document, explaining the difficulties of regulating odour pollution and introducing important terms as odour impact criteria.

Chapter 2. THE NEED OF A MULTI-LEVEL GOVERNANCE MODEL TO WALK TOWARDS ODOUR POLLUTION REGULATION: in this section, the multi-level governance model carried out during the EU Horizon 2020 D-NOSES project is explained, together with its need and complexities to further implement it.

Chapter 3. THE EUROPEAN REGULATORY FRAMEWORK OF ODOUR POLLUTION: briefly presents the legal mechanisms that the EU applies for regulating odours and some country-specific examples.

Chapters 4 to 13. REGULATORY FRAMEWORK OF ODOUR POLLUTION IN DIFFERENT COUNTRIES: presents the current situation regarding odour regulations in each of the D-NOSES countries, the actions carried out in the D-NOSES context and the recommendations for the next five years. The countries where the D-NOSES advocacy actions mainly took place include Portugal, Italy, Spain, Germany, Greece, Bulgaria, the UK, Chile, Uganda and Colombia. A customized strategic roadmap based on the D-NOSES actions is proposed for each one of them according to their current regulatory framework.

Chapters 15. CONCLUSIONS: summarizes the main conclusions found within the EU Horizon 2020 D-NOSES project.

Index

1. Introduction

Governments and environmental authorities have a complex task in the policy frame of odour regulations. There are as many approaches for regulating odour pollution as countries, leaving mostly citizens defenceless, but also industries and local authorities without a framework to act upon the issue - often leading to socio-environmental conflicts in the affected communities. A critical review of the current legislative framework and the suggestion of next steps is necessary to draw a better future in relation to odour pollution.

1.1 Scope and Purpose of the strategic roadmap for governance in Odour Pollution

One of the main objectives of EU Horizon 2020 Project D-NOSES (Distributed Network for Odour Sensing Empowerment and Sustainability) is to position odour nuisance, the second most important environmental cause of citizens' complaints[1] in the center of public debate. The need for action is becoming more urgent with the growing recognition at all levels of the harmful effects of bad air quality on people's health[2]. Reducing the impact and improving the affected citizens' quality of life requires a collaborative approach by all stakeholders. In addition, odour pollution is often a symptom of broader environmental issues caused by population growth, urbanisation and industrialisation. Therefore, odour manifestations should be considered as an alert signal and a potential call for an environmental impact assessment.

Aligned with Principle 10 of Rio Declaration[3], the EU Horizon 2020 D-NOSES project promotes a new methodology based on citizen science to monitor odour pollution[4] and a bottom-up approach to foster **public participation in decision making,** and to guarantee public

[1] ADEME, 2005. Pollutions olfactives: origine, legislation, analyse, treatment, Dunod, Paris, XII-388p.

[2] Some relevant studies on odour and health: National Research Council Committee on Odors, 1979. Odors from Stationary and Mobile Sources. Board on Toxicology and Environmental Hazards, Assembly of Life Sciences. National Research Council, National Academy of Sciences, Washington, DC.
Shusterman, D., 1992. Critical review: The health significance of environmental odor pollution. Archives of Environmental Health 47 (1), 76–87.
Schillman & Williams 2005. 'Science of Odor as a Potential Health Issue'. Journal of Environmental Quality 34(1): 129-138.
Government of Alberta.2017. Odours and Human Health. Environmental Public Health Science Unit, Health Protection Branch, Public Health and Compliance Division, Alberta Health. Edmonton, Alberta

[3] UN Commission on Human Rights, Human rights and the environment., 24 February 1995, E/CN.4/RES/1995/14, available at: https://www.refworld.org/docid/3b00f0cc14.html [accessed 30 September 2021]

[4] Arias R., Capelli L., Diaz Jimenez C. (2018). A New Methodology Based on Citizen Science to Improve Environmental Odour Management, Chemical Engineering Transactions, 68, 7-12. https://doi.org/10.3303/CET1868002

access to information on odour pollution through the International Odour Observatory[5]. The D-NOSES advocacy actions will ultimately allow for **access to environmental justice** through the introduction of odour pollution in the policy agendas, the standardisation of methodologies, and the contribution to the creation of common impact criteria and scientific guidelines for policy making. The recommendations, based on the project outcomes for capacity building, and governance for sustainability, will potentially safeguard the right to a healthy and sustainable environment for present and future generations in odour conflicted communities. Therefore, one of the leitmotifs in this *Strategic Roadmap* is the inclusion of participatory strategies in odour pollution policies at European, national, local and supranational level, boosting participatory democracy.

The experience gathered during the implementation of the pilot cases served as inspiration for writing this document. The dialogues between the **quadruple-helix agents**[6] (i.e. citizens, public administration, emitting activities and odour experts) helped to identify the perspectives and necessities of each group, and cathalised the co-creation of feasible improvements that will reduce the impact on the population.

This deliverable has been prepared to inform policymakers about the context and situation regarding odour pollution in Europe, focusing in the countries where D-NOSES took action. **We encourage governments and local authorities to use this document as an inspiration for developing a robust regulatory framework**. Odour nuisance has been ignored in most of the existing regulations, and citizen science has the potential to close that gap, connecting citizens with government and industries.

1.2 Approaches to regulate odour pollution

Decades of research experience support the inclusion of odours in the list of pollutant types that must be urgently regulated, as it may cause uncountable and undesirable reactions in people; ranging from annoyance to documented health effects. These impacts indicate that odour-related problems occur with sufficient frequency and severity to warrant regulatory intervention[7]. Indeed, odours have been ranked as one major generator of public complaints to regulatory agencies around the world[8]. The responsibility of public institutions is to set a regulatory framework that limits the odour nuisance in communities, and protects affected citizens.

Nevertheless, complexity, regarding odour pollution assessment in its different processes and conditions that establish whether an odour nuisance condition exists makes the process of adapting or creating specific legislation an impact criteria challenging. Usually, four steps are

[5] Odour Observatory is a web-based platform that provides resourceful information about odours for all stakeholders, to begin to level the playing field and increase awareness and knowledge in odour pollution.

[6] Schütz, F., Heidingsfelder, M.L., Schraudner, M. (2019) "Co-shaping the Future in Quadruple Helix Innovation Systems: Uncovering Public Preferences toward Participatory Research and Innovation" She Ji: The Journal of Design, Economics, and Innovation, Volume 5, Issue 2, Pages 128-146, ISSN 2405-8726, https://doi.org/10.1016/j.sheji.2019.04.002.

[7] Brancher M, Griffiths KD, Franco D, de Melo Lisboa H (2017). A review of odour impact criteria in selected countries around the world. Chemosphere. Feb;168:1531-1570. DOI: 10.1016/j.chemosphere.2016.11.160.

[8] Leonardos, G., (1995). Review of odour control regulations in the USA, in odours, Indoor and Environmental Air, Proceedings of a Specialty Conference of the Air and Waste Management Association, Bloomington, MN, pp. 73–84.

taken to move from the emission of an odour to the expression of the impact by the community:

1. Estimation of odour release values
2. Dispersion modelling
3. Correlation between the exposure value obtained from dispersion modelling and the expected annoyance
4. Correlation between the annoyance expected and the real nuisance and complaint expressed by the community

Most of the odour regulations that exist worldwide estimate the odour release values through dynamic olfactometry (see D2.4[9]). However, measuring odours at the emission source is not always easy, especially in the case of fugitive or diffuse sources (i.e. landfills or refineries) or in discontinuous processes with highly variable emissions. The measurement in itself has associated a high degree of uncertainty related to the sampling method, the variability of the panel or the olfactometry methodology - to which we have to add the uncertainty associated to dispersion modelling when we move to step 2. In addition, the inability of continuous monitoring limits the overall understanding of the problem, as source characterization is done punctually, and the effects of process and meteorological variations are not considered. This means that odours must first be measured objectively and reproducibly before they can be effectively subjected to quantitative regulation.

Due to this shortcoming, there is a need to introduce objectivity into odour impact assessment and to establish an odour impact criteria. Implementing odour regulations, on one hand, can easily be prone to overprotect, diminishing the competitiveness of the industries affected, or, on the other hand, underestimate the odour impact of the emitting industries over the affected communities. Therefore, the application of **objective odour impact criteria** based on standardised measurement methods that account for the real nuisance as perceived by the affected communities is imperative if a public institution wants to address the problem in the fairest way possible and provide solutions tackling the actual complaints.

The odour regulatory approaches that can be identified worldwide, use a typology of different odour impact criteria. **Ideally, the existence of an integrated regulatory framework that considers a combination of several impact criteria could be preferred, because these approaches will set the baseline for a stronger, holistic and situated odour legislation**. The most common odour impact criteria used in legislations worldwide are:

- **Maximum impact.** Based on ambient odour (immission values) or chemical concentrations. It is usually expressed in terms of odour concentration or frequency of perceived odours in ambient air.
- **Separation distance.** Based on a fixed or variable separation distance between the emission facilities and the potential receptors.
- **Maximum emission.** Based on odour and chemical emission rates in the odour sources.

[9] Izquierdo C., Diaz C., Anton A., Kavanagh R., Capelli L., Arias R., Salas Seoane N., Burbano J., Francis L. (2021) Analysis of existing regulations in odour pollution, odour impact criteria 2, D-NOSES, H2020-SwafS-23-2017-789315. Available at the odourobservatory.org.

- **Maximum annoyance.** Based on the annoyance caused to the community or in the number of complaints. Since nuisance occurs before any action can be taken, this approach serves only to abate odours after they occur, but not to prevent their occurrence. It should also be noted that the absence of complaints does not necessarily indicate an absence of an odour impact.
- **Technology.** Based on the implementation of Best Available Technologies (BAT), these are usually costly and time-consuming until implementation.
- **International standards as reference.** In many countries, the environmental impact assessment system uses international standards as reference, but these are limited since they do not represent the reality of each case study.

Odour concentrations are widely used in the implementation of odour impact assessments, comparing them with regulated immission limits. These concentrations are calculated using dispersion models based on the odour concentrations measured in the emission points (called olfactometry); but there is still little consensus on what odour concentration and/or averaging time represents the most effective and fair odour limits for off-site impacts[10].

Meanwhile, the odour limits, defined as **Odour Impact Criteria (OIC),** are established based on three different variables: *the odour concentration threshold (Ct), the threshold percentile compliance value (P) and the average calculation time used* in the dispersion model. These two first variables are set based on previous experiences and vary depending on the technical and economic scenario, such as the land use, location, industry type, annoyance of the odour and olfactometry standard, while the time interval established usually will need a peak-to-mean ratio (P) to convert the longer average values obtained through atmospheric dispersion modelling into the short periods related to human nose response.

Odour concentration is a key parameter to establish OIC, and defining its units is crucial. The most widely used unit is the **European odour unit per cubic meter (ou_E /m^3)**, which has to be obtained through the European standard EN 13725:2003[11]: Air quality- Determination of odour concentration by dynamic olfactometry. Nevertheless, other authorities have implemented different standards, e.g. US adopts dilution-to-threshold (D/T) units for field inspections and ou_E/m^3 for dynamic olfactometry, following the ASTM E679-04 standard[12]. The european units and the northamerican ones can be basically considered analogous, but there could be significant differences due to the different standard methods that are applied[13]. Three different groups have been identified in terms of regulatory framework on OIC [14] :

1. High concentration limits (C_t =10 ou_E/m^3) and low frequency percentiles (P=0.99)

[10] Mahin TD. Comparison of different approaches used to regulate odours around the world. Water Science and Technology. 44 (9) (2001). pp. 87-102. https://doi.org/10.2166/wst.2001.0514
[11]European Committee for Standardization (CEN). (2003). EN13725: Air Quality: Determination of Odour Concentration by Dynamic Olfactometry. CEN, Brussels.
[12] American Society for Testing and Materials (ASTM). (2011).ASTM E679e04. Standard Practice for Determination of odour and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits. ASTM, West Conshohocken.
[13] McGinley, M.A., Mann, J., (1998). European versus United States odour/odour standards of evaluation. In: Water Environment Federation 71st Annual Conference., Orlando, FL: 3e7 October 1998.
[14] Brancher, M., Schauberger, G., Franco, D., De Melo Lisboa, H., (2016). Odour impact criteria in South American regulations. Chem. Eng. Trans. 54, 169e174. https://doi.org/10.1016/j.chemosphere.2016.11.160

2. Low concentration limits (C_t =1 ou_E/m^3) and high frequency percentiles (P=0.90)
3. High concentration limits (C_t =1 ou_E/m^3) and low frequency percentiles (P=0.99)

It can be seen that the first two groups are less restrictive than the last one, and it coincides that they are the most widely applied. The third option is only found in some specific cases for new installations, sensitive areas and highly offensive odours.

The impact of an odour results from a combination of interacting factors, collectively known as FIDOL; frequency (F), intensity (I), duration (D), offensiveness (O), and location (L). **The odour impact criteria needs to be applied in a flexible way into the legislation, so it can be used in all kinds of odour pollution scenarios**. In that sense, it is possible to adjust the level in three different ways: **adjust the frequency (P)**, **adjust the odour concentration limit (C_t)** or include and **adapt an hedonic tone value (E)**. At the moment, the OICs address only the annoyance partially. Using the FIDOL factors as indicators of the odour impacts (Frequency, Intensity, Duration, Offensiveness and Location), the OICs typically only take into account two of them (Frequency (P) and Intensity (C_t)), hence the extrapolation of these criterias to the annoyance is quite simplistic. On the other hand, including all the five factors in the study makes it more difficult to legislatively implement it. Finding a balanced midpoint seems challenging and also, in terms of annoyance, the individual subjectivity of the community may produce a bias that can be addressed through data validation and plausibility tests. Some aspects that have to be considered are the personal connection to the odour emitting industry in the odour characteristics, the olfactory memories and the psychological state and physical attributes of the person.

It is important to point out that a model that can correlate OICs and annoyance is not found due to the complexities and characteristics of odour pollution. Nevertheless, **the way towards a more harmonized legal framework can be done by the inclusion of a multi-level governance model**, as proposed by D-NOSES. From the international to the local framework, there are already tools that help the process of creating a fair and comprehensive legislation regarding odour pollution that can be customized and adopted at the local level.

Other methodologies, such as citizen science for the monitoring of odour nuisance can be applied in most of the cases to have a more robust understanding of the annoyance in the community and the real impact from the receptor point of view. The strength of the methodology is directly related to the people that report any sort of odour perception, because then, the real impact on the population can be estimated easier, quicker and more accurately than using only the complaint register of the public institutions. In the D-NOSES pilots, it has been demonstrated that odour observations from affected communities correspond to reality, coinciding with and complementing traditional odour studies, and that citizens self-regulate themselves when trained and involved in continuous measurement, providing an accurate and consistent monitoring of the issue. This has the advantage of providing evidence to co-create affordable Odour Management Plans targeting the real nuisances that have the potential to quickly improve the situation and thus the overall quality of life of the communities.

2. The need for a Multi-level governance model towards odour pollution regulations

Citizens are often defenceless regarding odour nuisances due to the lack of harmonized regulations. This generates socio-environmental conflicts in affected communities, diminishes the quality of life of citizens, and reduces economic activity.

Odour characterization and measurement have become an important environmental issue, due to the general public's growing environmental awareness, and the impact of air quality on health and well-being. Regulating odour impacts entails the necessity of specific methods for odour measurement and odour impact assessment. However, **measuring odours is not a simple issue**, since it entails the need of objectifying a sensation. For this reason, specific methods shall be adopted.

Traditional odour management has been carried out using methodologies that follow a top-down approach. The *D-NOSES* ***Deliverable 2.1***[15] *Review on odour pollution, odour measurement and abatement techniques* provides a **comparison of the methods that are currently available for measuring odours**, both at emission and at receptor level, thereby focusing on their applicability and limitations. The nature of these methodologies often translates into a lack of transparency, communication and information exchange between the industries, government and citizens due to the usual top-down approach.

In addition, the legislative context in Europe and worldwide regarding odour pollution is quite vague (*further information in Deliverables 2.2*[16] *and 2.4*[17] *of D-NOSES: Analysis of existing regulation*

[15] Capelli L., Bax C., Diaz C., Izquierdo C., Arias R., Salas Seoane N. (2019) Review on odour pollution, odour measurement, abatement techniques, D-NOSES, H2020-SwafS-23-2017-789315. Retrieved from: D2.1_Review-on-odour-pollution-measurement-abatement_v3.2.pdf – DNOSES (Accessed 03/09/2021).
[16] Diaz C., Izquierdo C., Capelli L., Arias R., Salas Seoane N. (2019) Analysis of existing regulations in odour pollution, odour impact criteria 1, D-NOSES, H2020-SwafS-23-2017-789315. Retrieved from: https://dnoses.eu/d2-2-analysis-of-existing-regulation-in-odour-pollution-odour-impact-criteria-1-pdf/
[17] Izquierdo C., Diaz C., Anton A., Kavanagh R., Capelli L., Arias R., Salas Seoane N., Burbano J., Francis L. (2021) Analysis of existing regulations in odour pollution, odour impact criteria 2, D-NOSES, H2020-SwafS-23-2017-789315. Forthcoming - Available at https://odourobservatory.org/

in odour pollution, odour impact criteria 1 and 2). Some challenges that arise for regulating odour pollution are:

- Lack of a common European regulatory framework.
- Lack of or inadequate reference in European Directives such as the IED. In 2020 Air quality in Europe (AQE) reports do not mention the impact of odours on health, nor the European Green Deal.
- Heterogeneous regulatory framework in each country, region or even municipality, sometimes without an accepted scientific basis.
- The competences for regulating odours vary from country to country (e.g. Spain vs Portugal).
- A different governance model has to be defined for each country.
- Odour pollution is a local problem and it only makes sense to be regulated when it affects the population.
- Odour pollution is difficult to measure and traditional techniques do not account for real perception or nuisance on the population.
- Industrial opposition to regulation due to the cost of abatement measures
- Public sector opposition to regulation due to the perception of a bad image of the city, its effect on tourism or the loss of property prices.

Departing from these challenges, a multi-level engagement model to involve different governance institutions was conceived in the framework of the EU Horizon 2020 D-NOSES project (*see Figure 1*). This multi-level governance model is based on the **Responsible Research and Innovation (RRI) approach**[18] actions for sustainability, capacity building and governance in odour pollution. It includes a common, multi-level engagement model for quadruple helix stakeholders and communities that can be applied at national, regional, local and global levels. This model allows to implement participatory strategies, to define a series of citizen science interventions at community level, and to co-create ad hoc solutions to pave the way for standardisation and definition of common impact criteria as scientific guidelines for policy making.

[18] Responsible Research and Innovation Approach: https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

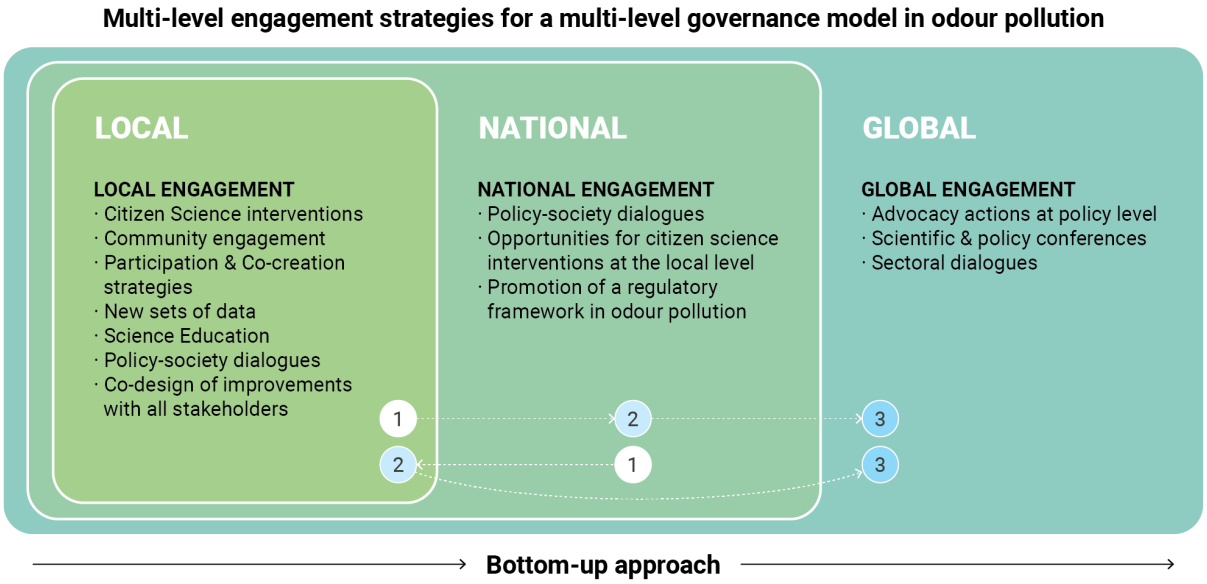


Figure 1: Scheme of the D-NOSES multi-level governance model

Some first general reflections obtained from the development of this multi-level governance model are the following:

- **Engagement of quadruple helix stakeholders is key**. Advancing towards the solution of the problem requires the involvement of all agents of the quadruple helix.
- **Understanding the context of the regions involved is crucial.** The socio-economical and political scenario, the governance structures to address odour pollution, the economic interests, potential conflicts of interest, and the community habits are some aspects that should be taken into account when regulating odour pollution.
- **The multi-level approach has to be flexible** in order to adapt it to the different contexts and governance models. For example starting from a national level as in Portugal, or beginning at the local level, as happened in the Spanish or Greek pilots.
- **Citizen science approaches can be difficult to accept by local authorities.** Therefore, cross-disciplinary communication and engaging strategies seem fundamental to overcoming barriers in the public sector.
- The innovativeness of the methodology carries both **advantages and disadvantages in terms of trust**. The data generated by the citizens can be considered as subjective and biased. Nevertheless, D-NOSES pilots proved the opposite.
- **Data collection and data analysis can be complex** in some cases, as there is not a standardized procedure yet (under way). Finding enough citizens that participate actively in the project and maintaining their engagement may be challenging and ad hoc engagement strategies should be designed. Data analysis has to consider all the different factors that affect odour pollution and should be done by odour experts, preferably in collaboration with the emitting industries (to correlate industrial operations data with citizen observations), with the environmental authorities (for the official uptake of the data) and with the citizens (who have the local knowledge of the issue and thus can contribute to the understanding of the collected data).

At the local level, 10 case studies[19] were performed in Europe (Portugal (2), Germany, Greece, Spain, Italy, Bulgaria and the UK) and in non-EU countries (Uganda and Chile). In all case studies, the D-NOSES policy and policy-society dialogues were an effective tool for kick-starting conversations with different stakeholders, and establishing networks that could be drawn upon at later, more policy-oriented, stages. The strategies followed in each pilot varied and were adapted to the context of the area. During the studies, pilot leaders organized co-creation workshops, citizen science interventions, and educational sessions with the objective of gathering information, increasing the empowerment of citizens, and co-design solutions with all the stakeholders. **The resulting approach is aimed to be universally replicable in diverse regions and situations around the globe, to generate scientifically valid and actionable data through citizen science interventions that provides evidence for odour pollution monitoring and has the potential to improve people's lives**.

In the same way, the policy aims in the D-NOSES countries varied, depending on local regulations, the specific odour issues being tackled and the local governance structure. The EU Horizon 2020 D-NOSES project created a Policy Brief[20] that was used as the main communication and dissemination document, introducing the issue of odour pollution as a growing societal concern and the needs for action with the inclusion of citizens (see Annex 16.2 - General version of Policy Brief); an advocacy toolkit that is a step-by-step guide on how to set up an advocacy strategy, providing tips and methods on how to engage and communicate with policy-makers (see Annex 16.3) and other resources available in International Odour Observatory (IOO), such as: Odour Regulation Maps[21], guidance for communities[22], industry guidance toolkit[23] and D-NOSES brochures[24]. In all scenarios, the dialogue among policy-makers, citizens, industries and odour experts was strongly supported by partners. For example, in Portugal a high level policy group was created to support the creation of a National Law to regulate odour issues in the country. In addition, in Spain, a group of experts in odours and citizen science, industries and associations have been working on the standardization of the methodology since 2019, expected to be published by the beginning of 2022. Other important actions were carried out in Chile, where D-NOSES partners contributed to the draft for the first odour emissions regulation in the country covering intensive swine farming. Further details of these and other actions carried out at national level are discussed for each country in the following sections.

Finally, the EU Horizon 2020 D-NOSES project covered the global level of engagement promoting the dialogue with each of the sectors, e.g., advocacy activities at policy level, papers

[19] For more information about the D-NOSES pilot case studies, please visit: https://odourobservatory.org/case-studies-pilot-updates/
[20] https://dnoses.eu/policy-brief/ (available in the languages of the D-NOSES Partners and adapted to the national contexts).
[21] Global regulatory framework on odour pollution represented on a map. Available in: https://odourobservatory.org/regulations/https://odourobservatory.org/regulations/
[22] Helpful guide to support the neighbors to improve your quality of life and effect positive change. Available in: https://odourobservatory.org/wp-content/uploads/sites/2/2019/10/Guidance-for-communities.pdf
[23] This toolkit walks all industries or activities through the steps you need to take to establish an **Odour Management Plan (OMP)**. Available in: https://odourobservatory.org/wp-content/uploads/sites/2/2021/02/Guidance-for-Industries.pdf
[24] Available in: https://dnoses.eu/downloads/

and scientific conferences (NOSE20, EGU 2019, CS and SDGs 2020, ECSA Conference, IWA 2021, and many more - see deliverables on Events), sectorial workshops and roundtables (APEA webinar) and diffusion of educational materials (MOOC in odour pollution). Moreover, as a culmination of the project, and in order to merge all the experiences gathered during its three and a half years, the D-NOSES final conference took place in October 2021, right after the end of the project, with a specific session devoted to advocacy on the 20th.

In the following sections, the situation regarding odour pollution will be commented on for Europe, the 9 countries that participated in the EU Horizon 2020 D-NOSES project, and for Colombia, which was engaged in the project through the 1st international seminar on odour management that took place in November 2029. Additionally, the actions carried out during the project to inform policies and promote a change will be presented as examples of the different approaches that can be done. Finally, some recommendations will be included to improve the current situation in each country in the medium to long term.

3. The European regulatory framework in Odour Pollution

The Industrial Emission Directive sets the common framework in the EU for odour pollution. Through BAT documents, the EU sets the technical requirements for different kinds of industrial facilities in terms of pollution. Nevertheless, odours are barely contemplated in BREF documents.

In the EU, odour pollution is regulated in the European Directive on Industrial Emissions (Directive 2010/75/EU[25]), known as the Industrial Emission Directive (IED). The IED requires a permit for industrial activities to operate and assure the environmental compliance of industrial processes. Through the concept of Best Available Techniques (BAT), the EU has produced more than 30 documents where the BAT references are included (BREF). As odour has been considered recently as an atmospheric pollutant, only the newest documents include special paragraphs about odour reduction techniques. Nevertheless, only the 2018 Waste Treatment BREF includes odour limits for biological treatments of waste. It is expected that the future Slaughterhouse and Animal by-products BREF will also include regulations regarding odour pollution, such as the implementation of Odour Management Plans (OMP) or recommended odour impact criteria. The following sectors (with more than 100 citations about odours in their BREFs) can be considered the sectors where odour pollution and abatement techniques are included:

- Common Waste Water and Waste Gas Treatment / Management Systems in the Chemical Sector
- Intensive Rearing of Poultry or Pigs
- Slaughterhouses and Animals by-products industries
- Food, Drink and Milk industries
- Waste treatment
- Production of Pulp, Paper and Board
- Refining of Mineral Oil and Gas

The compliance with BREF recommendations is one of the most common procedures that regional governments ask as a requirement for giving permits to new installations. Further

[25] Directive 2010/75 of the European Parliament and of the Council of the 24 November 2010 on industrial emissions (integrated pollution prevention and control), OJL 334, 17.12.2010. p17-119.

information about the European BAT Reference documents regarding odour is available in deliverables 2.3 and 2.5[26] of D-NOSES (*Compilation of good practices in odour pollution 1 and 2*).

As explained in Chapter 2, there is a common European odour unit (ou_E/m^3) that is widely used within Europe to set odour concentration thresholds. The standard EN 13725:2003 is fully established in the continent and serves as the main reference for setting Odour Impact Criteria (OIC) - usually combined with dispersion modelling. Some countries have already well-advanced legislation on odour pollution, such as the Netherlands or Belgium, while others do not even mention odours in any regulation. In table 1, some of the OIC implemented in EU countries that are not discussed in the following sections are presented.

Table 1. Odour Impact Criteria for different EU countries. (Extracted partially from Brancher et al, 2016[27])

Country	Odour Impact Criteria (OIC)		Targeted facilities	Targeted areas
	Oc (ou_E/m^3)	P		
Austria	1 and 5-8	92 and 97	NA	Residential areas
Hungary	3-5	NA	NA	NA
Denmark	5-10	99	Livestock - Industries	Sensitive receptors- Urban zones
France	5	98-99.5	Composting and Rendering	NA
Ireland	1.5	98	All situations	Target value
	3-6	98	Existing and new pig production	Limit value
Netherlands	0.7-1.4	98	Livestock feed industry (new and existing)	NA
	1.5	98	Breweries, composting (new) and Slaughterhouses	NA
	2.5	98	Forage dryers, meat processing	NA

[26] Capelli L., Izquierdo C., Antón A., Diaz C., Arias R., Hernández M. (2021), Compilation of good practices in odour pollution 2, D-NOSES, H2020-SwafS-23-2017-789315. Forthcoming - Available at odourobservatory.org.
[27] Brancher M, Griffiths KD, Franco D, de Melo Lisboa H (2017). A review of odour impact criteria in selected countries around the world. Chemosphere. Feb;168:1531-1570. DOI: 10.1016/j.chemosphere.2016.11.160.

	3.5	98	Coffee roasters	NA
Belgium (Flanders)	2/3/5	98	Industries (very unpleasant odours)	High/ medium/ low sensitivity areas
	0.5/2/2	98	Targeted Industries (very unpleasant odours)	High/ medium/ low sensitivity areas
	3/5/5	98	Industries (more pleasant odours)	High/ medium/ low sensitivity areas
	1.5/3/10	98	Targeted Industries (more pleasant odours)	High/ medium/ low sensitivity areas

Up to date, the EU Horizon 2020 D-NOSES Consortium informed the revision of several EU Directives and policy documents, including the IED2010/75/EU (Integrated Pollution Prevention and Control) or the BAT Reference Document (BREF) for Slaughterhouses and Animal By-products.

In the following chapters, the strategies followed in the EU countries and beyond, including Chile, Colombia and Uganda, for controlling odour pollution will be briefly discussed, taking into account that, in some of them, the most important criteria regarding odour is established at the European level.

4. Regulatory framework of odour pollution in Portugal

In Portugal, odour pollution is not specifically regulated in any legislation, and it is the national Parliament the one having the duty to act.

4.1 The Portuguese regulatory framework

In Portugal, odour pollution is not regulated through any legislation in the country. Nevertheless, the Article 9, DL No. 39/2018 of June 11 limits the diffuse emission of pollutants into the air. In this article, the legal regime for the prevention and control of emissions of pollutants is addressed, but odours are not contemplated. In that sense, national institutions are the ones responsible for controlling odour pollution. The IED is also applicable in most of the odour emitting industries in Portugal, as the country is part of the EU. For further information, read Chapter 3.

4.2 Towards a regulatory framework in odour pollution in Portugal: Actions done during D-NOSES

The EU Horizon 2020 D-NOSES project counted with three very active Portuguese partners (APEA, São João da Madeira municipality and Liport) that have significantly advanced towards an improved regulatory framework for odour pollution in Portugal. The partners are:

- APEA, the Portuguese Association of Environmental Engineers, which has promoted the creation of a high level policy group in Portugal, coordinated by APA (the Portuguese Environmental Agency), member of the D-NOSES Advisory Board, with the goal of preparing a first proposal of a national legislation on odour management. During the last three years, APEA held national dialogues with APA and IGAMAOT (The General Inspection of Agriculture, Sea, Environment and Spatial Planning), as well as regional and sectoral stakeholders, like several Coordination and Development Commissions including CCDR-North, CCDR-Center and CCDR-Alentejo. These dialogues aimed to create favourable conditions for the approval of new national and regional policies and methodologies for the licencing, operation and monitoring of economic activities causing odour pollution.
- Lipor, an association in charge of waste management operating across eight municipalities, responsible to lead one of the Portuguese D-NOSES pilots, ultimately established around the Tinto River with four local governments finally engaged.
- The municipality of São João da Madeira, which has suffered from odour problems from decades coming from a nearby rendering plant, and has run the second D-NOSES Portuguese pilot.

At the local level, most actions were undertaken by the two Portuguese pilots. **The most important outcome is related to the fact that odours are now included in environmental and industry-related debates both at the policy as well as at the community levels**. The pilot's legacy left well-established relationships between relevant actors whose collaborative work has proven effective, leaving an emerging socio-technical infrastructure to tackle odour pollution in the two areas. **Odours are now understood as a pollution issue**, not just as a general problem. While this may seem trivial, positioning this issue in an ongoing culture of environmental sustainability, and an environmentally-related political agenda can be considered as an outstanding achievement.

In the case of São João da Madeira, the odour pollution problem comes from long ago. It is related to a rendering plant next to the village and several actions have been undertaken before and during the D-NOSES Project to address the issue:

- In 2014 the municipality of S. João da Madeira expressed itself when renewing the environmental license with the competent authorities and requested its integration into inspections carried out by the authorities at national level;
- In 2016, the citizen movement "smell of non-casqueira" originated a petition with more than 5,000 signatures, which resulted in a resolution of the assembly of the Republic on July 19, 2017;
- The resolution of the assembly of the Republic defined the creation of a technical committee that integrated the municipality of SJM, as requested in 2014;
- SJM carried out 11 technical visits to the odour issuing company with the various regulatory authorities, APA, CCDR-n, and DRA, between 9/13/2017 and 7/26/2021, including the D-NOSES execution period.
- Technical meeting to present the project to regulatory authorities took place on March 22, 2019;
- The project was also presented to the Youth Municipal Assembly on May 29, 2019;
- As a result of the actions, the odour emitting industry undertook corrective measures and the odour situation was overly improved, resulting in a significant reduction of the perceived odours by the population.
- In addition, CMSJM collaborated with the Portuguese Environment Agency, through the transfer of data from the D-NOSES project, for the creation of the bill that will be the basis of the first national legislation in Portugal on the theme of odours.

In the case of Lipor, four municipalities were engaged, consistent with the objective of leveraging the Tinto River as a testbed to monitor odour pollution issues associated with illegal littering, agriculture-related contamination and WWTPs discharge, coupled with instances of illegal discharging of wastewaters from households. All four municipalities manifested interest in being part of EU Horizon 2020 D-NOSES project, stating their commitment to integrate citizen science-based processes for monitoring odour pollution in their Business as Usual (BAU) from now onwards. The project departed from a process of receiving and managing complaints scattered and fragmented. Multiple channels, not integrated, were used to report complaints, which were difficult to manage. Then, during the pilot, the D-NOSES methodology was perceived as an improvement to gather and manage citizen complaints. This led to the

establishment of a new pivotal figure – formally named "river keepers" - and the inclusion of monitoring odours in their scope. Through the pivotal figure of the "**Guarda Rio**", new data about odours is now generated and made available to the relevant bodies and entities as part of the norm. Creating this **new, sustainable, source of data - and related governance -** is also an important policy-related outcome of the project.

The D-NOSES methodology is planned to be included in the policy agenda of the participating municipalities, to be adapted and replicated in other settings including a landfill, and in another river. Municipalities also wanted to explore the suitability of citizen science and its application to tackle wider issues, environmental and non, to create meaningful relationships with their citizens. Interestingly, regarding the landfill next to the municipalities of Sobrado and Valongo, the problem emerged during the D-NOSES pilot and has been spontaneously collected in the OdourCollect application by several users, with 65 odour observations, specially during the spring of 2020, and the lockdown period associated with the COVID-19 pandemic. The problem was presented in the press and reached the attention of APA and IGAMAOT, and contributed to the triggering of the national regulation process. This suggests an organic, not planned, extension of the area of intervention resulting from the pilot, and increased even more the belief for a needed **regulation about odour management in Portugal**.

From this local level, the approach in Portugal has been to leverage the results, experiences, and related learning from LIPOR and CMSJM to inform a new odour-related policy at the national level. Coordinated by APEA with the support and evidence from the two D-NOSES pilots in Portugal, the high level policy group constituted in D-NOSES run several actions to promote a new regulation in odour pollution at national level in Portugal, which was presented by Mr. Nuno Lacasta, President of the Board of APA, during the final D-NOSES conference, on the 20th of October 2021, with a presentation entitled "*Towards a new odour regulation in Portugal*".

4.3 The way beyond: Recommendations for Portugal

Since 2019, APEA promoted the creation of a high level policy group in Portugal, coordinated by APA, with the aim of preparing a first proposal of a national legislation on odour management to be reviewed and adopted by the Ministry of Environment and Climate Action.

During the process, LIPOR recognised that including odour nuisances on regulations is a long and complex process, and entails several bureaucratic obstacles. Another perceived issue is related to the non-linear nature of the policy making process both among national-regional-local levels and across parties. Despite these difficulties, the Portuguese D-NOSES partners will continue to run national dialogues with APA and IGAMAOT, as well as with regional and sectoral stakeholders. These dialogues will aim to create favourable conditions at the national level for the approval of new national policies on odour management, as well as new national and regional methodologies for the licencing, operation and monitoring of economic activities causing odour pollution.

In June 2021, the president of APA announced that the Portuguese Environment Agency is now undertaking the preparation of a **Guidance toolkit for odour management and control in Portugal**. This guideline **will take into account citizens' inputs for the management plans and mitigation measures proposed**. The final desirable consequence of this toolkit should be a set of regulations for odour pollution, its monitoring, prevention and mitigation.

The responsibility in this case weighs on the national Parliament, as in Portugal they have jurisdiction in terms of environmental pollution. Once the national context implements odour regulations, local authorities will be able to address odour pollution in a much organic way.

5. Regulatory framework of odour pollution in Italy

The legal purview in Italy resides in each region, generating a variety of regulations in the country. Lombardy, Trento and Pugia have been working on their own guidelines to define how odour emissions and odour pollution issues shall be managed.

5.1 The Italian regulatory framework

In Italy, there is **no legislation at national level** regarding odour pollution management, and the different regions in the country have the autonomy to implement their own guidelines in terms of air quality. Most of the **regions have specific guidelines** on maximum emissions, aimed at certain activities (composting, WWTP), but only some of them have an odour regulation with specific OIC, based on the frequency and concentration of ambient odours. In addition, the IED is applied to most of the industrial activities in the country and therefore some facilities also need to comply with the European Directives[28].

The **region of Lombardy** published a Regional Guideline on odour emissions in 2012 (D.g.r. 15 febbraio 2012 - n. IX/3018) which is applied to new and existing facilities from all kinds of emitting activities with a high odour impact. This guideline foresees a procedure divided in 4 phases (A-B-C-D) to deal with an odour problem. Phase A is intended to verify if there is a real odour problem affecting the territory. This should be done by **involving the resident population**. Since the guideline is quite "old" now, the involvement of the citizens was designed to happen through the distribution of questionnaires, in order to check if the odour episodes exceeded a certain frequency (5%). If not, then the odour episodes are considered to be occasional, and no further action is conceived, otherwise the procedure foresees the activation of Phase B, which is the core of the guideline.

Phase B is based on dynamic olfactometry and dispersion modelling. The guideline defines different thresholds depending on the population affected (1.3 or 5 ou_E/m^3 will affect 50-85 or 90-95 percent of the population) at the 98% percentile on an annual basis. There is also a

[28] Bokowa, A.; Diaz, C.; Koziel, J.A.; McGinley, M.; Barclay, J.; Schauberger, G.; Guillot, J.-M.; Sneath, R.; Capelli, L.; Zorich, V.; Izquierdo, C.; Bilsen, I.; Romain, A.-C.; del Carmen Cabeza, M.; Liu, D.; Both, R.; Van Belois, H.; Higuchi, T.; Wahe, L. (2021) Summary and Overview of the Odour Regulations Worldwide. *Atmosphere* Vol *12*, 206. https://doi.org/10.3390/atmos12020206

convert factor from hourly to peak concentrations (F=2.3). However, it should be highlighted that the Lombard guideline doesn't fix any acceptability criteria.

If Phase B highlights an odour impact that is considered to be incompatible with the surrounding territory, then Phase C should be activated, which entails action to reduce the odour impact. Finally, Phase D is a verification phase of the actions undertaken in Phase C.

In the **Province of Trento**, the guidelines implemented are based on the leading example of Lombardy. The main difference with the guideline of the Province of Trento is that this document sets specific acceptability criteria, which are a function of the distance of the receptor from the plant. Moreover, different limits are set for existing or new plants.

Meanwhile, the **region of Puglia** proposed a different kind of regulation, based on an analytical approach to measure the "limit concentration" of 40 different odorants (chemical compounds), each one with the use of a specific analytical technique. This complex approach was published on the D.g.r. 16 April 2015. It also fixed odour concentration limits in terms of 2,000 ou_E/m^3 for punctual sources and 300 ou_E/m^3 for diffuse emitting sources.

5.2 Towards a regulatory framework in odour pollution in Italy: Actions done during D-NOSES

In the Italian pilot undertaken in the area of Castellanza, four industries participated: a chemical plant, the municipal wastewater treatment plant (also treating 30-40% of industrial wastewater), a business in the textile industry (dyeing), and a minor wastewater treatment plant connected to the textile industry. The pilot plan was then to correlate observations with meteorological information and employ official techniques following the regional guideline of the Region of Lombardy, where it was taking place. Consequently, **the pilot demonstrated the effectiveness of complementing the D-NOSES citizen science methodology with the traditional scientific approaches to comply with existing regulations**.

In general, "*the odour situation has not changed yet, but we provided interested parties with a better and more informed way to look at this problem*". As a demonstration of this, the wastewater plant has already invested some financial resources to address the identified issues. According to the feedback received, at the end of the project, municipalities were "*happy but not too happy*". This was mainly because the problem, according to them, has not been solved yet. However, the advancements achieved through the D-NOSES intervention are clearly demonstrated, which in turn leaves an important learning as a legacy that is currently informing the way forward.

The pilot is also contributing to the existing guidelines in place in Lombardy, specifically to phase A, which is not very effective at the moment. Indeed, in most cases, Phase A is skipped and Phase B is activated directly for odour impact assessment with dynamic olfactometry and dispersion modelling. Citizen science has a window of opportunity in this regard.

Another aspect that is believed to be extending the existing guidelines is the approach in terms of the odour-related training provided to all stakeholders. **Skills and knowledge about odour have been transferred to participating citizens and local authorities**. This is also valid for the industries involved, as prior to D-NOSES they "*did not even know that odours can be measured*".

Figure 2: Policy dialogues in Italy

5.3 The way beyond: Recommendations for Italy

The Italian national regulatory framework is currently delegated into the different regions, as it is specified in Article 272-bis of the Legislative Decree 152/2006. This article was included in 2017 and it only put into paper the previous situation in the country, i.e. that the prevention and control of odour emissions was the responsibility of the regions. The current framework caused the repeal in the implementation of a new legislation on odour management in a specific region, Puglia (Above-mentioned in section 5.1)[29]. The problem arose because of the incompatibility with the European legal framework related to the IED facilities with national permits.

This example, caused by the absence of a national regulatory framework in Italy, demonstrated the **necessity of facing the problem of odours in the countr**y. The level of **legislative freedom of the Italian regions should be accompanied by technical and expert suggestions**[30]. In that sense, it should be desirable to include **national guidelines** that provide a pathway for regional legislators to control, prevent and monitor odours.

The guidelines should not only contain suggested emission limit values, or BATs references, but also procedures to **evaluate the grade of annoyance perceived by the population**. Here, the D-NOSES methodology can be very helpful in the pursuit of achieving an inclusive and complete legal framework in Italy. In the end, monitoring in real-time the annoyance of the affected communities can be a useful resource of information for policy-makers, which could trigger monitoring processes following the approach of the Lombardy guidelines.

[29] olores.org "Repealed the odour regulation of Apulia" 5th of August 2019. (Visited 16th of september of 2021)
[30] Rossi N.A., Il Grande M., Pretto U., (2018), Update on the Italian Regulation about Odour Emissions and Impact and Future Perspectives, Chemical Engineering Transactions, 68, 31-36. https://doi.org/10.3303/CET1868006

6. Regulatory framework of odour pollution in Spain

In Spain, municipalities have the responsibility to regulate odour pollution due to the lack of odour legislation at national and regional levels. Municipal ordinances are usually only created in places with odour conflicts, sometimes these are outdated or not based on scientific knowledge nor technical standards.

6.1 The Spanish regulatory framework

Spain does not have any national law regulating odours. As it happens in the rest of the European countries, IED is applied to several industrial activities. Olfactometry studies coupled with dispersion modelling, or other types of studies such as field inspections, are usually carried out in facilities susceptible of producing an odour impact. Only one autonomous region (Andalucía) mentions odour as an air pollutant[31].

The regulatory framework in the country gives the responsibility of regulating odours to local authorities, as there is a lack of legislation at the regional and national levels. In general, there are only regulations in municipalities where there have already been odour conflicts. For example, in the town of Sarrià de Ter, the regulation was established after the complaints of half of its residents.

In the region of **Catalonia**, a draft for a new law was developed in 2005, but it was not finally approved due to strong industrial opposition. However, the draft regulation is regularly used as reference since it establishes odour limits for certain odour emitting activities that can be included in environmental permits. This happens specially in Catalonia in relation to waste management, but also in other regions in Spain. Inspired by the UK H4 guidelines, this draft included OIC depending on the type of emitting activity ranging from most offensive to less offensive odours:

- 3 ou_E/m^3 P98 for waste management, rendering of animal byproducts, distillation of animal and vegetal products, slaughterhouses, paper and pulp industry;

[31] Decree 239/2011, of July 12, which regulates the quality of the atmospheric environment and creates the Registry of Air Quality Assessment Systems in Andalusia Available online: https://www.juntadeandalucia.es/boja/2011/152/5

- 5 ou_E/m^3 P98 for livestock, processed meat, smoked food, rendering of vegetal by-products, treatment of organic products, wastewater treatment plants;
- 7 ou_E/m^3 P98 for roasting and processing coffee or cocoa facilities, bread ovens, pastry and cookies, beer, production of flavors and fragrances, drying plant products, and other activities.

Some municipalities have used the Catalonian draft as reference to set the limits for odour pollution (for instance, San Pedro de Pinatar), while others regulate odour impacts by defining areas with odour saturation where new industries or new urban areas cannot be placed (i.e. Alcantarilla).

In the city of **Las Palmas de Gran Canaria**, an "odour perception index" was established for implementation of an OIC in their municipal ordinance for the protection of the atmosphere[32]. Based on odour concentration, several factors are included in the evaluation of this index, such as odour type, duration, intermittency, wind direction and period of time.

The absence of upper legislations (at regional and national level) makes that each municipality chooses a different approach, which in some cases do not follow standardized methods in Europe[33]. This is usually made in a very specific context during long term unresolved conflicts with an odour-emitting activity. That is why these ordinances are usually focused on some type of emitting industry, and some of them have chosen approaches not standardized at the European level. For example, the case of Villena, where the local ordinance set the odour limits based on the Texas regulations, i.e. field olfactometry using D/T units of odour, not standardized at European level[34]; the case of Riudellots de la Selva (Girona) establishes an infrastructure for the recording of odour-related complaints and their notification to the responsible activities potentially associated with the complaint.

6.2 Towards a regulatory framework in odour pollution in Spain: Actions done during D-NOSES

Within D-NOSES, several actions were done in Spain to advance the regulatory framework and to promote the official use of citizen generated data by environmental authorities, specifically the data generated in the Barcelona pilot.

[32] City Council of Las Palmas de Gran Canaria. Municipal Ordinance for the Protection of the Atmosphere Against Pollution by Forms of Matter, Las Palmas de Gran Canaria, Department of the Environment; Boletín Oficial de Las Palmas: Las Palmas, Spain, 1999. Available online: https://www.laspalmasgc.es/export/sites/laspalmasgc/.galleries/documentos-medio-ambiente/ONF_CONTAMINACIONFORMASMATERIA_17.pdf

[33] The list of municipalities with odour ordinances is the following: Castelldefels, Barcelona (1989) , Sant Vicent del Raspeig, Alicante (1994), Las Palmas de Gran Canaria, Canary Islands (1999), Banyoles, Girona (2004), Lliçà de Vall, Barcelona (2006), A Coruña, Galicia (2007), Riudellots de la Selva, Girona (2009), San Pedro del Pinatar, Murcia (2011), Villena, Alicante (2013), Alcantarilla, Murcia (2016), Sarrià de Ter, Girona (2018).

[34] Boletín Oficial de la Provincia de Alicante, Municipal Ordinance for the prevention and integrated control of pollution. 28th October 2013, nº205, 78 https://www.villena.es/wp-content/uploads/2014/10/Ordenanza-control-contaminacion.pdf

At the local level, the main actions were done through the involvement of the regional environmental authority, the **Metropolitan Area of Barcelona (AMB)** in the pilot. Important achievements include the establishment of an effective, collaborative working group including actors from across the quadruple helix to work together in the Barcelona pilot. The decision to have the Regional Authority on board from the beginning was a crucial step to start the Barcelona pilot, as the AMB is the owner of most of the emitting activities. They have substantially helped the D-NOSES team to reach the right contacts within the city councils at both the technical and the political levels. Having the AMB on board also contributed to give legitimacy to the project and to enable a more effective approach to the odour emitting activities, as well as throughout the different phases of the intervention. However, this initially generated some mistrust among community leaders. This mistrust was then addressed by explaining the nature of this project (i.e. a research project using citizen science prioritising citizens' participation in gathering data and allowing them to participate in local decision making) and communities and organized citizens associations complaining about the issue were finally successfully involved.

Despite all stakeholders involved in the pilot, the relationship with the odour emitting actors was hard to manage. They had an initial positive attitude and expressed their interest in collaboration with the AMB, but the sharing of their operational data has not happened to date. This has been problematic as crossing and correlating data from OdourCollect with their industrial practices was a key goal for the pilot to find situations of improvement. The Regional Authority in Barcelona has declared to be open to continue with the data analysis to correlate the citizen's generated data with industrial operations and potentially adopt the D-NOSES methodology to tackle odour issues concerning them and their communities. A more advanced stage of development of the methodology, given the fact that Barcelona was the first D-NOSES pilot, together with the current standardization process of the methodology, will contribute to the acceptance of the data generated by citizens by the environmental authorities and emitting industries to monitor odour pollution.

At the national level, part of the D-NOSES team (AMIGO, Ibercivis and Science for Change (SfC)), have been participating in a working group promoted by partner AMIGO since May 2019, to **work in a Spanish standard to monitor odour pollution through citizen science**. The working group includes some of the actors involved in D-NOSES, such as the AMB, consultancy agencies, olfactometry laboratories, public administrations, industrial managers and owners of odour emitting activities, associations and NGOs. The participation of the D-NOSES team has allowed the concept and basic principles of citizen science to be included in the technical standard, **the first of its kind that will include "citizen science" on its title**.

The initiative to elaborate this standard, with the support of the Spanish standardization body, UNE, arose during the project due to the need to standardize a citizen science methodology to map and evaluate odour pollution to promote its official uptake by environmental authorities. It also covers the limitations of currently standardized methodologies at European level (e.g. dynamic olfactometry and field panels), and accounts for real time odour observations monitoring from the receptor point of view. In fact, the standardization of the methodology is

of utmost importance to promote its official uptake by environmental authorities and municipalities at the national level, and increase trust in citizen generated data.

The standard is planned to be published and approved by UNE, the Spanish standardization body, by the beginning of 2022. It will help to consolidate the methodology in Spain and to serve as inspiration for other countries to adopt the methodology, in the same way that the German standards on field panels (VDI3940-1:2006[35]), odour intensity (VDI3882-1:1992 [36]) or hedonic tone (VDI3882-2:1994 [37]) have been used throughout Europe and ultimately adopted at European level, for example, in the case of field inspections (EN16841-1:2016[38] Ambient air - Determination of odour in ambient air by using field inspection - Part 1: Grid method). It is the aim of the Consortium to promote the adoption of the new standard at European level as well, once approved at the national level in Spain, as one of the main legacies of D-NOSES. The contents on the standard were presented in the NOSE Conference 2021[39] within the session dedicated to D-NOSES, and in the 9th IWA odours and VOCs conference in October 2021, where the results of the Barcelona pilot were also presented.

6.3 The way beyond: Recommendations for Spain

The Spanish context in regard to odour pollution is still underdeveloped and the lack of a national regulatory framework complicates the implementation of suitable ordinances in the cities and towns that suffer from odour. In that sense, environmental authorities in Spain should include guidelines that provide a pathway for the regional legislators and the emitting industries to control, prevent and monitor odours. AMIGO association, noticing the lack of guidelines and clear framework in the country, has created a working group that is elaborating a **model for municipal ordinances in Spain**[40]. The working group is composed of odour experts (part of the team of D-NOSES: AMIGO and SfC), environmental authorities and emitting industries that will join their different points of view for the generation of a common document for Spanish cities, towns and villages. This guideline will offer a tuition for local policy-makers to manage and control the environmental odour pollution in their municipalities.

Nowadays, most citizens' complaints do not have any importance for Spanish institutions. We encourage the public sector in Spain to use the example of the D-NOSES project and its pilot in Barcelona as a good practice for involving the community in the process of coping with not only odour pollution, but also with any kind of socio-environmental conflicts. Through the upcoming Spanish standard, the acceptance and diffusion of the methodology will be increased not only in the country but also internationally. The real nuisance caused to the population has to be taken into account in the development of new guidelines and local ordinances.

[35] VDI 3940 Part 1: Measurement of Odour Impact by Field Inspection - Determination of Odour Intensity and Hedonic Odour Tone. (2006) Beuth Verlag GmbH, Berlin.
[36] VDI 3882 Part 1: Olfactometry: Determination of Odour Intensity. (1992) Beuth Verlag GmbH, Berlin.
[37] VDI 3882 Part 2: Olfactometry: Determination of Hedonic Odour Tone. (1994) Beuth Verlag GmbH, Berlin.
[38] EN 16841-1, 2016, Ambient air - Determination of odour in ambient air by using field inspection - Part 1: Grid method, European Committee for Standardization (CEN), TC264 WG27,Brussels.
[39] Izquierdo et al., 2020. Developing of a New Spanish Standard "Building Collaborative Odour Maps through Citizen Science". Chemical Engineering Transactions, Vol. 82.
[40] AMIGO association will create a Guideline about odours for municipal ordinances. (August 2021)

7. Regulatory framework of odour pollution in Germany

Germany is one of the countries with the most advanced odour regulatory framework in Europe and some guidelines created in the country are applied worldwide. In 2021, Germany will be the first European country with a general odour limit in ambient air.

7.1 The German regulatory framework

Germany is a particular case as it represents probably the **most advanced European country** in relation to the level of maturity of odour-related policies[41], with more than 30 years in odour measurement techniques, technical standards and regulations. There is a specific odour national regulation called **Guideline on Odour in Ambient Air (GOAA)**[42] that defines criteria for protection against odour episodes. GOAA deals with odours necessarily arising from industrial and livestock facilities. Odorous gases from road traffic, domestic heating, vegetation, manure spreading, and similar sources are not included. The criteria defined in this guideline are based on the detection of recognizable odour, i.e. the description of the smell and the frequency of exposure is quantified by odour detection above the recognition threshold of an odour in a given percentage of times within one hour, i.e. the concept of the odour hour[43].

In this way, GOAA aims to determine recognisable odours in terms of odour frequencies and for this it uses grid measurements to estimate the frequency of exposure to recognisable ambient odours. The grid measurements apply the concept of odour-hour according to the guideline VDI 3940-1:2006. An odour hour occurs when the percentage odour time of a single measurement reaches or exceeds 10% by convention. The grid method is the only method to determine the perceived odour in the field over periods of six months to one year. When dispersion modelling is used, the most common method used in this country calculates the mean odourant concentration as the average hourly value. If the average hourly value is above an assessment threshold of 0,25 ou_E/m^3, the relevant hour is counted as an odour hour.

[41] D2.2 Analysis of existing regulation in odour pollution, odour impact criteria 1. Retrieved from: https://dnoses.eu/d2-2-analysis-of-existing-regulation-in-odour-pollution-odour-impact-criteria-1-pdf/ (Accessed 03/09/2021).
[42] GOAA (2008). Guideline on Odour in Ambient Air GOAA. Detection and Assessment of Odour in Ambient Air. Second Version, Berlin, Germany.
[43] F.-B. Frechen. (2000). Odour measurement and odour policy in Germany. *Water Sci Technol* 1 March; 41 (6): 17–24. doi: https://doi.org/10.2166/wst.2000.0088

In general, the duration is expressed by the odour frequency (876 odour hours per year in residential areas and 1,314 hours per year in commercial and industrial areas). If the odour frequency exceeds the specific exposure limit values, the odour exposure is classified as a considerable nuisance. Consequently, the concept of odour-hours weights many short odour episodes, which have a higher effect on annoyance, more than fewer long ones. The limit values expressed as relative odour frequencies per year are 0.10 (10%) for residential and mixed areas and 0.15 (15%) for commercial and industrial areas. A remarkable characteristic of this regulation is that it includes the definition of clearly pleasant odours using the polarity profile method. For clearly pleasant odours, a weighting factor of F= 0.5 can be used before applying the limit value.

The assessment criteria are determined by total odour exposure (EXPtot) that is based on the value of the existing odour exposure and the expected additional odour exposure. As a rule, the odour exposure is classified as a severe nuisance if the total odour exposure (EXPtot) exceeds the regulatory exposure limit value (EXPlim) set, as follows:

- *Residential and mixed areas:* 0.25 ou_E/m^3 at the 90th percentile;
- *Commercial, industrial, agricultural areas:* 0.25 ou_E/m^3 at the 85th percentile.

These limit values, classified by the type of land use, are relative frequencies of odour-hours. A constant F of 4 is applied to address hourly mean values from short-time peak concentrations of 1 s. A concentration threshold of 1 ou_E/m^3 is used, therefore, applying F, a Ct ¼ 0.25 ou_E/m^3 for 1-h mean concentration.

Nowadays, the Federal Ministry of Environment of Germany is working to upgrade guideline GOAA to a legislation status by incorporating the text in "**Technical Instructions on Air Quality Control**" (Technische Anleitung zur Reinhaltung der Luft - TA Luft). In this way, provisions in the TA Luft related to odour management (for example, minimum distances between industry and residential areas) will be added as a regulatory limit of odour hour in ambient air (for residential or industrial areas) that cannot be exceeded. This new guideline will finally become a law in Germany and odour will be officially included in the regulatory body of this country, and thus Germany will be the first country in Europe having a general limit for odour in ambient air.

7.2 Towards a regulatory framework in odour pollution in Germany: Actions done during D-NOSES

No consistent advocacy actions were taken in the German pilot during the EU Horizon 2020 D-NOSES project because the policy stakeholder (the municipality involved) decided that they did not have the capacity to actively support the project and thus ended the dialogues and their willingness to participate. In this way, the German pilot team still went ahead with online citizen engagement, albeit without the municipality's support. Still, a German version of the Policy Brief (see Annex 16.2 - General version of Policy Brief) was developed and sent to the heads of those state agencies in charge of air quality and thus, odour pollution, namely the

Federal Ministry for Environment, Nature Conservation and Nuclear Safety and all 16 state Ministries for Environment.

It is also envisaged to present the results of the D-NOSES project in November 2021 during the VDI biennial conference “Gerüche in der Umwelt” organized by Verein Deutscher Ingenieure (VDI), which develops all technical standards regarding Odour characterization and measurement in Germany. This biannual two-day conference is by far the most important meeting on odours in Germany and counts with the participation of all relevant stakeholders from the public administration, scientist and odour consultancies and odour laboratories. This will give the German pilot team the chance to discuss the D-NOSES methodology with relevant national leaders in the regulation of odour pollution.

7.3 The way beyond: Recommendations for Germany

The upgraded guideline GOAA will be incorporated into the "Technical Instructions on Air Quality Control" (Technische Anleitung zur Reinhaltung der Luft - TA Luft), being then obligatory in all 16 federal states. Still, access to environmental information of certain installations usually is very limited during the environmental licencing process. Once an environmental licence is granted, it may be quite difficult for citizens to obtain information on odour measurements of odour emitting industries or activities. TA Luft as a regulation focussed on public administration will not strengthen citizens' position in odour affected communities.

As mentioned before, Germany can be considered as a pioneer country, which early developed standards for measuring and quantifying odours and odour annoyance in Europe. Consequently the country adopted odour regulations on very different levels, such as environmental licensing, standard air quality regulations and the requirement of BATs for certain economic activities.

In a federal state, decisions should be made at the smallest possible local level. This is especially true for the odour problem, which is usually a local problem of limited scope. With this in mind, D-NOSES encourages an **increased citizen participation during and especially after the issuance of the operating permit**. To this end, there are a number of efforts at the municipal level, but also technical regulations, such as VDI 7000:2015[44] ("Early public participation in industrial and infrastructure projects"). With regard to odour nuisance, hurdles to the recognition of the legitimacy of odour data collected by citizens should be reduced or eliminated.

[44] VDI 7000. Early public participation in industrial and infrastructure projects (2015). Beuth Verlag GmbH, Berlin.

8. Regulatory framework of odour pollution in Greece

There is no specific odour regulation in Greece

8.1 The Greek regulatory framework

Nowadays, Greece does not have regulations concerning odour emitted from industrial sources. Odour problems have not been addressed by local regulations since it is still considered as part of the wider environmental ambient air quality issue. Research in national legislation confirmed that provisions about odour exist only for urban activities where no specific limits are in place. Moreover, there is no integration of the particular issue of odours from BREFs guidance documents to the national legislation. Nevertheless, when industries are interested in measuring odours, standards such as EN 13725:2003 and EN 16841-1:2016 are requested from the installations and implemented by the analytical laboratories for odour measurement.

Finally, the Ministry of Environmental and Energy has adopted the IED applied to several industrial activities and, within this context, the facilities susceptible of producing an odour impact may have specific odour limits and odour control methods.

8.2 Towards a regulatory framework in odour pollution in Greece: Actions done during D-NOSES

In Greece, the D-NOSES pilot was focused in a residential area of about 20,000 people that live near a refinery in Thessaloniki and evolved through inputs, feedback cycles and negotiations, which gradually increased partner's understanding of the issue, the context, its key actors, and their interactions. This residential area covered three zones: zone of Evosmos-Kordelio, zone of Menemeni and zone of Kalochori. The key actors in this pilot were identified to be the local residents, the local authority and the refinery. The existing scenario was far from perfect for establishing collaborative citizen science work, because the relationship between stakeholders was not positive. The regional authority was initially against planning the pilot around the refinery, due to the very sensitive position of the industry for the public opinion. Also, the regional authority, in collaboration with Aristotle University of Thessaloniki, had already an environmental program with the refinery in progress. The negotiation resulted in the additional inclusion in the target area of a river where untreated wastewater was released from households and/or industrial activities. Public government agencies were targeted at three levels: local, regional, and ministry level. These, especially the latter, had already put in

place their own methodology for measuring and managing environmentally-related emissions, through automated sensors.

In terms of sequence, the **Regional Authority of Central Macedonia** was approached first. A **letter of support** was received from them and that is argued to have opened the doors for initial discussions with other actors. For instance, the commitment from the regional authority opened the door to engage local schools in the intervention. Thessaloniki hosts an important branch of the Ministry of Education, and the relationship with the regional authority was harnessed to reach these, and, ultimately, local schools.

Leveraging the support of the regional authority, the next step was about approaching the **municipality** trying to convince them to participate in the pilot. With respect to the municipality, "participate" in Greece meant addressing two objectives: (1) endorse the project which, with the support of the local authority, would have gained credibility; to demonstrate the last aspect, having a letter of support from the regional authority was welcomed very positively by other stakeholders (specifically the university, citizens and some other industries such as environmental consultants and hospitality companies); and (2) the opportunity to link with an entity that knows the local (policy) context, enacted those approaches that existed at the beginning of the pilot, and has the knowledge of the overall ecosystem - i.e. can link to additional stakeholders at different levels (e.g. a branch of police dealing with environmental issues, which the D-NOSES partner did not know it existed, the inspectors within the national **Ministry of Environment**).

Another argument to trigger interest and motivation referred to the opportunity for public sector agencies to improve internal processes through the D-NOSES tools, principles and learnings. However, this was not initially well-received. For example, **from the ministry and the authorities' side, the initial proposal of integrating citizen science in their current practices was not seen as crucial** by them. The reason provided was that they were skeptical of the value of these subjective measurements, compared with the objective hard data being collected through their sensors. However, also pushed by one of these three levels (i.e. the regional one), after a series of iterations and discussions, local authorities started to acknowledge the value of D-NOSES, i.e. the potential contribution of citizen science to their existing work. The ministry appeared to be more detached from the pilot, although they were present.

The plan for action was made through the thoughtful delivery of a comprehensive workshop involving communities, the university, and the regional authority. A stakeholder consultation action was implemented in June 2021, and these were organized in separate meetings based on the different stakeholder groups. Initial meetings were held with community champions in advance of the final workshops in order to discuss possible ambiguities or queries that might arise. The outcome of these initial meetings was quite positive although the main question asked was what would be the next steps after the completion of the project. The results were regarded as quite reasonable in terms of geographical allocation of the observations, as well as in terms of type of odour per area and intensity.

The main workshops were divided into two groups. The first group consisted of citizens and university representatives. After presenting the results, a conversation concerning the operations of the refinery and the potential existence of patterns between the observations and incidents that affected the community for the same period of time was triggered. On some occasions there has been an identification of those two parameters. There has also been a discussion concerning the issues the observers had with the OdourCollect App and also some clarifications concerning the written questionnaires. The second group was that of the Regional Authority. Results were presented and methods discussed to map the area at an even greater scale. The observations in terms of qualitative and quantitative results were well accepted and confirmed the feedback from the citizen complaints that the Authority has been gathering so far. The meteorological data were also discussed, as the weather monitoring stations operated by the Authority were not operating sufficiently.

An important outcome from the pilot in Greece relates to the achievement of **alignment of views and perspectives between citizens and the regional authority**. This means mainly the regional authority acknowledging the issues experienced by the local citizens and the other way around. This is an important building block to develop a relationship based on trust and collaboration, rather than on conflicts and counterparts. By the end of the project, the regional authority demonstrated their appreciation and the perceived potential value of citizen science to monitor odour pollution and the potential of the new methodology to complement traditional measurements.

Another important outcome relates to the discovery of the **relationship between bad odour events and meteorological conditions**, and specifically how odours occur based on the weather and how tangible data can inform how they fluctuate over time. In this way, an important outcome refers to the demonstration of the usefulness of the D-NOSES methodology to **reach meaningful scientific conclusions on odour pollution monitoring**.

Figure 3: Policy dialogues in Greece

8.3 The way beyond: Recommendations for Greece

With respect to policy, odours have not been part of the local legislative landscape to-date. Odour problems have not been addressed by the local legislation since it is still considered as part of the wider environmental ambient air quality issue. Moreover there is no integration of

the particular issue of Odour from the BREF guidance documents to the national legislation. It should also be mentioned that the Ministry of Environmental and Energy has adopted the IED focusing on specific environmental parameters in terms of stack emission monitoring and control and in ambient air quality rather than in specific odour nuisance. In Greece, local authorities initially showcased their concerns about the quality of the citizen generated data, and especially their reliability to inform new policies. The D-NOSES pilot contributed to address this challenge. By the end of the project, the regional authority demonstrated their appreciation and the perceived potential value of citizen science to monitor odour pollution.

Figure 4: Meetings with policy makers and the Regional Authority from Thessaloniki.

The value is perceived as in **gaining a previously unavailable understanding of the issue, its magnitude and its effects on local people**. The authority understands the potential of the new methodology to complement traditional measurements, rather than a standalone methodology, which is a vision shared by the D-NOSES consortium.

Both the D-NOSES Advocacy Toolkit and the Policy Brief were leveraged in this range of activities. The first was studied and used to inspire the development of the approach and the interactions at the ministry, regional, and local levels. While this was useful to develop a framed mindset prior to these interactions, the team acknowledges that the conversations dynamically evolved in a natural way, rather than following a pre-established process.

In addition, partner MIO-ECSDE, based in Athens and in charge of the D-NOSES advocacy actions, have achieved to get on board a **Greek MEP, Ms Maria Spiraky (co-chair of the European Parliament Intergroup on "Climate Change, Biodiversity, and Sustainable Development"), to host and organize an event in the European Parliament** in October 2021, where this strategic roadmap for governance in odour pollution will be presented, together

with the *Green Paper on Odour Pollution*. At the end of her intervention, MEP Ms Maria Spiraky expressed her interest in knowing more about the work undertaken in Greece to follow on it and requested to share the results with her office, which potentially will have an effect on potential new regulations to address the issue in Greece.

However, there is no foreseen change in the Regulation for the coming years in Greece. Provisions related to odours in Greek legislation, as mentioned above, still do not exist and consequently in the environmental permits of the industry, odour issues concern primarily prevention techniques that are not obligatory. Hopefully, the event in the European Parliament hosted by a Greek MEP will contribute to a change in the mindset and to the recognition of the importance of recognizing ambient odours as pollutants to pave the way for future regulations.

9. Regulatory framework of odour pollution in Bulgaria

There is no specific odour regulation in Bulgaria.

9.1 The Bulgarian regulatory framework

In Bulgaria, there is no odour regulation at national level. Nevertheless, the Ordinance of the 10th of September of 2012 included the implementation of sanctions for odour emitting industries, even though the regulation is not specific about odours. The Regional Inspectorates for Environment and Water (RIEW), who are part of the control system of the Ministry of Environment and Water (MOEW), are the 16 regional authorities that impose sanctions all across the country.

As in the rest of the EU, in Bulgaria the IED is applied to several industries. The implementation of BATs is compulsory in order to obtain new permits and odour abatement technologies are included usually in the BAT Reference (BREF) documents.

9.2 Towards a regulatory framework in odour pollution in Bulgaria: Actions done during D-NOSES

In Bulgaria, prior to the EU Horizon 2020 D-NOSES project, odours have not been included in the local policy discourse and were not part of the future plan. The pilot in Bulgaria provides an important different perspective to the D-NOSES project because the pilot was led by the local authority, the **Sofia Municipality**. The research question and the overall pilot was framed around odours from food waste production, collection, and management practices.

The different data collected and analysed in the Sofia pilot allowed achieving a more granular understanding of the food-waste related ecosystem in Sofia. This accumulated knowledge was leveraged internally in several ways. For example, the **food-waste collection schedules were re-thought and improved**. While this may be seen as deviating from the citizen science principle in D-NOSES, the outcomes of the pilot somewhat addressed several facets of the issue, and shows how **the methodology also allows to address urban issues**. This is, however, consistent with the local attitude whereby *"this is a problem that the public sector needs to solve"*.

Another important outcome is the realization that the odour problem is not as much perceived as a pressing issue by the public, despite the fact that the complaints received and collected before seem to indicate otherwise.

Figure 5: Policy dialogue in Sofia, Bulgaria

An important reflection from this pilot and the peculiarity of this being led by the local Council is that too often engagement of and reach to policy makers is taken for granted once the authority is formally engaged in the process. The pilot in Bulgaria demonstrates that **this is not enough to ensure triggering new policy making processes**. Internally, different departments are responsible for different elements related to the scenario and ecosystem considered in this pilot. Integration, information flows and knowledge exchange across these is not always immediate and overcoming internal silos is far from easy even for another internal department. Moreover, local councils generally, and Sofia Municipality specifically, work under the influence and policy provided at the national level. **Having a local council involved in the project does not automatically translate to having the full spectrum of policy makers on board**. Given the circumstances, it has been impossible to draft new policies and regulations on odours. As mentioned above, following the recent interaction with the ministry level, the plan is to develop a full draft by 2023/2024.

The experience of the Sofia Municipality is also important to reflect upon if and how citizen science can be leveraged in an intervention led by a City Council. In other words, citizen science projects typically target public authorities as part of their intervention (either at the beginning to have them on board throughout, or at the end to provoke policy making informed by data collected by citizens in a more protest-like manner). Interestingly, the partner argues that citizen science can be potentially beneficial, but it depends on the domain. This is not (only) to say that certain topics are not suitable for the discipline, but mainly refers to the fact that effective **interventions can be accomplished if citizens are interested in the topic under investigation**. Although this is very context dependent, in Bulgaria topics that raise interest among people are related to air quality, road and transport quality, and snow-related issues.

Another question was asked in relation to what other citizen science projects need to do to get the attention and engagement of the local authority. Importantly, the recommendation is made on becoming aware of the policy priorities for the area and **position the collaboration within**

the existing priorities. At the basis, people within the council need to comply with their own strategic plans and collaboration is more effective if established as a **win-win program**. The Policy Brief (or something similar in nature) should literally hit a priority item for the council, and only by doing so, relevant internal people accountable for that specific item are willing to help. The process shouldn't therefore be "*here is what we do, and we try to convince you that this is relevant*", but rather "***this is how I can help you to achieve your already existing objectives***".

9.3 The way beyond: Recommendations for Bulgaria

There is still a long way to go in Bulgaria regarding odour pollution due to its underdeveloped legislation in the field. Identifying those necessities, the policy-makers should promote debate with the aim of creating new guidelines and finally legislating about odour pollution. The local authorities should have the support and guidance of the regional and national institutions, and therefore, a **multi-level governance approach** seems the best possible approach in regard to odour pollution.

In all Europe, a change towards a more inclusive and citizen-centered policy is undergoing. Citizen generated data can be very helpful to have a quicker and more efficient communication system between authorities and population. In that sense, the D-NOSES methodology can be found as inspiration for new guidelines and regulations in odour pollution and other socio-environmental challenges where receptors and **citizens affected are an important part of the solution**.

10. Regulatory framework of odour pollution in United Kingdom

In the United Kingdom, local authorities are in charge of investigating odour complaints. Additionally, there are several guidelines for monitoring, control and prevention of odours at regional level.

10.1 Regulatory framework in the United Kingdom

In the United Kingdom, there are no national regulations about odours. However, each authority of England, Wales, Scotland and Northern Ireland uses similar published guidelines to issue permits for the industries. One of the first guidelines published was the Integrated Pollution Prevention and Control directive (IPPC) where limits are set in Appendix 3 (modelling odour exposure) of the **H4 Horizontal Odour Management**[45] (2011), focusing on activities that are included in Environmental Permitting Regulations (EPR). Smaller facilities are regulated by local authorities, which use three ways for controlling odours: (i) planning, (ii) permitting, and (iii) statutory nuisance.

The Environment Agency (EA) **H4 Horizontal Odour Management** sets the maximum odour concentration that may only be exceeded during 2% of the hours in a year (98th percentile) and are differentiated on the basis of the level of potential olfactory annoyance associated with the industrial category under consideration:

- 1.5 ou_E/m^3 for most offensive odours (decaying animal or fish remains, processes involving septic effluent or sludge and biological landfills, oil refining, wastewater treatment)
- 3 ou_E/m^3 for moderately offensive odours (intensive livestock rearing, fat frying (food processing, sugar beet processing and green waste composting)
- 6 ou_E/m^3 for less offensive odours (brewery, confectionery, chocolate manufacture, fragrance and flavourings and coffee industries)

[45] Environment Agency, United Kingdom (2011). H4 Odour Management – How to comply with your environmental permit. Retrieved from:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296737/geho0411btqm-e-e.pdf

The regulators often rely on using emission data provided by the industry or by using their own monitoring, and some changes in the limits can be done at the local level depending on the situation. E.g. When the community is already sensitized to the odour, the limit can be set lower (C_T=0.5 ou_E/m^3). Nevertheless, these suggestions are not scientifically verified, each authority may have its own systems and thresholds to trigger any investigations. Finally, the UK has other guidelines related to odours, such as guidance on the assessment of odour for planning[46].

10.2 Towards a regulatory framework in odour pollution in the United Kingdom: Actions done during D-NOSES

Initially, the UK team scoped two pilot study areas: (1) The Royal Docks in the London Borough of Newham; and (2) Penrith in Cumbria. Unfortunately, The Royal Docks area failed to continue successfully to the data-collection phase due to the COVID-19 pandemic. On the other hand, the potential pilot in Penrith focused on an animal-rendering plant which was upsetting some residents. Due to the lack of community buy-in to engage in the D-NOSES project, this pilot was ended. Consequently, in March 2020, a call was put out via social media to communities in the UK suffering from odour issues, and desk research was conducted into relevant stories covered in the media. As a result, the pilot team identified two potential new pilots, the first location was Southall and Hayes in West London, and the second location was Rossington, South Yorkshire.

In Southall and Hayes, the team managed to involve policy-makers, and the **London Borough of Ealing**. After several emails and discussions with a local MP in Ealing and his representatives, they agreed to support the project and sent an open letter to the Leader of the council requesting him to adopt OdourCollect and citizen science in addressing local odour issues. The request highlighted that current monitoring and complaints procedures are inadequate, namely the residents being required to complain by telephone with reportedly long wait times could lead to under-reporting. Without complaints, the council were not obliged to investigate and so the situation was difficult to resolve.

An online meeting with a newly elected Leader of the council was held in July 2021 where OdourCollect, citizen science, data collected to date and D-NOSES were introduced in more detail. The result was an **agreement to adopt the use of citizen science and the app as part of their monitoring and complaints procedure** and they confirmed their interest in a round table meeting with all stakeholders. It was also agreed that **the Council would receive real-time alerts of any odour observations** via the app so that these could be investigated immediately and extra resources would be assigned to this. Later, in August 2021, as a result of the analysis of the records from OdourCollect, **the council recruited a dedicated environmental officer to investigate odour complaints**.

Moreover, the team co-developed outputs and actions together with representatives from the London Borough of Ealing, emitting industries and local residents at a roundtable meeting in

[46] Institute of Air Quality Management - IAQM (2018). Guidance on the assessment of odour for planning. Retrieved from: https://www.iaqm.co.uk/text/guidance/odour-guidance-2014.pdf

September 2021. The agreed actions included Ealing Council adopting and promoting the use of OdourCollect to supplement their existing complaints procedures. They requested to **set up a real-time alert of odour reports** from the app to speed up the process of reporting odour complaints, which was developed by the D-NOSES team and is now also being shared with the industries and authorities so that any incidents can be investigated immediately and industry activities can be checked. Indeed, by sharing data from OdourCollect with industries and the council in Southall, UK, it was **possible to cross-reference an odour episode identified by communities with specific odour-emitting activities** (the laying of asphalt roads in a new housing development). In addition, the Council agreed to set up a dedicated space on their official website to share any relevant information and updates about odour investigations and the industries agreed to use this space to provide citizens with regular updates on the activities they were carrying out that could cause an odour.

While scoping the Rossington pilot, the UK team held meetings with residents, industries, Doncaster Council and local councillors in Rossington. During these meetings, which were informal in nature to encourage an open and equal space for discussion, the aims were to provide an opportunity for residents to voice their concerns and request action on the odour issues they were facing. It was also a chance for policy-makers to respond, and inform the citizens about what council officers were already doing to address odours.

10.3 The way beyond: Recommendations for United Kingdom

The next steps are around **access to information and access to public participation**. Therefore, the use of the app OdourCollect for data collection will be further promoted by the policy makers. The Council along with the industries and policy-makers will continue to receive email alerts of real-time odour observations. Citizens will have access to local information on odour complaints. Investigations and potential odour episodes and further analysis of the data will be provided to the policy-makers in order to inform future efforts.

The Southall and Hayes pilot will provide an example of effective collaboration between stakeholders and best practice that can be replicated in communities elsewhere across the UK. Local authorities will be encouraged, driven by the local partner, MfC, to adopt the D-NOSES methodology to engage communities in the process of addressing odour issues and reducing conflict within their administrations.

Hopefully, the experience will be inspiring enough to promote the use of citizen generated data by other environmental authorities and municipalities. The standardization of the methodology will also facilitate the possibility of being included in some of the regional technical guidelines to complement traditional odour monitoring techniques. This would be an important step since UK guidelines have been used as reference for odour monitoring in many other European countries.

11. Regulatory framework of odour pollution in Chile

In Chile, new odour regulations are going to be published in the next few years for different industrial sectors, following a national strategy to adopt international standards of odour control.

11.1 The Chilean regulatory framework

In recent years, Chile has been characterized by having several socio-environmental conflicts related to odour episodes, specifically conflicts caused by pig and poultry production; but even so, there is **no national regulation on odours to date**. The only current law is restricted to the regulation of Total Reduced Sulfur compounds (TRS) for pulp and mill industries[47]. Also, there are **ordinances in some municipalities**, which establish restrictions on the generation of odours that may be a health risk or be annoying to the community[48].

Since 2012, the **Ministry of Environment** addressed odour pollution with the development a document called **National Odours Strategy in Chile** (2014-2017)[49] which may help some critical industrial activities potentially generating odours to adopt improvements or technologies and practices to control odour; in addition to establishing odour emission limit values. The Ministry of Environment establishes a prioritisation of potential odour-generating activities based on the following criteria: (1) Activities with a greater number of complaints; (2) Activities with a greater number of facilities; (3) Activities involved in socio-environmental conflicts due to odours.

As from 2017, the country formally requires an **odour assessment** for projects submitted to the environmental impact assessment system, using international standards as references. Chile has adopted several European standards that have been homologated by the National Institute of Normalization such as:

[47] Decree 37/2013. Establishes emission standards for odour-generating TRS compounds associated with the manufacture of kraft pulp or sulphate, based on the revision of Decree 167/1999, minsegpres, which establishes emission standards for nuisance odours (hydrogen sulphide compounds and mercaptans: TRS gases) associated with the manufacture of sulphate pulp. Retrieved from: https://www.bcn.cl/leychile/navegar?idNorma=1049596

[48] ECOTEC Engineering Ltd. Background for Regulation of Odours in Chile; ECOTEC Engineering Ltd.: Santiago, Chile, 2013. Retrieved from: https://olores.mma.gob.cl/wp-content/uploads/2019/03/ECOTEC-Ingenieria.pdf (accessed on 2 February 2021).

[49] Ministry of the Environment Chile. Strategy for The Management of Odours in Chile; Ministry of the Environment Chile: Santiago, Chile, 2017. Retrieved from: https://olores.mma.gob.cl/wp-content/uploads/2019/03/Estrategia_Olores_Actualizacion2017.pdf.

- NCh 3387:2015[50]: Air Quality Assessment of Odour Annoyance Survey;
- NCh 3386:2015[51] : Air Quality—Static sampling for olfactometry; reference to German standard VDI 3883-1:2015[52];
- NCh 3190:2010[53]: Air Quality—Determination of odour concentration by dynamic olfactometry; reference to German standard VDI 3880:2011[54] and European standard EN 13725:2003.

In 2018, with the creation of a specific department of odours in the Ministry of Environment, it was decided that a new set of regulations specifically to address odour pollution in the main industrial sectors affecting communities in the country will be produced, the first one targeting the pig sector. A process for an open consultation[55] for the draft regulation of the emission of pollutants in pig farms[56] (June 2020) was initiated from 16/12/2020 to 12/03/2021, receiving **309 inputs** from a wide variety of stakeholders. As a result, the new regulation, the first one of its kind in the country, is expected to enter into force in 2022. The D-NOSES team (ECOTEC, Ibercivis and AMIGO) contributed to the open consultation[57] recommending the participation of citizens to evaluate nuisance. The next industrial sectors to be addressed are swine's farms, fisheries, wastewater treatment plants, the cellulose industry and landfills. Additionally, **in 2019, the deputies of the Chamber of Chile approved the introduction of "odour" as an environmental pollutant** within this regulation.

Odour Complaints are handled with the Health **Authority** (formed by the Ministry of Health and its Regional Ministerial Secretariats of Health). It is the responsibility of this authority to monitor odour emissions and use sanctions such as fines, closures, cancellation of operating licenses or permits, or even closing facilities depending on the number of infractions. An offensive odour indicator parameter, which is the number of complaints or allegations made by the community to the Health Authority, is used.

[50] Instituto Nacional de Normalización. NCh3387:2015: Air Quality and Assessment of Odour Annoyance Survey; Instituto Nacional de Normalización: Santiago, Chile, 2015.
[51] Instituto Nacional de Normalización. NCh3386:2015: Air Quality—Static Sampling for Olfactometry; Instituto Nacional de Normalización: Santiago, Chile, 2015.
[52] VDI 3883-1:2015. Effects and assessment of odours - Assessment of odour annoyance - Questionnaires. (2015) Beuth Verlag GmbH, Berlin
[53] Instituto Nacional de Normalización. NCh3190:2010: Air Quality—Determination of Odour Concentration by Dynamic Olfactometry; Instituto Nacional de Normalización: Santiago, Chile, 2010
[54] VDI 3880:2011.Olfactometry - Static sampling. (2015) Beuth Verlag GmbH, Berlin
[55] Observations and Responses Citizen Consultation on the "Preliminary draft standard for the emission of pollutants in pig farms which, due to their odours, generate nuisance and constitute a risk to the quality of life of the population". Consultation period 16-12-2020 to 12-03-2021. Retrieved from: https://planesynormas.mma.gob.cl/archivos/2021/proyectos/f07_563.MEMO_EDUPAC_N_91_2021_Consolidado_Observaciones_Olores.pdf
[56] Interior and Public Safety Ministry of Chile (2020). Extract from the preliminary draft of the standard for the emission of pollutants in pig farms that, due to their odours, generate nuisance and constitute a risk to the quality of life of the population; prepared by the Environment Ministry. Retrieve from: https://www.diariooficial.interior.gob.cl/publicaciones/2020/07/22/42711/01/1785167.pdf
[57] Arias R., Salas Seoane N., Diaz C., Schleenstein Gerhard (2021). Statement on: . Retrieved from: the preliminary draft of the standard for the emission of pollutants in pig farms that, due to their odours, generate nuisance and constitute a risk to the quality of life of the population. Retrieved from: https://consultasciudadanas.mma.gob.cl/storage/citizen/6432/D-Noses%20Statement%20on%20Chilean%20Emissions%20Standard.pdf (Accessed 03/09/2021).

11.2 Towards a regulatory framework in odour pollution in Chile: Actions done during D-NOSES

D-NOSES partner ECOTEC has a long record of advocacy actions regarding odour pollution in Chile. In 2013, it was awarded with a consultancy contract with the Ministry for Environment in order to recommend a roadmap for an integral odour regulation. Based on the outcomes of this contract, the Ministry developed its Policy on Odours. In parallel, ECOTEC elaborated a draft document for a guideline on odours within the national environmental licensing scheme. This guideline was published some years later, in 2019. Since 2008, ECOTEC professionals have also participated on a regular basis in several standardization committees for different technical standards regarding odours.

The D-NOSES advocacy actions therefore were embedded in their regular professional work regarding odour regulation in Chile. Within the EU Horizon 2020 D-NOSES project, experts from ECOTEC adapted the D-NOSES policy brief and developed a special Chilean version (See Annex 16.2 -Chilean version of Policy Brief).

At the national level, an important event was organized in collaboration with D-NOSES partner AMIGO, together with Olores.org and the backing of the Ministry of Environment of Chile: The 5th International Conference on Environmental Odours & VOCs Management on the 26-27 of November 2019 in Santiago, Chile. During the conference, the D-NOSES team was given the chance to present and promote the project and methodology, and the expected scientific outcomes from the pilots, and a stand was set for the project. The D-NOSES team (ECOTEC, AMIGO, Ibercivis, IFC, SJM) set up a stand including roll-up banners to describe the project as well as different brochures and branded materials to promote the project during the conference. The travel was also useful to initiate the engagement actions for the pilot in Chile.

Also in November 2019, ECOTEC and IFC conducted a workshop on citizen science and odour pollution in and for the Ministry for Environment and - together with IBERCIVIS - also had a meeting with leading staff and head of the Air Quality/Atmospheric Pollution Department and the unit responsible for Odours, Noise and Light pollution. In both cases, policy-makers positively embraced the D-NOSES methodology and considered it for testing and introduction in future policies.

Figure 6: D-NOSES workshop for the Chilean Health Ministry and Environmental Ministry, with a copy of the D-NOSES policy brief

Another important aspect was a workshop conducted by ECOTEC and Ibercivis (with collaboration from AMIGO) for two professionals of the Chilean Ministry in May 2021. These actions are in line with the advocacy actions the D-NOSES consortium started with regard to the first Chilean Emissions regulation. These include several informal (virtual) meetings, phone calls and the D-NOSES statement on a proposal for the first Chilean odour emissions regulation for piggeries. Finally, D-NOSES prepared a document to inform the regulation under consultation after an open process launched by the Ministry in March 2021, because an important limitation has been identified. In particular, the new regulation is planned based on measurement taken only at the plant site (or the origin or odour source), without any reference to the surrounding environment, i.e. the area affected by the odour, or the receptor point of view, which is the target of the D-NOSES methodology. Data from D-NOSES was then submitted to the Ministry of Environment to influence the extension of focus of the policy into the real impact of these odours on people. Meetings with the Ministry have taken place during the pilot at different phases (also in the presence of the D-NOSES project coordinator) to raise awareness and transfer these inputs into the policy making process.

At the **regional level**, public hearings are already considered within environmental licensing schemes, and requirements towards citizens' inclusion may be considered in permits. The aim of the dialogues in this setting was, therefore, to encourage the consideration of citizen-based odour observations in environmental permits. The EU Horizon 2020 D-NOSES project and its approach were presented at a dedicated workshop, which was streamed for regional participants of the Environmental Ministry. The D-NOSES policy brief was also handed over to the Environmental Ministry and will be distributed to its regional branches.

At the local level, in Chile, some local regulations (ordinances) exist to integrate national regulations on odours. However, these are very weak and the municipality usually has no

means to enforce measures for odour control at source. Therefore, no specific policy aims were targeted at the local level beyond support for the D-NOSES pilot in the selected municipality.

11.3 The way beyond: Recommendations for Chile

The main recommendations are contained in the Chilean Policy Brief and also in the aforementioned document "D-NOSES Statement on Anteproyecto de Norma de Emisión de Contaminantes en Planteles Porcinos que, en Función de sus Olores, generan Molestia y constituyen un Riesgo a la Calidad de Vida de la Población"[58].

The draft regulation (and probably those forthcoming) is focused on emission measurements at the source and dispersion modelling. Thus, the proposed regulation does not only take into consideration Principle 10 of the Rio Declaration, but rather violates it in several aspects (it should be noted, though, that Chile has not ratified to date the Escazú convention). The **D-NOSES Consortium strongly believes that the new odour regulations under approval in Chile for different industrial sectors represent an excellent opportunity to include affected citizens in the regulation of odours**, to produce real-time data on the perception of the nuisance in order to act on the emitting sources and reduce the impact, thus effectively improving the quality of life of the affected population.

D-NOSES recommendations suggest to include techniques that allow measuring at the receptors instead of focussing solely at the emission side, because odour measurement is complex and faces high levels of uncertainty during sampling, storage of samples and analysis, and dispersion modelling is also a complex task. Those techniques may include source strength determination with plume measurements and surveys to determine the odour nuisance caused in neighbouring communities. Both techniques are standardized in Chile through NCh3533/2:2017 "Medición del impacto de olor mediante inspección de campo - Medición de la frecuencia del impacto de olores reconocibles - Método de la pluma" (plume method) and NCh3387:2015 "Calidad del aire - Evaluación de la molestia por olores - Encuesta" (surveys).

The D-NOSES "Statement on Anteproyecto de Norma de Emisión de Contaminantes en Planteles Porcinos que, en Función de sus Olores, generan Molestia y constituyen un Riesgo a la Calidad de Vida de la Población" also includes several other both generic and very specific recommendations and suggestions regarding the future emissions standard that hopefully will be considered, specifically the use of the D-NOSES methodology to gather real-time odour observations from the receptors point of view.

[58] Arias R., Salas Seoane N., Diaz C., Schleenstein Gerhard (2021). Statement on: . Retrieved from: the preliminary draft of the standard for the emission of pollutants in pig farms that, due to their odours, generate nuisance and constitute a risk to the quality of life of the population. Retrieved from: https://consultasciudadanas.mma.gob.cl/storage/citizen/6432/D-Noses%20Statement%20on%20Chilean%20Emissions%20Standard.pdf (Accessed 03/09/2021).

12. Regulatory framework of odour pollution in Uganda

Uganda is developing a new draft for Air Quality Regulations and Standards, that includes odours.

12.1 The Ugandan regulatory framework

There is **no standard or assigned policy to address odour issues** in Uganda to date. However, Uganda has made a bold move to revamp its 24-year old environmental law, the National Environment Act (Cap. 153) (the "NEA") that failed to address emerging environmental issues and has subsequently been replaced by The **National Environment Act 2019**.

In general, the draft regulations include that a **person** shall not cause or allow the generation of odour from any source contrary to the NEA and Public Health Act. If a person does, however, carry activities that result in the emission of odours, is required to use best environmental practices and put in place measures to reduce such odours to a level acceptable to the receiving environment and in compliance with the ambient air standards. In the case of odours emitted from **industrial processes**, the Authority shall require the operator of the facility to reduce the odour by practical means to ensure compliance with the ambient air standards and maximum emission limits for vents and other sources within a specified timeframe.

The draft regulations state that **measurements for odour** shall be taken from the boundary of the property from which the emission originates, taking into account: the odour descriptors, the composition of the odour, the odour concentrations; and acceptable limits measured using appropriate equipment. Two odour measurements shall be made within a period of one hour, these measurements being separated by an interval of at least fifteen minutes.

The **limits** referred to under the regulation depend on type of land use; residential or commercial purposes, and all other land use areas. In the former, they will be applied when odour is detected after the odorous air has been diluted with seven or more volumes of odour-free air and in all other land use areas, they apply when odour is detected after the odorous air has been diluted with fifteen or more volumes of odour-free air; and for an industrial process when odour is detected after the odorous air has been diluted with one hundred twenty-seven or more volumes of odour-free air. **The draft is in the final stage of review and due to be formalised later this year.**

12.2 Towards a regulatory framework in odour pollution in Uganda: Actions done during D-NOSES

D-NOSES partner MfC, together with Ibercivis and SfC, planned to achieve the support of the international cooperation area of the AMB to run the pilot. This was instrumental in order to build the partnerships that led to the set-up of the D-NOSES pilot and subsequent input to the **draft regulations** through their earlier work with the **National Environmental Agency (NEMA)**, **Kampala City Council Authority (KCCA)**, and **Makerere University** in developing capacity to monitor local air quality and broader community awareness raising efforts. This pilot organized different events that were attended by members of NEMA, the Ministry of Water and several Directorates of the local government. These took different forms: face to face, on site, and online when engaging teams outside Kampala. One even took a hybrid format with a group gathering in Kampala and the other participants connected online. The events covered topics related to limitations and training needs in relation to odour monitoring, odour had to be included within the strategic governance, along with noise and air quality and current odour-monitoring procedures and where citizens could support or improve these.

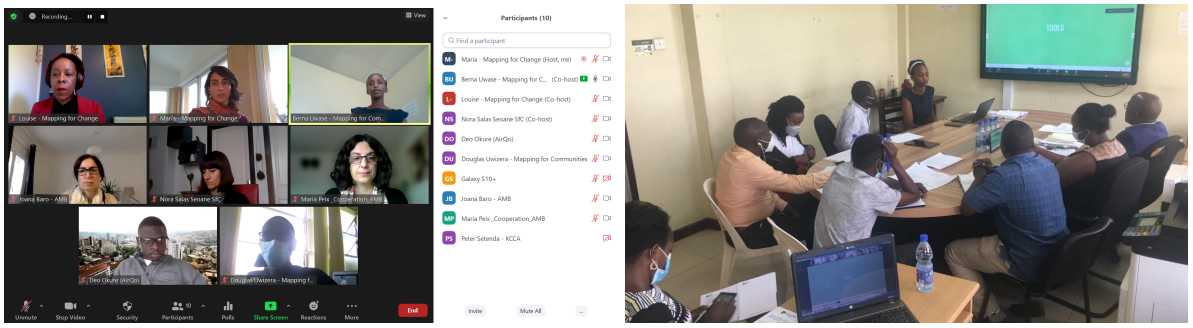


Figure 7: Hybrid session in Kampala, 27 April 2021

Moreover these events in the Kampala pilot were key to identifying the main odour problems (Framing the problem) and the **environmental-monitoring procedures in place at both local, regional, and national levels**. At the city level, an understanding and description of how waste is both generated and disposed of in markets, including food, plastics and other materials was obtained. Furthermore, through these events and other actions undertaken, waste management and how it is managed more broadly across the city was addressed to inform policy-makers about both the issues and suggestions for improvements that the market vendors and other stakeholders had made. All these findings were put into a report and shared with KCCA, and with specialised staff from the public administration of the AMB in Barcelona. MfC organised a joint online meeting on 27 April 2021, with staff from KCCA, Mapping for Communities, D-NOSES partners, a researcher from Makerere University and staff from AMB. Participants discussed ideas to improve odour pollution in Kampala markets and how to incorporate elements of the methodology into the local council's environmental-monitoring activities. **AMB drafted and shared specific short- and long-term measures inspired by markets in other African countries**.

At national level, the D-NOSES pilot in Kampala contributed to the ongoing policy effort in the country to develop **Air Quality Regulations and Standards** through partner MfC who reviewed an early draft of the regulations, specifically in relation to odour. Further input from odour experts from the D-NOSES consortium (AMIGO) and AMB in Barcelona was provided. The latest draft (April 2021) now includes significant changes compared to the original document from 2019. Suggestions made by the D-NOSES odour experts (e.g. to include the FIDOL factors) were included in the new text, as well as limits for odour emissions outside the boundaries of the emitting industries. This is now in the hands of the National Environmental Agency (NEMA) Executive Director (and a member of the D-NOSES Advisory Board). Of particular note, despite the adversities inflicted by the COVID-19 pandemic, pilot leaders in Uganda were able to coordinate the pilot remotely and still make great progress; this in itself represents an achievement, in terms of adaptability and the commitment of all stakeholders to ensure the pilot was a success.

12.3 The way beyond: Recommendations for Uganda

Despite the progress made to introduce a new regulatory framework in Uganda, there is still a considerable way to go both in terms of its deployment and building capacity amongst regulators and the public administration. Furthermore, broader dissemination of the citizen engagement and reporting mechanism introduced by D-NOSES offers the opportunity to report odour nuisances impacting communities under which the regulations can be enforced. Mapping for Change will look for opportunities to secure funding to further support progress with this regard. They will continue to communicate with the NEMA in relation to the publication of the Air Quality Regulations and Standards. At the same time, MfC will maintain and build on the relationships established with policy-makers and other stakeholders so as to support the incorporation of tools and methodologies for environmental monitoring in Kampala and across Uganda.

13. Regulatory framework of odour pollution in Colombia

The D-NOSES team has been very active in the participation of scientific events worldwide to present and promote the use of the new methodology to monitor odour pollution and the D-NOSES tools. Thanks to these actions, interesting work has been undertaken in Colombia, the leading country in terms of odour regulation in Latin America, which is worth it to be included as an additional national strategic roadmap.

13.1 The Colombian regulatory framework

In Colombia, since 1994, odour pollution issues have been taken into consideration with the regulation of the protection and control of air quality. In 2006, the **Air Quality Standard**[59] was established, which includes maximum permissible levels for the main odour-generating substances. Odour is not yet referred to as a mixture of substances, but is assessed by segregating it by odour substances and/or odour compounds. In 2011, the most important step was taken, which is the homologation of the European standard EN 13725:2003 to sample and measure odours using dynamic olfactometry with the Colombian Technical Standard NTC 5880: 2011[60], where the complexity of ambient odours is evaluated as a mixture.

Later in 2013, German standards were used as a reference to create technical standards such as NTC 6011:2013[61] "Static Sampling for Dynamic Olfactometry" and the standard NTC 6012-1:2013[62] about the "Effects and Assessment of Odours. Psychometric Assessment of

[59] MINAMBIENTE (2006). Environment and Sustainable Development Ministry of Colombia. Resolution 601 of 2006 (April 4). By which the Air Quality Standard or Immission Level is established for the entire national territory under reference conditions. Bogotá. Retrieved from: https://www.icbf.gov.co/cargues/avance/docs/resolucion_minambientevdt_0601_2006.htm

[60] ICONTEC. (2011). Colombian Institute of Technical Standards. Air Quality. Determination of Odour Concentration by Dynamic Olfactometry; NTC 5880: Bogotá, Colombia. Available online: https://tienda.icontec.org/gp-calidad-del-aire-determinacion-de-la-concentracion-de-olor-por-olfatometria-dinamica-ntc5880-2011.html

[61] ICONTEC.(2013). Colombian Institute of Technical Standards. Static Sampling Olfactometry; NTC 6011; ICONTEC: Bogota, Colombia. Available online: https://tienda.icontec.org/gp-olfatometria-muestreo-estatico-ntc6011-2013.html

[62] ICONTEC (2013).Colombian Institute of Technical Standards. Effects and Evaluation of Odours Psychometric Evaluation of Odour Discomfort Questionnaires; NTC 6012—1; ICONTEC: Bogota, Colombia. Available online: https://tienda.icontec.org/gp-efectos-y-evaluacion-de-los-olores-evaluacion-sicometrica-de-las-molestias-por-olores-cuestionarios-ntc6012-1-2013.html

Odour Annoyance through Questionnaires". In the same year, the **Colombian Ministry of Environment and Sustainable Development** approved the **Resolution 1541:2013**[63]. This resolution is the main legal instrument to prevent, mitigate and/or control the impact of activities potentially generating offensive odours, and sets the procedure for tackling odour complaints, as well as odour limits for specific activities:

- OIC based on odour concentration, frequency, duration and offensiveness are established for compliance, considering the 98th percentile of modelled 1-h concentrations on an annual basis. In other words, in approximately 175 h (~7.3 days) during a typical year, the impact should be exceeded at each receptor point in the affected area. Depending on the emitting source, standard limits have been set, for example, 3 ou_E/m^3 for wastewater treatment plants, 5 ou_E/m^3 for livestock production units and 7 ou_E/m^3 for coffee grinding. These standard limits are often cited in Chile as reference in the absence of national values.
- Levels for odorous specific gases are also established, such as: H_2S, reduced sulfur compounds (TRS), and NH_3, with daily limits of 7μg/m^3, 7μg/m^3 and 91 μg/m^3. The hourly limits for H_2S, TRS and NH_3 are 30 μg/m^3, 40 μg/m^3 and 1,400 μg/m^3, respectively.

Also this regulation includes dispersion modelling, which should be performed according to the guide adopted by the Ministry of Environment, Housing and Territorial Development. The simulations should be carried out using atmospheric dispersion models recommended by the Environmental Protection Agency of the United States (US EPA): CALPUFF and AERMOD.

The basis for the deployment of this regulation is the **submission of an individual complaint by a member of the public** with an alleged odour nuisance to the competent environmental authority. The environmental authority then proceeds to **validate this complaint using surveys** standardised by NTC 6012-1:2013 (Maximum period of 30 working days) and with Resolution 2087:2014[64] evaluate the need to require a **plan to reduce the impact of offensive odours (PRIO)** to the odour emitting activity, who has three months to submit the document. Subsequently, the odour emitting activity implements measures to manage its odour emissions, but these measures should have been previously assessed and approved by the environmental authority. Finally, the authority monitors the PRIO and in case of non-compliance the activity is required to measure odour sources.

[63] MINAMBIENTE (2013). Environment and Sustainable Development Ministry of Colombia. Resolution 1541 of 2013 (November 12). By which the permissible levels of air quality or immission are established, the procedure for the evaluation of activities that generate offensive odours and other provisions are issued. Bogotá: Diario Oficial No. 48.975, 15 nov. 2013. Available online: https://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=71917

[64] MINAMBIENTE (2014). Environment and Sustainable Development Ministry of Colombia. Resolution 2087 of 2014 (December 16). Whereby the Protocol for the Monitoring, Control and Surveillance of Offensive Odours is adopted. Bogotá: Diario Oficial No. 49.380, 30 dic. 2014. Available online: https://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=71401&dt=S

13.2 Towards a regulatory framework in odour pollution in Colombia: Actions done during D-NOSES

In 2019, D-NOSES Partner AMIGO contributed to the organization of the **first scientific conference in Colombia devoted to odour pollution**, in parallel to a scientific conference that took place in Santiago de Chile. The odour situation in Colombia is similar to Chile, both have specific odour regulations and standards. Details of both conferences can be found in Deliverable D7.5 Events 2[65] and the agenda for the International Seminar on Odour Management (Cali, Colombia) which can be found here. The participation of the D-NOSES partners (AMIGO, Ibercivis) in this highly successful conference, where more than 150 people, delegates representing the quadruple helix were mostly from the public sector (36%) and private (59%), but also included representatives from academia (3%) and citizens (2%). The result of participating in these events was the beginning of the actions that have been developed in Colombia and Chile, the latter were already planned as a partner of D-NOSES.

In this event a **co-creation session of the International Odour Observatory** (IOO) and OdourCollect was encouraged. The main highlights of this co-creation session were in the case of odour observatory: the content that people want to find is related with a way easy to describe the odour measurement methodologies and show the estimated costs of each; prevention or techniques for treatment; odour regulations; repository of cases studies with an experience of solving conflicts due to odours and an interactive section to children in order to create an environmental culture. In terms of training, the IOO can offer different topics depending on stakeholders: citizens can be trained in basic odour concepts, measurement technologies and therefore learn to recognize odour problems. The industries can be trained in good practices or technologies for odour reduction and control, know successful experiences and procedures for handling odour complaints. Another highlight was the type of information that should include in the maps such as improvement actions undertaken to resolve or manage the odour problem to compare before and after odour observations maps once good practices or best available techniques are implemented; location of potential odour emitting sources, meteorological information, and online tools to perform geodatabase analysis. Finally, about OdourCollect, the following aspects were proposed to be improved: information of the odour concepts used, information about environmental variables (wind direction, wind speed, precipitation, temperature), historical report on complaints generated at a certain point, notifications on the reported of the same smell and development elements that encourage to use the app.

[65] D-NOSES Consortium, (2020), D-NOSES Events 2, H2020-SwafS-23-2017-789315. Retrieved from: https://dnoses.eu/wp-content/uploads/2020/05/D7.5-DNOSES-Events-2.0_final.pdf

Figure 8: D-NOSES partners Carlos Díaz from AMIGO and Rosa Arias from IBERCIVIS - Science for Change during their participation in the International Seminar on Odour Management in Cali, Colombia, in 2019.

13.3 The way beyond: Recommendations for Colombia

Despite the fact that Colombia has extensive odour regulations, its deployment still has drawbacks. One of these is related to the odour reporting mechanism by citizens and their subsequent validation by the environmental authority. This process has been carried out in a manual way, which has incurred human biases and a strenuous waste of time to attend the complaint. With the dissemination of the D-NOSES project in different events, **alliances were built between SfC and the Ministry of the Environment of Colombia** to improve the procedure of execution and analysis of the odour nuisance through surveys; a standardized method in Colombia through the standard NTC 6012-1:2013. The validation of complaints is highly variable among jurisdictions and appears to be arbitrary. It is highly time-consuming, data validation procedures are difficult to establish, as surveys are currently done door to door and on paper, and it requires the expertise of a social scientist to deploy the surveys, which is hardly available for the environmental authority, who has only 30 working days to prepare and run the surveys on the field. In addition, the success of this approach in providing adequate and fair protection to the citizens and industries has not yet been demonstrated. Another handicap is that only one complaint is enough to trigger the mechanism, meaning that having a monitoring system of odour nuisance such as OdourCollect in place could help reduce the administrative burden for environmental authorities in Colombia.

This new project is still under development, and different meetings were held with the Ministry, who showed interest in the methodology to evaluate odours and especially in the OdourCollect application to improve the efficiency in handling odour complaints. Likewise, OdourCollect will allow monitoring the measures to reduce the odour impact of sources.

14. Conclusions

There is still a long way to go in regulating harmonised frameworks of odour management. In the past, governments and political actors have not been fully aware of the environmental and health problems that can be directly linked to odours. In addition, the current methodologies, that are the bases of most of the regulations, have several weaknesses and follow a top-down approach that needs a revision towards a more inclusive approach.

One of the main objectives of D-NOSES was to work on the interface of science and policy to 1) introduce odour pollution in the policy agendas and 2) produce citizen generated data to make informed decisions. The policy-society dialogues played a critical role here, by informing policy-makers about the issue and opening up channels for discussion through which citizens could share their own views and experiences. This paved the way for further policy and advocacy actions which, thanks to the 'foundations' laid by the dialogues, are likely to have had a significant impact. After the cumulative experience of this three-year and a half project, **D-NOSES advocates for a multi-level engagement model for governance in odour pollution** which involves the different governance institutions at local, regional and national levels in order to better regulate odour pollution. This multi-level governance model can be applied worldwide, and aims to engage quadruple helix stakeholders using a bottom-up approach based on the promotion of a dialogue between affected stakeholders -from citizens, public institutions and industries to academia. **Citizens**, being co-producers of odours (e.g. waste and wastewater), **are co-responsible** for odour emissions. Their inclusion in local decision-making and management processes enables them to increase their awareness of environmental challenges, improve their behaviour and inform local regulations for sustainable communities. Through the inclusion of citizens, **industries can improve their relationships with communities**, and local authorities can increase their transparency and accountability and enhance the **confidence of communities in public institutions[66]. At the same time, this new approach shifts the focus from pollution abatement to pollution prevention.**

There are already positive outcomes that have resulted from the advocacy actions. The case of Portugal is noteworthy, where a new national regulation for odour management and control is being prepared, and where citizen input will be considered. The multi-level governance model approach helped for a deeper understanding of which steps to follow in relation to involving the local, regional, national and global levels in each case. This will lead to the composition of a strong regulatory framework in the country, and hopefully will serve as inspiration for other countries in Europe.

The difficulties in balancing stakeholders' interests can be surpassed through transparency, accountability and dialogue, leading to an improved relationship between citizens, local authorities and emitting activities. At the same time, impacted communities by odour pollution

[66] D-NOSES consortium (2019) Odour Pollution - A growing societal concern. D-NOSES Policy Brief #1. Retrieved from Policy-Brief_-Digital-A4-Europe_EN.pdf (dnoses.eu).

should be taken into account in any future policy or legislative frameworks, and citizen science can be a first-rate tool for achieving this. In other words, policy-makers should promote the inclusion of citizen science initiatives and models (such as the D-NOSES one) in odour regulation and take full advantage of all the benefits offered, which outweigh the drawbacks and challenges.

15. References

American Society for Testing and Materials (2011).ASTM E679e04. "Standard Practice for Determination of Odour and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits". ASTM, West Conshohocken.

Arias R., Capelli L., Diaz Jimenez C. (2018). A New Methodology Based on Citizen Science to Improve Environmental Odour Management, Chemical Engineering Transactions, 68, 7-12. https://doi.org/10.3303/CET1868002

Arias R., Salas Seoane N., Diaz C., Schleenstein Gerhard (2021). Statement on: . Retrieved from: the preliminary draft of the standard for the emission of pollutants in pig farms that, due to their odours, generate nuisance and constitute a risk to the quality of life of the population. Retrieved from: https://consultasciudadanas.mma.gob.cl/storage/citizen/6432/D-Noses%20Statement%20on%20Chilean%20Emissions%20Standard.pdf (Accessed 03/09/2021).

Brancher, M., Schauberger, G., Franco, D., De Melo Lisboa, H., (2016) "Odour impact criteria in South American regulations". Chem. Eng. Trans. 54, 169e174. DOI:10.3303/CET1654029

Brancher, M., Griffiths, K. D., Franco, D., & de Melo Lisboa, H. (2017). A review of odour impact criteria in selected countries around the world. Chemosphere, 168, 1531–1570. https://doi.org/10.1016/j.chemosphere.2016.11.160 .

Bokowa, A.; Diaz, C.; Koziel, J.A.; McGinley, M.; Barclay, J.; Schauberger, G.; Guillot, J.-M.; Sneath, R.; Capelli, L.; Zorich, V.; Izquierdo, C.; Bilsen, I.; Romain, A.-C.; del Carmen Cabeza, M.; Liu, D.; Both, R.; Van Belois, H.; Higuchi, T.; Wahe, L. Summary and Overview of the Odour Regulations Worldwide. *Atmosphere* 2021, *12*, 206. https://doi.org/10.3390/atmos12020206.

Boletín Oficial de la Provincia de Alicante, Ordenanza Municipal para la prevención y control integrado de la contaminación 28th October 2013, nº205, 78. Retrieved from: https://www.villena.es/wp-content/uploads/2014/10/Ordenanza-control-contaminacion.pdf (Accessed 15/09/2021).

Capelli L., Izquierdo C., Antón A., Diaz C., Arias R., Hernández M. (2021), Compilation of good practices in odour pollution 2, D-NOSES, H2020-SwafS-23-2017-789315.

City Council of Las Palmas de Gran Canaria. Municipal Ordinance for the Protection of the Atmosphere Against Pollution by Forms of Matter, Las Palmas de Gran Canaria, Department of the Environment; Boletín Oficial de Las Palmas: Las Palmas, Spain, 1999.Retrieved from: https://www.laspalmasgc.es/export/sites/laspalmasgc/.galleries/documentos-medio-ambiente/ONF_CONTAMINACIONFORMASMATERIA_17.pdf (Accessed 15/08/2021).

Directive 2010/75 of the European Parliament and of the Council of the 24 November 2010 on industrial emissions (integrated pollution prevention and control), OJL 334, 17.12.2010. p17-119.

D.G.R. 15 febbraio 2012 - n. IX/3018. Regione Lombardia: Determinazioni generali in merito alla caratterizzazione delle emissioni gassose in atmosfera derivanti da attività a forte impatto odorigeno. Retrieved from: http://www.olfattometria.com/download/dgr-lomb.pdf

D-NOSES (2018) Analysis of existing regulation in odour pollution, odour impact criteria 1. Retrieved from: https://dnoses.eu/d2-2-analysis-of-existing-regulation-in-odour-pollution-odour-impact-criteria-1-pdf (Accessed 03/09/2021).

D-NOSES (2021) Analysis of existing regulation in odour pollution, odour impact criteria 2. Forthcoming - Available at https://odourobservatory.org/

D-NOSES Consortium, (2020), D-NOSES Events 2, H2020-SwafS-23-2017-789315. Retrieved from: https://dnoses.eu/wp-content/uploads/2020/05/D7.5-DNOSES-Events-2.0_final.pdf

Decree 37/2013. Establishes emission standards for odour-generating TRS compounds associated with the manufacture of kraft pulp or sulphate, based on the revision of Decree 167/1999, minsegpres, which establishes emission standards for nuisance odours (hydrogen sulphide compounds and mercaptans: TRS gases) associated with the manufacture of sulphate pulp. Retrieved from: https://www.bcn.cl/leychile/navegar?idNorma=1049596 (Accessed 08/09/2021).

ECOTEC Engineering Ltd. (2013) Background for Regulation of Odours in Chile: Santiago, Chile. Retrieved from: https://olores.mma.gob.cl/wp-content/uploads/2019/03/ECOTEC-Ingenieria.pdf (Accessed 2/02/ 2021).

Environment Agency, United Kingdom (2011). H4 Odour Management – How to comply with your environmental permit. Retrieved from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296737/geho0411btqm-e-e.pdf

European Committee for Standardization (2003). EN 13725: Air Quality: Determination of Odour Concentration by Dynamic Olfactometry. CEN, Brussels.

European Committee for Standardization (2016). EN 16841-1:2016, Ambient air - Determination of odour in ambient air by using field inspection. CEN, Brussels.

F.-B. Frechen. (2000). Odour measurement and odour policy in Germany. *Water Sci Technol* 1 March; 41 (6): 17–24. doi: https://doi.org/10.2166/wst.2000.0088.

GOAA (2008). Guideline on Odour in Ambient Air GOAA. Detection and Assessment of Odour in Ambient Air. Second Version, Berlin, Germany. Feststellung und Beurteilung von Geruchsimmissionen - Geruchsimmissions-Richtlinie) Länderausschuss für Immissionsschutz, LAI- Schriftenreihe No. 5, Berlin (in German); (available in English).

ICONTEC. (2011). Colombian Institute of Technical Standards. Air Quality. Determination of Odour Concentration by Dynamic Olfactometry; NTC 5880: Bogotá, Colombia. Available online: https://tienda.icontec.org/gp-calidad-del-aire-determinacion-de-la-concentracion-de-olor-por-olfatometria-dinamica-ntc5880-2011.html

ICONTEC.(2013). Colombian Institute of Technical Standards.Static Sampling Olfactometry; NTC 6011; ICONTEC: Bogota, Colombia. Available online: https://tienda.icontec.org/gp-olfatometria-muestreo-estatico-ntc6011-2013.html

ICONTEC (2013).Colombian Institute of Technical Standards. Effects and Evaluation of Odours Psychometric Evaluation of Odour Discomfort Questionnaires; NTC 6012—1; ICONTEC: Bogota, Colombia. Available online: https://tienda.icontec.org/gp-efectos-y-evaluacion-de-los-olores-evaluacion-sicometrica-de-las-molestias-por-olores-cuestionarios-ntc6012-1-2013.html

ICONTEC, (2014). Measurement of Odour Impact by Field Inspection. Measurement of the Impact Frequency of Recognizable Odours. Mesh Measurement; NTC 6049—1; ICONTEC: Bogotá, Colombia.

ICONTEC, (2014). Measurement of Odour Impact by Field Inspection. Measurement of the Impact Frequency of Recognizable Odours. PenMeasurement; NTC 6049—2; ICONTEC: Bogota, Colombia, 2014.

ICONTEC, (2014). Measurement of Odour Impact by Field Inspection. Determination of Odour Intensity and Hedonic Odour Tone; NTC 6049—3; ICONTEC: Bogota, Colombia, 2014.

ICONTEC, (2014). Measurement of Odour Impact by Determining Hedonic Tone of Odour Polarity Profiles; NTC 6049—4; ICONTEC: Bogota, Colombia, 2014.

Instituto Nacional de Normalización (2010) NCh3190:2010: Air Quality—Determination of Odour Concentration by Dynamic Olfactometry; Instituto Nacional de Normalización: Santiago, Chile.

Instituto Nacional de Normalización (2015) NCh3387:2015: Air Quality and Assessment of Odour Annoyance Survey; Instituto Nacional de Normalización: Santiago, Chile.

Instituto Nacional de Normalización (2015) NCh3386:2015: Air Quality—Static Sampling for Olfactometry; Instituto Nacional de Normalización: Santiago, Chile.

Institute of Air Quality Management - IAQM (2018). Guidance on the assessment of odour for planning. Retrieved from: https://www.iaqm.co.uk/text/guidance/odour-guidance-2014.pdf

Interior and Public Safety Ministry of Chile (2020). Extract from the preliminary draft of the standard for the emission of pollutants in pig farms that, due to their odours, generate nuisance and constitute a risk to the quality of life of the population; prepared by the Environment Ministry. Retrieve from: https://www.diariooficial.interior.gob.cl/publicaciones/2020/07/22/42711/01/1785167.pdf

Izquierdo, C. et al. (2020) “Developing of a New Spanish Standard "Building Collaborative Odour Maps through Citizen Science” The Italian Association of Chemical Engineering, VOL.

82, 2020. Retrieved from: Developing of a New Spanish Standard "Building Collaborative Odour Maps through Citizen Science" (Accessed 10/09/2021).

Izquierdo C., Diaz C., Anton A., Kavanagh R., Capelli L., Arias R., Salas Seoane N., Burbano J., Francis L. (2021). Analysis of existing regulations in odour pollution, odour impact criteria 2, D-NOSES, H2020-SwafS-23-2017-789315.

Junta de Andalucia, Decree 239/2011, of July 12, which regulates the quality of the atmospheric environment and creates the Registry of Air Quality Assessment Systems in Andalusia. Retrieved from: https://www.juntadeandalucia.es/boja/2011/152/5 (Accessed 02/08/2021).

Leonardos, G., (1995) "Review of odour control regulations in the USA" in odours, Indoor and Environmental Air, Proceedings of a Specialty Conference of the Air and Waste Management Association, Bloomington, MN, pp. 73–84.

Mahin TD. Comparison of different approaches used to regulate odours around the world. Water Science and Technology. 44 (9) (2001). pp. 87-102. https://doi.org/10.2166/wst.2001.0514

McGinley, M. A., Mann, J. (1998). European versus United States odour/odour standards of evaluation. In Water Environment Federation 71st. October. Annual Conference, Orlando, Florida (pp. 3-7).

MINAMBIENTE (2006). Environment and Sustainable Development Ministry of Colombia. Resolution 601 of 2006 (April 4). By which the Air Quality Standard or Immission Level is established for the entire national territory under reference conditions. Bogotá. Retrieved from:
https://www.icbf.gov.co/cargues/avance/docs/resolucion_minambientevdt_0601_2006.htm

MINAMBIENTE (2013). Environment and Sustainable Development Ministry of Colombia. Resolution 1541 of 2013 (November 12). By which the permissible levels of air quality or immission are established, the procedure for the evaluation of activities that generate offensive odours and other provisions are issued. Bogotá: Diario Oficial No. 48.975, 15 nov. 2013. Available online: https://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=71917

MINAMBIENTE (2014). Environment and Sustainable Development Ministry of Colombia. Resolution 2087 of 2014 (December 16). Whereby the Protocol for the Monitoring, Control and Surveillance of Offensive Odours is adopted. Bogotá: Diario Oficial No. 49.380, 30 dic. 2014. Available online: https://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=71401&dt=S

Ministry of the Environment Chile (2017) Strategy for The Management of Odours in Chile; Ministry of the Environment Chile: Santiago, Chile. Available online: https://olores.mma.gob.cl/wp-content/uploads/2019/03/Estrategia_Olores_Actualizacion2017.pdf

Observations and Responses Citizen Consultation on the "Preliminary draft standard for the emission of pollutants in pig farms which, due to their odours, generate nuisance and

constitute a risk to the quality of life of the population". Consultation period 16-12-2020 to 12-03-2021. Retrieved from: https://planesynormas.mma.gob.cl/archivos/2021/proyectos/f07_563.MEMO_EDUPAC_N_91_2021_Consolidado_Observaciones_Olores.pdf

Rossi N.A., Il Grande M., Pretto U., (2018), Update on the Italian Regulation about Odour Emissions and Impact and Future Perspectives, Chemical Engineering Transactions, 68, 31-36. https://doi.org/10.3303/CET1868006

Schütz, F., Heidingsfelder, M.L., Schraudner, M. (2019) "Co-shaping the Future in Quadruple Helix Innovation Systems: Uncovering Public Preferences toward Participatory Research and Innovation" She Ji: The Journal of Design, Economics, and Innovation, Volume 5, Issue 2, Pages 128-146, ISSN 2405-8726, https://doi.org/10.1016/j.sheji.2019.04.002.

Verein Deutscher Ingenieure (VDI). (2006) VDI 3940 Part 1: Measurement of Odour Impact by Field Inspection; Measurement of the Impact Frequency of Recognizable Odours, Grid Measurement. Beuth Verlag GmbH, Berlin.

VDI 3940 Part 1: Measurement of Odour Impact by Field Inspection - Determination of Odour Intensity and Hedonic Odour Tone. (2006) Beuth Verlag GmbH, Berlin

VDI 3882 Part 1: Olfactometry: Determination of Odour Intensity. (1992) Beuth Verlag GmbH, Berlin.

VDI 3882 Part 2: Olfactometry: Determination of Hedonic Odour Tone. (1994) Beuth Verlag GmbH, Berlin

VDI 7000. Early public participation in industrial and infrastructure projects. (2015) Beuth Verlag GmbH, Berlin

16. Annex

16.1 Acknowledgements and project participants

The D-NOSES Consortium:

The EU Horizon 2020 D-NOSES Consortium wants to express its infinite gratitude to the institutions, organizations, industries and hundreds of citizens who have helped us in undertaking the pilot study cases, disseminating the project and validating the data, deploying the wide range of advocacy actions during the project, and contributing to raising awareness on odour pollution at local, regional, national, European and international events and scientific conferences. Also, the participation of our Advisory Board has been key to trigger some of the advocacy actions described hereby. Without their contribution this Strategic Roadmap on Odour Pollution would not have existed. We also like to thank MEP Ms Maria Spiraki for hosting the event in the European Parliament "*Revisiting odour pollution in Europe*" on October 28th, 2021. The agenda and the recording of the event can be found here.

16.2 D-NOSES policy brief - General version

D-NOSES

Distributed Network for Odour Sensing, Empowerment and Sustainability

ODOUR POLLUTION A GROWING SOCIETAL CONCERN

HIGHLIGHTS

- Odour nuisances, being the second cause of environmental complaints after noise, lead to a significant decline in our quality of life and must be urgently addressed.
- Odour regulations across Europe and within countries differ significantly from each other. In many places they are even completely lacking. There is a need for bottom-up, multi-level governance in Europe in order to protect its citizens.
- Odorous gases are commonly measured at the source (emission). The level of the odours in surrounding residential areas (immission) is more complex to determine, but also much more relevant to measuring the impact on residents.
- The Distributed Network for Odour Sensing, Empowerment and Sustainability (D-NOSES) project will reverse the way in which odour pollution is commonly tackled, through a co-creative citizen science approach.

MAIN ODOUR ISSUES IN EUROPE

The sources that generate odours in European communities are numerous and diverse; in many cases the same community is exposed to more than one odour source. Industrial activities, waste management and agriculture/livestock represent the main challenges regarding odour emissions within Europe.

HOW TO CITE

D-NOSES consortium (2019) Odour Pollution - A growing societal concern. D-NOSES Policy Brief #1

Authors: Simone Rüfenacht (ECSA), Clarisse Guiral (ECSA), Alaa Abou Daher (MIO-ECSDE), Anastasia Roniotes (MIO-ECSDE), Jose Uribe (ISWA), Nora Salas Seoane (IBERCIVIS), Rosa Arias (IBERCIVIS).

This policy brief was facilitated by the lead authors (ECSA) through open interaction and discussion with the D-NOSES consortium. While this was carried out as part of H2020 D-NOSES Coordination and Support Action project, the views expressed in it do not reflect the consensus opinion of D-NOSES partners.

Coordinated by: ibercivis

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 789315

ODOUR POLLUTION IS...

... the second reason for citizens' environmental complaints after noise across Europe[1]

Increased and prolonged exposure to odour pollution is having a **significant impact** on affected communities. The need for action is becoming more urgent with the growing recognition at all levels of the **harmful effects of bad air quality** on people's health and lives. Reducing the impact and improving the affected citizens' quality of life will require a **collaborative approach** by all stakeholders; a reliable measure of the real nuisance will be central to this initiative and crucial to its success.

"Almost 60% of complaints in the field of air pollution concern odour nuisance" (Poland, 2016, Information from the Polish delegation to the Council of the EU).

In Chile, 14.7% of all official complaints received by the Ministry of the Environment were related to odours (data from 2016). In addition, many affected residents took to the streets in, often violent, mass protests to express their concerns about the odour nuisances.

... not just a nuisance

Odours have generally been assumed to be annoying, but harmless. There is, however, evidence that persistent exposure to odours can have **adverse effects that go beyond mere inconvenience**[2]. People in affected communities can suffer from headaches, throat and eye irritation, nausea, sleeplessness, anxiety, stress, or even respiratory problems. In addition, odours affect the quality of life (social effects) and have **possible economic impacts**[3] (e.g. tourism or loss of property value).

"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." *(WHO)*[4]

Odour issues can therefore generate **conflicts between the residents and the emitters** which have to coexist in increasingly limited space, and lead to possible obstacles to the continuation or expansion of odour-emitting activities.

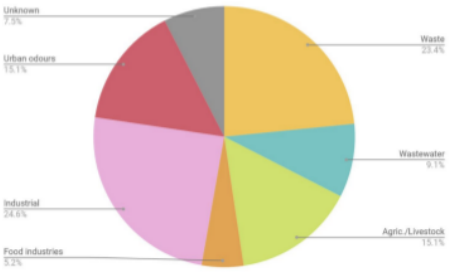
HEALTH IMPACTS

A study in Finland[5] surveyed over 1,000 residents living at varying distances to major waste treatment centres. Those closer to the centres, and thus exposed to odour nuisance, reported more physical symptoms, such as shortness of breath, eye irritation, fever / shivering and even muscular pains. This study shows a direct link between odour nuisance and effects on human health.

... an indicator of environmental impact

In addition, odour pollution is often a **symptom of broader environmental issues** caused by population growth, urbanisation and industrialisation. Frequently associated with air pollution, odours can also often be correlated with soil and water contamination, and sanitary problems (poor waste management). Furthermore, gases emitted in landfills and livestock facilities are mixtures of methane (greenhouse gas) and toxic odorous gases (e.g. hydrogen sulphide), and thus contribute to climate change. Therefore, odour manifestations should be considered as an **alert signal** and a potential **call for an environmental impact assessment**.

Odour nuisance from Rio Tinto river (a small affluent of the Douro river, North Portugal), alerting to illegal discharges as serious environmental problem along its course.



Overview of the general distribution of odour sources in all European D-NOSES partner countries (source: D-NOSES deliverable D4.1[6], based on over 220 cases of odour complaints reported in the local and national press from the past 8 years).

[1] ADEME, 2005. Pollutions olfactives: origine, legislation, analyse, treatment, Dunod, Paris, XII-388p.
[2] Schillman & Williams 2005. 'Science of Odor as a Potential Health Issue'. Journal of Environmental Quality 34(1): 129-138.
[3] Batalhone et al, 2002. Economics of Air Pollutions. Hedonic Price Model and Smell Consequences of Sewage Treatment Plants in Urban Areas, Working Paper 234, University of Brasilia, 25p.
[4] Constitution of the World Health Organization: Principles: https://www.who.int/about/mission/en/
[5] Aatamila et al, 2011. 'Odour annoyance and physical symptoms among residents living near waste treatment centres', Environmental Research 111 (1k 164-170.
[6] Balestrini et al, 2018. Map of odour issues and priorities. Multilevel engagement plan for stakeholders and communities D-NOSES deliverable D4.1 v5.1, 100p. (https://dnoses.eu/wp-content/uploads/2019/01/D4.1-Map-of-Odour-Issues.pdf)

European environmental regulations largely ignore odour issues

Odour pollution has repeatedly been ignored in environmental regulations **leaving citizens defenceless**.

According to the Directive 2010/75/EU[7] on Industrial Emissions, European countries must prevent and limit air, soil and water pollution, as well as negative environmental effects such as odours. A European standard defines how to sample and measure odours in the laboratory (EN 13725:2003[8]) (see next page), thereby quantifying odour emissions. However, no standard regulates the need for an odour risk analysis at the planning stage or the requirement for odour control management to be included in permits. Ultimately, there are still **no common criteria to establish impact odour thresholds**. We advocate that odour thresholds need to be established in cases where residents are impacted and odour nuisance is present.

DISPARATE ODOUR REGULATIONS IN EUROPE

Some efforts have been made to regulate odours throughout Europe at the national, regional and even municipal levels[9]. However, it has not led to the drawing up of clear, Europe-wide definitions, terms and criteria and there are **still many European areas that have no odour regulations** at all.

Due to the lack of regulations, situated technical studies are rarely conducted, data on odour pollution are scarce or not accessible, and the implementation of effective odour control strategies is usually disregarded. It is often the citizens who build up the pressure for local authorities and odour emitting industries to monitor and control odour emissions.

WHEN CITIZENS GET INVOLVED

Inhabitants of a southern German district have been complaining about nightly odour nuisance since 2015. The centralisation of residents' observations by the municipality, although late, was crucial in advancing the search for odorous sources. The collection and cross-referencing of spatiotemporal and weather data made it possible to delimit the area concerned and identify a potential emitter. Empowering citizens to collect data through the use of innovative tools could have enabled the authorities to act more quickly to prevent and reduce odour emissions.

Odour regulation in eight European countries and in Chile (D-NOSES partners)

EU
Directive 2010/75/EU on Industrial Emissions (applies to all European partner countries)

AUSTRIA
- No national regulation on odours
- Recommendation to apply the "Directive for the Assessment of Emissions from Livestock Farming" (2017, replacing the previous one from 1995) in diverse regulations and permit procedures

BULGARIA
- Under the Environmental Protection Act, certain permits include conditions for monitoring and strict control of odour emissions
- Some odour issues are addressed in single regulations (ordinances) related to waste management, air pollution, wastewater treatment, etc.
- An ordinance related to air pollution includes sanctions for industries releasing odorous substances

GERMANY
- Federal Immission Control Act (BImSchG) regulates the licensing of potential odour emitters and defines significant odour nuisance
- Technical Directive on Air Pollution Control (TA Luft) describes the use of BImSchG in practice and sets specific emission limits
- Directive on Odour Immissions (GIRL) sets limit values for odour exposure in habituated and industrial zones

GREECE
- No national regulation on odours

ITALY
- No national regulation on odours
- Local guidelines on odour emissions, primarily based on a modellistic approach (Region of Lombardy, Region of Piemonte, Region of Puglia, Province of Trento)

PORTUGAL
- No national regulation on odours
- Diffuse emission of pollutants is regulated by Article 9, DL No. 39/2018 of June 11
- Some environmental licences present conditions to minimise odours

SPAIN
- No regulation on odours at national or regional level, but in some municipalities (Lliçà de Vall, Banyoles, Alcantarilla, Las Palmas, etc.), although there is no coherence between ordinances
- In Catalonia, a specific regulation to control odour pollution was drafted in 2005, not adopted, but used as reference to set odour limits from different emitting activities elsewhere in Spain

UK
- Environmental Protection Act 1990 assigns a duty to the local councils to investigate all odour complaints
- Several guidelines on odour management, Pollution Prevention and Control in Scotland

CHILE
- Since 20 years there is an emission standard for total reduced sulphur compounds (TRS) associated with the manufacture of sulphated pulp
- During the last 5 years, there have been several actions alongside a national odour management strategy that includes adoption of international technical standards, odour evaluation within the environmental licensing scheme (guideline on odours published in December 2017 providing standards) and ongoing efforts on odour emission standards for selected activities (e.g. piggeries).

THE NEED FOR A BOTTOM-UP, MULTI-LEVEL GOVERNANCE MODEL

Odour pollution has generally a local impact and therefore **local regulations are often the most effective management strategy**. Regulations on national and international levels, however, are crucial to provide a fundamental framework and are even required in some countries (e.g. Portugal).

Citizens, as the producers of many odorous products (e.g. waste and wastewater), **are co-responsible** for odour emissions. Their inclusion in local decision-making and management processes enables them to increase their awareness of environmental challenges, adjust their behaviour and co-create local regulations for sustainable communities.

Through the inclusion of citizens, **industries can improve their relationships with communities**, and local authorities can increase transparency and **confidence in public institutions**.

[7] Directive 2010/75 of the European Parliament and of the Council of the 24 November 2010 on industrial emissions (integrated pollution prevention and control), OJL 334, 17.12.2010. p17-119.
[8] CEN, 2003. EN 13725:2003. Air quality. Determination of odour concentration by dynamic olfactometry.
[9] Brancher et al., 2017. 'A Review of Odour Impact Criteria in Selected Countries around the World'. Chemosphere 168:1531-1570.

Measuring odours and impacts

COMMON METHODS USED

An odour is commonly characterised by its concentration, rather than by its chemical composition. Expressed in odour units per cubic metre (ou_E/m^3), odour concentration is determined in a laboratory by **dynamic olfactometry**, a sensorial technique based on the participation of a panel of people with confirmed average sensitivity (method standardised at European level EN 13725:2003[8], under revision). The **quantification of odour emissions at the source** based on this technique serves as input data to **odour dispersion models**. Such models provide easily understandable averaged results that are not only descriptive, but also predictive (useful for new plant under construction)[10].

However, the results of this technique have high uncertainty levels, do **not report citizens' discomfort or real-time annoyance** and therefore do not provide accurate estimates of their exposure to odours.

Methods to evaluate odour impact at the receptors (citizens) include the recent European standard EN 16841:2016[11] on **field inspection of odours** (grid and plume methods) through human assessors, which is used increasingly for environmental odour assessment. However, these field inspections are **time-consuming and often induce high costs**, and still do not provide real-time information on the discomfort of the impacted citizens.

There is a need for a **cost-effective technique to assess the perceived nuisance** directly within the community. Citizens own the most precise and cost-effective sensor to measure odours - their own noses - and have a clear motivation for engagement: recovering their quality of life.

The involvement of citizens helps the industry and local authorities to obtain **real-time data at lower economic costs**. These data inform the optimisation of industrial processes and reduce the impact of odour pollution on the communities, while advancing the state of the art of odour management.

The **intervention of citizen science** in odour pollution is therefore of great interest. Citizen science has recently been experiencing an increase in support from the European commission, mainly in the fields of environmental monitoring and regulations. In addition, the open science movement has gained a lot of awareness. As a result, open science and citizen science project numbers have been steadily increasing throughout Europe and beyond.

"Informed opinion and active co-operation on the part of the public are of the utmost importance in the improvement of the health of the people." *(WHO)*[4]

Our approach in D-NOSES: empowerment of citizens to co-design local solutions

The Distributed Network for Odour Sensing, Empowerment and Sustainability (D-NOSES) project is an EU H2020-SwafS (Science with and for Society) funded project that aims to provide an **inclusive, bottom-up approach** to tackle odour pollution issues at all levels in a cost-effective way.

Our approach is **to empower citizens to become a driving force for change through citizen science**. Odour problems can be mapped using the free **collaborative mapping app OdourCollect** (*https://odourcollect.eu*), which will allow industries to optimise their processes and to check the effects of newly implemented good practices and corrective measures at a lower cost. This methodology takes citizens' annoyance into account through **first-hand observations** and enables citizens to **co-design solutions** with all stakeholders, such as environmental NGOs, local authorities, odour-emitting industries and odour experts.

THROUGH THE IMPLEMENTATION OF THE PRINCIPLE 10 OF THE RIO DECLARATION (1992), D-NOSES WILL STRENGTHEN:

- **Not only access to information, but also generation of new data in odour pollution** through the International Odour Observatory (*https://odourobservatory.org*)
- **Public participation in local decision-making** (multi-level engagement strategies of stakeholders and communities, co-creation and citizen science approaches)
- **Access to justice** through advocacy actions to introduce odour pollution to the policy agendas

TAKE HOME MESSAGES

- Odour pollution is linked to environmental and health issues and therefore needs to be more closely regulated in Europe.
- The inclusion of citizens in odour regulation and management processes is beneficial for all stakeholders, as it promotes scientific education, improves relationships and increases confidence in public authorities.
- Be part of the solution! Get involved in our co-creation process: Find out more on the D-NOSES website (*www.dnoses.eu*)

[10] Capelli et al. 2013. 'Measuring Odours in the Environment vs. Dispersion Modelling: A Review'. Atmospheric Environment 79: 731-743.
[11] CEN, 2016. EN 16841:2016. Ambient air - Determination of odour in ambient air by using field inspection, Brussels.

16.2 D-NOSES policy brief - Chilean version

D-NOSES

Distributed Network for Odour Sensing, Empowerment and Sustainability

CONTAMINACIÓN ODORÍFICA UNA CRECIENTE PREOCUPACIÓN SOCIAL

HECHOS DESTACADOS

- Los olores molestos, que son la segunda causa de molestias y denuncias medioambientales después del ruido, provocan una disminución significativa de nuestra calidad de vida y deben ser tratadas con urgencia.
- Las regulaciones de olores a nivel internacional difieren significativamente entre sí. Al igual que en Chile, en muchos países incluso son inexistentes. Es necesaria una gobernanza ascendente y multinivel para proteger a la ciudadanía.
- Los gases odoríficos se miden comúnmente en la fuente (emisión). El nivel de los olores en las áreas residenciales circundantes (inmisión) es más complejo de determinar, pero también mucho más relevante para medir el impacto en las personas residentes.
- El proyecto Distributed Network for Odour Sensing, Empowerment and Sustainability (D-NOSES) invertirá la forma en que se aborda comúnmente la contaminación por olor, a través de un enfoque de ciencia ciudadana con estrategias participativas y co-creación.

PRINCIPALES PROBLEMAS DE OLORES MOLESTOS EN CHILE

Un estudio[1] realizado en 2013 para el Ministerio del Medio Ambiente identificó 2.000 instalaciones con potencial de generar malos olores. De éstos, más de 250 habían recibido reclamos formales en el pasado.
En 2018, se modificó la Ley sobre Bases Generales del Medio Ambiente, declarando el olor como un contaminante. En paralelo, el Ministerio actualizó su Estrategia para la Gestión de Olores soportada en cinco pilares:
Fortalecimiento del marco regulatorio, levantamiento de información, incrementar conocimiento, coordinación intersectorial y fortalecimiento institucional.
Se reconocen como actividades prioritarias: Planteles porcinos, plantas de harina de pescado, plantas de tratamiento de aguas servidas, plantas de celulosa y sitios de disposición final de residuos sólidos.

CÓMO CITAR ESTE TRABAJO

D-NOSES Consorcio (2019) Contaminación Odorífica. Una creciente Preocupación Social. D-NOSES Policy Brief #1 (Versión Chilena)

Autores: Simone Bäumler (ECSA), Clarisa Guiral (ECSA), Alaa Abou Daher (MIO ECSDE), Anastasia Roniotes (MIO ECSDE), Jose Uribe (ISWA), Nora Solar Sesena (IBEROVIS), Rosa Arias (IBEROVIS).

Este Policy Brief fue elaborado por los autores principales (ECSA) a través de una interacción y discusión abierta con el consorcio D-NOSES. Aunque esto se llevó a cabo como parte del proyecto H2020 D-NOSES Coordination and Support Action, las opiniones expresadas en él no reflejan la opinión consensuada de los socios de D-NOSES.

Coordinado por: Ibercivis

Este proyecto ha recibido financiación de la Unión Europea Programa Horizonte 2020 Investigación e Innovación bajo en Acuerdo de Subvención Número 787315

LA CONTAMINACIÓN POR OLOR ES...

... la segunda causa de queja medioambiental después del ruido en Chile y Europa[2]

El aumento y la exposición prolongada a la contaminación odorífica está teniendo un **impacto significativo en las comunidades afectadas.** La necesidad de actuar se hace cada vez más urgente con el creciente reconocimiento a todos los niveles de los **efectos nocivos de la mala calidad del aire en la salud y la vida de las personas.** La reducción del impacto y la mejora de la calidad de vida de la ciudadanía afectada requerirán un **enfoque colaborativo** de todas las partes interesadas; una medida fiable de las molestias reales será fundamental para esta iniciativa y crucial para su éxito.

"Casi el 40% de las quejas en el ámbito de la contaminación atmosférica se refieren a molestias por olores" (Polonia, 2016, información de la delegación polaca ante el Consejo de la Unión Europea).

En Chile, el 14,7% de todas las quejas oficiales recibidas por la Superintendencia de Medio Ambiente estaban relacionadas con olores (datos de 2016). Además, muchos de los residentes afectados salieron a las calles en protestas masivas, a menudo violentas, para expresar su preocupación por las molestias causadas por el olor.

... no solo una molestia

Generalmente se ha supuesto que los olores son molestos, pero inofensivos. Sin embargo, hay pruebas de que la exposición persistente a los olores puede tener **efectos adversos que van más allá de las meras molestias**[3]. Las personas en las comunidades afectadas pueden sufrir dolores de cabeza, irritación de garganta y ojos, náuseas, insomnio, ansiedad, estrés o incluso problemas respiratorios. Además, los olores afectan a la calidad de vida (efectos sociales) y tienen **posibles repercusiones económicas**[4] (por ejemplo, turismo o pérdida de valor de la propiedad).

"La salud es un estado de completo bienestar físico, mental y social y no sólo la ausencia de enfermedades." (OMS)

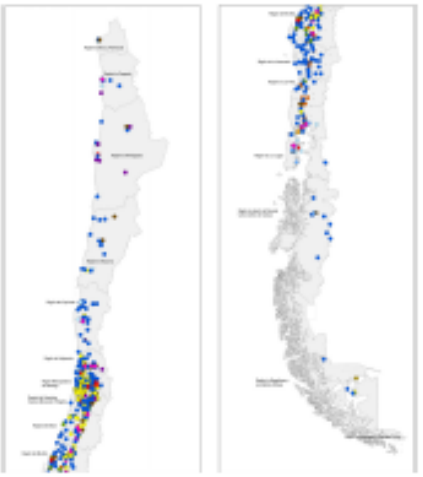
Por lo tanto, los problemas de olor pueden generar **conflictos entre las comunidades y las fuentes emisoras,** que tienen que coexistir en un espacio limitado, y pueden conducir a posibles obstáculos para la continuación o expansión de la actividad emisora.

IMPACTOS EN LA SALUD

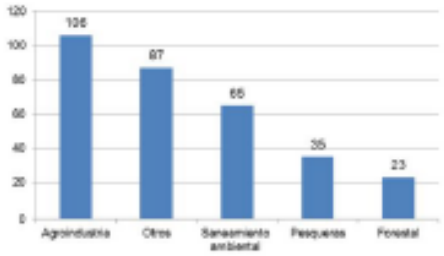
Un estudio realizado en Finlandia[6] encuestó a más de 1.000 residentes que viven a distancias distintas de los principales centros de tratamiento de residuos. Los que están más cerca de los centros, y por lo tanto expuestos a las molestias por olor, informaron de más síntomas físicos, como falta de aliento, irritación ocular, fiebre/escalofríos e incluso dolores musculares. Este estudio muestra una relación directa entre las molestias por olores y los efectos en la salud humana.

... un indicador de impacto medioambiental

Además, la **contaminación por olor es a menudo un síntoma de problemas medioambientales más amplios** causados por el crecimiento de la población, la urbanización y la industrialización. Frecuentemente asociados con la contaminación del aire, los olores también pueden estar correlacionados con la contaminación del suelo y del agua, y con problemas sanitarios (mala gestión de los residuos). Además, los gases emitidos en los vertederos y en las instalaciones ganaderas son mezclas de metano (gas de efecto invernadero) y gases tóxicos y olorosos (por ejemplo, sulfuro de hidrógeno), lo que contribuye al cambio climático. Por lo tanto, las manifestaciones de olor deben considerarse como una **señal de alerta y una llamada potencial para una evaluación del impacto ambiental.**



Mapa nacional de ubicación de establecimientos potenciales generadores de olor según actividad[1]



Actividades con mayor número de denuncias de olores, periodo 2013 – 2016 según datos de la Superintendencia del Medio Ambiente[7]

[1] ECOTEC, 2013. Antecedentes para la Regulación de Olores en Chile. Informe desarrollado a solicitud de la Subsecretaría del Medio Ambiente.
[2] ADEME, 2005. Pollutions olfactives: origine, législation, analyse, traitement. Dunod, Paris, XII 388p.
[3] Schiffman & Williams 2005. 'Science of Odor as a Potential Health Issue' Journal of Environmental Quality 34(1): 129 138.
[4] Batalhone et al. 2002. Economics of Air Pollutions. Hedonic Price Model and Smell Consequences of Sewage Treatment Plants in Urban Areas. Working Paper 231. University of Brasília. 25p.
[5] Constitution of the World Health Organization: Principles.
[6] Aatamila et al. 2011. 'Odour annoyance and physical symptoms among residents living near waste treatment centres' Environmental Research 111 (1): 164 170.
[7] Ministerio del Medio Ambiente. 2017. Estrategia para la gestión de olores en Chile. Actualización año 2017. Santiago de Chile. Noviembre 2017.

La normativa medioambiental ignora en gran medida los olores

La contaminación por olor ha sido **repetidamente ignorada en las regulaciones ambientales, dejando a la ciudadanía indefensa**. De acuerdo con la Directiva 2010/75/EU sobre emisiones industriales, los países europeos deben prevenir y limitar la contaminación del aire, el suelo y el agua, así como los efectos medioambientales negativos como los olores.

En Chile, desde hace 20 años existe una norma de emisión para los compuestos de azufre reducidos totales (TRS) asociados a la fabricación de pasta sulfatada, pero en términos generales, no existe una regulación adecuada de olores molestos. El año 2014, el Ministerio del Medio Ambiente, promulgó una Estrategia para la Gestión de Olores en Chile, de manera de iniciar acciones en esta materia. Durante los últimos 5 años, ha habido varias acciones junto con dicha estrategia que incluyc la adopción de normas técnicas internacionales, la evaluación de los olores en el marco del sistema de concesión de licencias ambientales y los esfuerzos en curso sobre las normas de emisión de olores para determinadas actividades.

Por lo tanto, existen homologaciones de normas técnicas europeas que permiten la cuantificación de emisiones y de la situación de inmisión de olores. También, para el Sistema de Evaluación de Impacto Ambiental existe desde fines del 2017 una **Guia para predicción y evaluación de impactos por olor en el SEIA**[8], sin embargo, **no existen criterios comunes para establecer umbrales de impacto por olor**. Sin embargo, podemos constatar que no existen criterios comunes para el uso de la normativa de referencia y tampoco para los alcances de la aplicación de la guia durante la evaluación ambiental y para definir las medidas de seguimiento y control de los permisos ambientales. Abogamos por que se establezcan umbrales de olor en los casos en que los residentes se vean afectados y haya molestias por olor.

Además, en 2018 y 2019, el Ministerio del Medio Ambiente ha iniciado los procesos de dictación de normas de emisión para planteles porcinos y plantas de procesamiento de recursos hidrobiológicos.

CUANDO LA CIUDADANÍA SE INVOLUCRA

Los habitantes de un distrito del sur de Alemania se quejan de las molestias nocturnas por olor desde 2015. La centralización de las observaciones de los residentes por parte del municipio, aunque tardía, fue crucial para avanzar en la búsqueda de fuentes de olor. La recogida y el cruce de datos espacio-temporales y meteorológicos permitió delimitar la zona en cuestión e identificar un posible emisor. Capacitar a la ciudadanía para recoger datos mediante el uso de herramientas innovadoras podría haber permitido a las autoridades actuar con mayor rapidez para prevenir y reducir las emisiones de olor.

Regulaciones de olor en 8 países Europeos (socios de D-NOSES)

Se han realizado algunos esfuerzos para regular los olores en toda Europa a nivel nacional, regional e incluso municipal[9]. Sin embargo, no ha conducido a la elaboración de definiciones, términos y criterios claros a escala europea y **todavía hay muchas áreas europeas que no tienen ninguna regulación**. Debido a la falta de reglamentación, rara vez se realizan estudios técnicos situados, los datos sobre contaminación por olor son escasos o inaccesibles y, por lo general, no se tiene en cuenta la aplicación de estrategias eficaces de control del olor. A menudo es la ciudadanía la que ejerce presión sobre las autoridades locales y las industrias emisoras para que supervisen y controlen las emisiones de olor.

AUSTRIA
- No existe una normativa nacional sobre olores.
- Recomendación de aplicar la "Directiva para la evaluación de las emisiones de la ganadería" (2017) en diversos reglamentos y procedimientos de autorización.

BULGARIA
- En virtud de la Ley de protección del medio ambiente, algunos permisos incluyen medidas para el seguimiento y control de olores.
- Existen ordenanzas sectoriales que abordan algunas cuestiones relacionadas con los olores de manera periférica.

ALEMANIA
- La Ley Federal de Control de Emisiones regula la autorización de emisores potenciales de olores.
- La Directiva Técnica sobre el Control de la Contaminación del Aire describe la aplicación de la ley y establece límites de emisión.
- La Directiva sobre Inmisión de Olores establece límites para la exposición.

GRECIA
- No existe una normativa nacional sobre olores.

ITALIA
- No existe una normativa nacional sobre olores.
- Directrices locales sobre las emisiones de olores, basadas principalmente en un enfoque modelístico (Región de Lombardía, Región de Piamonte, Región de Apulia, Provincia de Trento).

PORTUGAL
- No existe una normativa nacional sobre olores
- Medidas de control se pueden establecer en permisos ambientales.

ESPAÑA
- No existe regulación sobre olores a nivel nacional o regional, pero sí en algunos municipios, pero falta coherencia entre las ordenanzas.
- En Cataluña, en el año 2005 se elaboró un borrador de reglamento para el control de la contaminación por olor, no adoptado, pero utilizado como referencia para establecer los límites de olor de las diferentes actividades emisoras en el resto del Estado.

REINO UNIDO
- La Ley de protección del Medio Ambiente de 1990 asigna a los municipios la tarea de investigar reclamos y denuncias por olores.
- Existe una serie de guías para la gestión y control de olores.

LA NECESIDAD DE UN MODELO DE GOBERNANZA MULTI-NIVEL DE 'ABAJO A ARRIBA'

La contaminación por olor tiene generalmente un impacto local y por lo tanto **las regulaciones locales son a menudo la estrategia de gestión más efectiva**. Sin embargo, las regulaciones a nivel nacional e internacional son cruciales para proporcionar un marco fundamental e incluso son necesarias en algunos países (por ejemplo, Portugal).
La ciudadanía, como productores de muchos productos olorosos (por ejemplo, residuos y aguas residuales), son **corresponsables de las emisiones de olores**. Su inclusión en los procesos locales de toma de decisiones y gestión les permite aumentar su conciencia de los desafíos ambientales, ajustar su comportamiento y co-crear regulaciones locales para comunidades sostenibles.

Mediante la inclusión de la ciudadanía, **las industrias pueden mejorar sus relaciones con las comunidades**, y las autoridades locales pueden aumentar la transparencia y **la confianza en las instituciones públicas**.

[8] Servicio de Evaluación Ambiental, 2017. Guía para predicción y evaluación de impactos por olor en el SEIA. Diciembre 2017.
[9] Brancher et al., 2017. 'A Review of Odour Impact Criteria in Selected Countries around the World' Chemosphere 168:1531 1570.

Medición de olores e impactos

MÉTODOS COMUNES UTILIZADOS

Un olor se caracteriza más por su concentración que por su composición química. Expresado en unidades de olor por metro cúbico, la concentración de olor se determina en un laboratorio por **olfatometría dinámica**, una técnica sensorial basada en la participación de un panel de personas con sensibilidad media confirmada (método normalizado a nivel internacional por EN 13725:2003, homologado en Chile por NCh 3190.of2010). La **cuantificación de las emisiones de olores en la fuente** basada en esta técnica sirve como datos de entrada para los **modelos de dispersión de olores**. Estos modelos proporcionan resultados promediados fácilmente comprensibles que no sólo son descriptivos, sino también predictivos (útiles para las nuevas instalaciones en construcción)[10].

Sin embargo, los resultados de esta técnica tienen altos niveles de incertidumbre, **no informan de molestias por parte de la ciudadanía ni de molestias en tiempo real** y, por lo tanto, no proporcionan estimaciones precisas de su exposición a los olores.

Los métodos para evaluar el impacto de los olores en los receptores (ciudadanía) incluyen la norma chilena NCh 3533:2017 (una homologación de la norma europea EN 16841:2016 sobre **inspecciones de campo de olores** a través de evaluadores humanos, que se utiliza cada vez más para la evaluación ambiental de olores. Sin embargo, estas inspecciones de campo requieren mucho tiempo y a menudo conllevan altos costos, por lo que aún no proporcionan información en tiempo real sobre la incomodidad de la ciudadanía afectada.

Se necesita una técnica rentable para evaluar las molestias percibidas directamente en la comunidad. La ciudadanía posee el sensor más preciso y económico para medir los olores, su propia nariz, y tiene una clara motivación para comprometerse: recuperar su calidad de vida.

La participación de la ciudadanía ayuda a la industria y a las autoridades locales a obtener **datos en tiempo real a un coste económico más bajo.** Estos datos informan la optimización de los procesos industriales y reducen el impacto de la contaminación por olor en las comunidades, a la vez que avanzan en el estado del arte de la gestión de olores.

La intervención de la ciencia ciudadana en la contaminación por olores es, por tanto, de gran interés. La ciencia ciudadana ha experimentado recientemente un aumento del apoyo de la Comisión Europea, principalmente en los ámbitos del monitoraje y la regulación medioambientales. Además, el movimiento de la ciencia abierta ha ganado mucha conciencia. Como resultado, el número de proyectos de ciencia abierta y ciencia ciudadana ha ido aumentando constantemente en toda Europa y fuera de ella.

"La opinión informada y la cooperación activa del público son de suma importancia para mejorar la salud de la gente." (OMS)[9]

Nuestro enfoque en D-NOSES: empoderamiento de la ciudadanía para co-diseñar soluciones locales

El proyecto Distributed Network for Odour Sensing, Empowerment and Sustainability (D-NOSES) es un proyecto financiado por la Unión Europea H2020-Swafs (Ciencia con y para la sociedad) cuyo objetivo es proporcionar un **enfoque inclusivo y 'de abajo a arriba'** para abordar los problemas de la contaminación por olor a todos los niveles de una manera rentable.

Nuestro enfoque consiste en empoderar a la ciudadanía para que se convierta en una fuerza impulsora del cambio a través de la ciencia ciudadana. Los problemas de olores pueden ser cartografiados utilizando **la aplicación de mapeo colaborativa gratuita OdourCollect** (https://odourcollect.eu), que permitirá a las industrias optimizar sus procesos y comprobar los efectos de las nuevas buenas prácticas y medidas correctivas implementadas a un menor coste. Esta metodología tiene en cuenta las molestias de la ciudadanía a través de observaciones de primera mano y permite a ésta **co-diseñar soluciones conjuntamente** con todas las partes interesadas, como las ONG medioambientales, las autoridades locales, las industrias emisoras de olores y los expertos en olores.

A TRAVÉS DE LA IMPLEMENTACIÓN DEL PRINCIPIO 10 DE LA DECLARACIÓN DE RIO (1992), D-NOSES FORTALECERÁ:

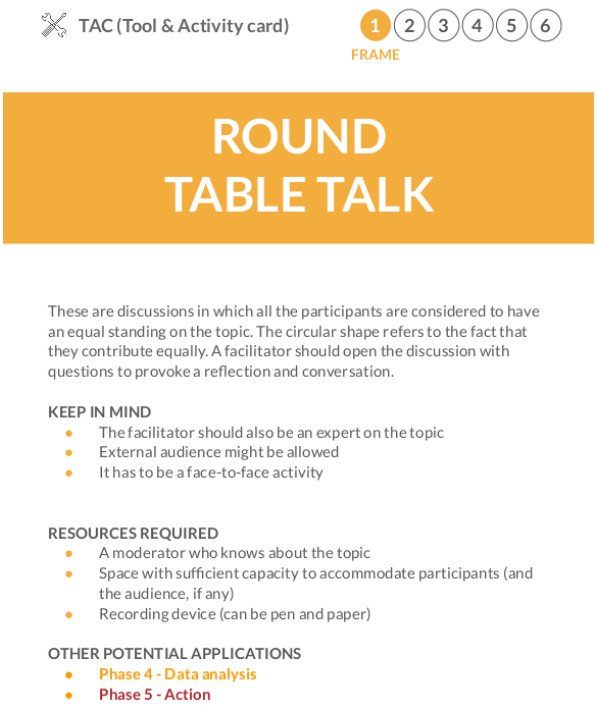
- **No sólo acceso a la información**, sino también **la generación de nuevos datos sobre la contaminación por olor** a través del Observatorio Internacional del Olor (https://odourobservatory.org)
- **Participación pública en la toma de decisiones a nivel local** (estrategias de participación a múltiples niveles de las partes interesadas y las comunidades, enfoques de co-creación y ciencia ciudadana).
- **Acceso a la justicia** a través de acciones de incidencia para introducir la contaminación por olor en las agendas políticas.

MENSAJES PARA LLEVAR A CASA

- **La contaminación por olor está relacionada con cuestiones medioambientales y sanitarias y, por lo tanto, debe ser objeto de una regulación más estricta en Europa.**
- **La inclusión de la ciudadanía en los procesos de regulación y gestión de los olores es beneficiosa para todas las partes interesadas, ya que promueve la educación científica, mejora las relaciones y aumenta la confianza en las autoridades públicas**
- **¡Sea parte de la solución! Involúcrese en nuestro proceso de co-creación: Obtenga más información en el sitio web de D-NOSES (https://dnoses.eu)**

[10] Capelli et al., 2013, 'Measuring Odours in the Environment vs. Dispersion Modelling: A Review', Atmospheric Environment 79: 731 743.

16.3 The D-NOSES engagement toolkit - Relevant cards for policy-society dialogues



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

MEC (Method Card)

POLICY DIALOGUE

Policy dialogue is often a process rather than a one-off event and therefore difficult to define. However, the World Health Organisation definition is useful for our purposes "An iterative process connecting the technical to the political, addressing the aspirations of the people, involving multiple stakeholders aiming to change formal or informal policy, strategy and plans informed by evidence to have maximum (public) health impact." (Briefing note, Policy Dialogue: What it is and how it can contribute to evidence-informed decision-making 2015)

KEEP IN MIND

- Before any true dialogue can begin, you must have defendable, reliable and relevant data to present.
- Not all participants will have a scientific background so use appropriate language.
- It is useful to gradually build relationships with the decision makers and influencers

POSSIBLE APPLICATIONS

- Phase 5 - Action

TAC (Tool & Activity card)

1 2 3 4 5 6

FRAME

POLICY BRIEF

A policy brief is a guideline for policy makers, which provides information on a certain topic in a condensed form that can help readers understand, and likely make decisions about, government policies. Give objective summaries of your research, include good practices and policy recommendations and, if possible, argue for particular courses of action. These are usually in printed form, but can also refer to other online communication strategies (e.g. blogs).

What should a policy brief include (4 pages)?

- Title
- Executive summary (Rationale for action on the problem
- Focus on the problem
- Answer the question: Why do something different?
- Proposed policy option(s)
- Focus on the solution
- Answer the question: What to do? What not?
- Odour regulations in Europe
- Policy recommendations
- Focus on the application
- Answer the question: How to implement

KEEP IN MIND

- Keep your audience in mind: it mostly consists of people who are not familiar with your topic yet. Do not use jargon!
- Are there questions that need to be answered? What are your audience's interests or concerns?
- Information needs to be justified and based on sound scientific data.
- Whenever possible, include precedents.
- Lead with a short statement that summarises the essence of the brief and catches the reader's attention. This is usually written last.
- Keep entire brief to max 2-4 pages (1,500 words).