



D-NOSES

Distributed Network for Odour Sensing,
Empowerment and Sustainability

Green Paper on Odour Pollution

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

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List of Acronyms

Acronym	Description
AQE	Air Quality in Europe
BAT	Best Available Techniques
BREF	Best Available Techniques reference documents
D-NOSES	Distributed Network for Odour Sensing Empowerment and Sustainability
EEA	European Environmental Agency
ECHR	European Court of Human Rights
EU	European Union
OC	OdourCollect App
RRI	Responsible Research and Innovation
SDGs	Sustainable Development Goals
UN	United Nations
UNECE	United Nations Economic Commission for Europe
WHO	World Health Organization
WWTP	Wastewater Treatment Plants

Foreword by Ms. Colombe Warin



“Funded under the EU Research and Innovation programme Horizon 2020, *Science with and for Society* Programme, D-NOSES implemented citizen science hands-on activities on a specific and innovative area: odour pollution.

D-NOSES aimed to involve citizens with Responsible Research and Innovation using co-creation tools to become drivers of change. At a time when **the involvement and engagement of citizens** is an area of

particular interest for the European Commission led by Mrs von der Leyen, D-NOSES promoted a quadruple helix approach at local, regional, national and global levels.

This is an example of what the new Eurobarometer survey on ‘European citizens’ knowledge and attitudes towards science and technology’ released on 23rd September 2021, showed: 9 in 10 EU citizens (86%) think that the **overall influence of science and technology is positive**. Respondents most often mention, among others, the fight against climate change when asked in which areas research and innovation can make a difference. Additionally, the majority thinks that **involving non-scientists in research and innovation** ensures that science and technology respond to the needs and values of society (61%). Hopefully the legacy of D-NOSES will continue towards the empowerment of citizens in science and in areas of citizens’ interest after the end of the project. No doubt that the International Odour Observatory will help guarantee access to information on odour pollution and develop interactions with CSOs, NGOs, local public authorities, odour emitting industries and academia”.

Ms. Colombe Warin, Former Project Officer of D-NOSES,
European Commission (European Research Executive Agency)



Foreword by Dr. Sven Schade



Citizen science approaches can bring numerous benefits, both to the participants and to society at large. Those benefits do not only include contributions to science and education, or eventual behavioural change. Citizen science can also contribute to public governance, for example, by integrating citizen science approaches in the structures and processes of policy making, implementation and evaluation - at different geographic scales.

We see especially many cases and frameworks emerging that interconnect citizen science with environmental monitoring. Those come in different flavours: from complementing authoritative sources, to becoming an essential part in the data flows that are used for evidence-based policy making. Prominent examples (e.g. the monitoring of birds) are accompanied by additional topics, such as air and water quality, noise, and (micro) plastics. Furthermore, - also to highlight some of the achievements within the European Union - best practices in citizen science for environmental monitoring have recently been published to more systematically connect citizen science with European environmental policies.

Beyond these provisions of information to policy making processes - and especially present at the local level - citizen science approaches also help to solve specific problems that matter to people. This interplay between citizen science and social innovation we witnessed, for example, in the EU-funded Citizens' Observatories projects, and in some of the Collaborative Awareness Platforms that received funding some years ago.

As part of the Science with and for Society (SwafS) family of projects, D-NOSES could build on these developments, help interconnecting some of the loose ends, and take an important additional step. Focussing on the specific topic of odour pollution, the D-NOSES project succeeded in designing and showcasing a flexible and yet systemic approach to embed citizen science approaches in multi-level governance structures. Benefitting from an environmental topic that is less regulated than others, the project illustrates ways to offer people more possibilities to participate in science and in policy making.

Dr. Sven Schade, Project Leader, European Commission, Joint Research Centre (JRC)

Foreword by Prof. Moh Redjali



In my experience as Mayor of Temara (Morocco) since 2003, I have had to deal with the major socio-environmental problem affecting communities, that odour pollution is. The increased quantities of waste due to rapid urbanization and the resulting leachate pose a series of challenges that weighs heavily on communal budgets and human well-being. Specifically in our region, it has proven very difficult and expensive to address and

control the sources of odour nuisance from a major landfill. To date the problem remains, and becomes day after day even more acute and is causing much concern despite the many efforts done and the extensive resources spent to minimize the impacts on the health of citizens and of the environment. This Green Paper of the D-NOSES project provides most of what an elected official or administrator dealing with local governance issues needs to know in terms of challenges but also recommendations for improved regulatory and policy frameworks for odour pollution. It addresses a real need.

Prof. Moh Redjali, Mayor of Temara (Morocco). Chair of the Circle of Mediterranean Parliamentarians for Sustainable Development (COMPSUD). University professor at l'Institut Agronomique et Vétérinaire Hassan II of Rabat. D-NOSES Advisory Board Member.

A handwritten signature in blue ink, appearing to be 'M. Redjali'.

Foreword by Prof. Laura Capelli



As a scientist working in odour pollution, I have often highlighted the difficulties related to environmental odour impact assessment, and the fact that there are no simple solutions to complex problems.

Odour scientists have been working hard in the development of specific methods for odour sampling and measurement, with the specific purpose of becoming more and more precise in characterizing odour emissions and in determining the exposure to odours of affected communities. And it is now clear that there isn't a unique way to tackle odour pollution problems: often the combination of different methods is the only way of getting a satisfactory understanding of the issue to design sustainable solutions.

In this context, citizen science has the potential to offer unique advantages compared to other odour measurement techniques: it may represent the only method to get real-time and spatially distributed information about the presence of odours in a determined study area. Also electronic noses may detect the presence of odours in ambient air, but in practice, their cost limits the number of instruments that can be installed in the field.

For this reason I was honoured to be appointed as scientific manager of this project and, after 3 and half years of work, I can say that I am very satisfied with the results achieved, especially in the different pilot studies carried out around the world. The pilot studies were very different from each other under all aspects, from the geographical characteristics of the study area, to the number and type of emitting sources involved, the specific objectives to be achieved and the engagement of the different stakeholders.

Despite these differences, they all have proven the effectiveness of citizen science – sometimes applied in combination with other methods – in getting a more complete picture of the specific issue in a collaborative way.

I believe that the D-NOSES project really helped in setting the basis for a future standardization of the methodology, which is highly desirable in order to complement the current methods for odour impact assessment.

Prof. Laura Capelli, Associate Professor at the Department of Chemistry, Materials and Chemical Engineering of the Politecnico di Milano University. Her research activity led to the publication of more than 150 papers in journals, books and conferences (ca. 96 ISI/Scopus indexed publications; Scopus H-Index = 22). She is scientific coordinator and organizer of the NOSE international conference series on environmental odour monitoring and control, and member of the scientific committee of other relevant conferences in this field (e.g., MKO, IWA). D-NOSES Scientific Manager.



Executive Summary

The Green Paper on Odour Pollution is a policy document that aims to place odour pollution in the policy agendas by providing recommendations to better tackle the issue and move towards an improved regulatory framework in Europe.

Odour pollution is the second cause of environmental complaints by citizens across Europe, and often a symptom of broader environmental issues caused by population growth, urbanisation and industrialization. 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 as reflected in the EU Action Plan: "Towards Zero Pollution for Air, Water and Soil" of the European Green Deal. However, odour regulations across Europe and within countries differ significantly from each other. In many places they are even completely lacking. The *Green Paper on Odour Pollution* advocates for the need of a bottom-up, multi-level governance model in odour pollution within Europe in order to protect the affected citizens and support the environmental authorities and emitting activities in order to improve the situation.

The *Green Paper on Odour Pollution* is the first attempt in the development of such a set of recommendations to tackle odour pollution at the local, regional, national and global levels and aims to provoke an open discussion on the approach to tackle odour pollution. The document reviews the overall odour measurement techniques and the policy framework for action on odour pollution. It proposes methods and recommendations for the reduction of odour impacts as well as encouragement for its legislation.

The document is structured as follows:

Chapter 1. INTRODUCTION presents an overview of odour pollution and the scope and purpose of this Green Paper.

Chapter 2. TURNING A CHALLENGE INTO AN OPPORTUNITY: THE GREEN PAPER ON ODOUR POLLUTION shows how the growing public recognition of persistent environmental odours as a serious problem at an international level is a sign to begin working towards introducing odour governance that works for all actors affected. In addition, it posits an overview of the latest declarations from the World Health Organization and the European Court of Human Rights on the matter.

Chapter 3. MULTI-LEVEL GOVERNANCE MODEL IN ODOUR POLLUTION AND THE EUROPEAN POLICY CONTEXT presents why regulating odour pollution is not a straightforward issue, the five main challenges in regulating odours, the current European regulatory framework and the urgent need of adopting a multi-level governance model for

odour management, which also contributes to compliance with Principle 10 of the Rio Declaration and the Sustainable Development Goals.

Chapter 4. CITIZEN SCIENCE AS A NECESSARY METHODOLOGY TO TACKLE ODOUR POLLUTION introduces how odours have been traditionally managed and how citizen science as a method, represents an excellent tool to collaboratively tackle ‘wicked’ odour related to socio-environmental challenges, locally and globally, going beyond the current state of the art.

Chapter 5. THE ODOUR OBSERVATORY: THE CIVIC RIGHT TO CONTRIBUTE TO ENVIRONMENTAL INFORMATION shows why also in environmental odour governance, citizens have the right to contribute to producing their own data, and how the International Odour Observatory and the App OdourCollect were created to provide useful information about odours for all stakeholders, levelling thus the playing field and increasing awareness and knowledge.

Chapter 6. THE WAY FORWARD: INTRODUCING ODOUR POLLUTION IN THE POLICY AGENDAS the final section of the Green Paper on Odour Pollution presents a brief overview of the multi-level governance model for action, and some recommendations towards an improved policy framework for odour pollution in Europe.

Keywords: Odour, Odour Pollution, Environment, Citizen Science, Policy, Regulation, Multi-level Governance.

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1. Introduction

Odour nuisance, being the second cause of environmental complaints, leads to a significant decline in the quality of life of those affected and must be urgently addressed.

Odour pollution is the second reason for citizens' environmental complaints after noise across Europe¹, accounting for **more than 30% of citizen environmental complaints worldwide**², and has 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 inconvenience³ such as continuous headache, anxiety, stress, lack of concentration, sleeping disorders and even increased respiratory problems. 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. Reducing the impact and improving the affected citizens' quality of life requires a collaborative approach by all stakeholders; and a reliable measurement of the real nuisance. In addition, **odours may have an economic impact**⁴ (e.g. less tourism or loss of property value) **and these are often a symptom of broader environmental issues caused by population growth, urbanization and industrialization, generating** therefore, potential conflicts between residents and emitters, which have to coexist in increasingly limited space.

This Green Paper on Odour Pollution is the first step in the development of an integral solution to odour pollution in Europe and aims to stimulate public discussion on the future approach to odour policy. It reviews the current overall odour situation in Europe, followed by the outline of a framework for action, including access to information and policy options for the reduction of odour pollution in Europe.

¹ ADEME, 2005. Pollutions olfactives: origine, législation, analyse, traitement, Dunod, Paris, XII-388p.

² Pollutions, olfactives: origine, législation, Analyse, traitement. ADEME 2005.

³ 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.

⁴ 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.

1.1 Scope and Purpose of the Green Paper on Odour Pollution

The process of developing this *Green Paper* has been the result of the coordination, research, public engagement activities and consultations carried out during the three and a half years of execution of [The Distributed Network for Odour Sensing, Empowerment and Sustainability \(the EU Horizon 2020 D-NOSES project\)](#) thanks to all [D-NOSES partners](#) and [D-NOSES Advisory Board members](#), who constantly promoted the dialogue between society, science, industry, and policy - following the quadruple helix model of stakeholder engagement⁵ and using citizen science methodologies to advance towards a multi-level governance model in odour pollution. The EU Horizon 2020 D-NOSES Consortium would also like to express its infinite gratitude to the large number of citizen scientists, citizen associations, local organizations and authorities, and industries/SMEs who have participated in the project's [10 different pilot case studies](#) and have given their time and motivation to gather and analyse new sets of data in odour pollution, contributing to a wider understanding of the issue from a multi-stakeholder point of view. Both the quantity and quality of the uncountable contributions show the unquestionable interest of citizens and organizations in tackling and regulating odour pollution (See Annex 8.1: Acknowledgements and project participants).

The *Green Paper on Odour Pollution* serves as a foundation for further development of research and plans by different stakeholders with specific objectives in odour pollution and a planned future *White Paper*. This work is still in progress with the aim to produce a public debate within the European Institutions or for any individual or organization interested in the topic. However, this Consortium is not responsible for the use which might be made of the following information by any individual or organization acting on behalf of the European Commission or the EU Horizon 2020 D-NOSES Consortium.

⁵ 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>.

2. Turning a challenge into an opportunity: the Green Paper on Odour Pollution

The growing public recognition of persistent environmental odours as a serious problem at an international level is another sign that the time has come to begin introducing odour governance to protect the exposed population.

As posited by Mr. Virginijus Sinkevičius, Commissioner for the Environment, Oceans and Fisheries: “Environmental pollution negatively affects our health, especially the most vulnerable and socially deprived groups, and is also one of the main drivers of biodiversity loss. The case for the EU to lead the global fight against pollution is today stronger than ever. With the Zero Pollution Action Plan, we will create a healthy living environment for Europeans, contribute to a resilient recovery and boost transition to a clean, circular and climate neutral economy”⁶.

Unfortunately, odour pollution is not tackled directly in any point of the **Zero Pollution Action Plan** nor in the recently approved **European Green Deal**. But real life shows consistency, where uncountable studies claim that persistent environmental odours can be much more than just a nuisance and evidence is mounting about its serious effects on affected people and community **health**, such as headaches, sleeplessness, stress, anxiety, nausea, respiratory problems and other psychological as well as physiological effects. Furthermore, studies have shown also the practical and economic reality of odour nuisance as connected to a fall in productivity, reduced economic activity and lowered house and community prices⁷.

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 authorities and odour emitting industries to monitor and control odour emissions. The EU Horizon 2020 D-NOSES approach, by incorporating citizen science as a methodology to

⁶ European Commission (2021). “European Green Deal: Commission aims for zero pollution in air, water and soil”. [Commission aims for zero pollution in air, water and soil \(europa.eu\)](https://ec.europa.eu/commission/presscorner/detail/en/ip_21_1111)

⁷ 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.

address odour pollution, offers at least one great advantage over the traditional measurement techniques: it can measure the actual impact on people rather than just the physical presence and concentration of odours. The present document aims at showing the path towards turning this persistent environmental threat into a new opportunity for everyone.

2.1 Odour Pollution: an underestimated global problem affecting communities

Human noses are able to recognize up to a trillion different smells and is by far the best instrument that we have to detect odours⁸. We might also agree that not all odours are pleasant. Inasmuch as persistently exposed to bad odours, the wonder of the sense of smell can soon become a real nightmare. Even the frequent exposure to nice smells, depending on their intensity, may lead to the same issues. The problem comes when this is not taken into account in any norm nor regulation, leaving citizens unarmed. In fact, **odour pollution is an underrepresented concern in environmental regulations globally**⁹. What is more, odours are barely regulated, and when regulated, regulations do not provide a whole picture of the problem, even though as we already mentioned, odour pollution is the second environmental concern in the EU after noise in the number of citizens' complaints¹⁰. Besides, **emission limits and acceptability criteria for odour impacts differ significantly among jurisdictions**¹¹.

But not everything is lost. The negative effects of persistent odours have caught the attention and concern from international organizations, which have also become more active on this issue. For instance, the **World Health Organization (WHO)** has affirmed that odour nuisance affects our quality of life, and therefore the social wellbeing dimension of health (SDG3). They also define an odour nuisance threshold based on the size of the affected people (less than 5%) and the duration of exposure (less than 2%), explicitly acknowledging impact rather than chemical concentrations, since annoyance is influenced by a number of psychological and socioeconomic factors¹². On the other hand, the **European Court of Human Rights (ECHR)** similarly has explicitly posited that smells can materially affect people's well-being and can be in breach of Article 8 of the European Convention on Human Rights, which refers to the Right to respect for private and family life, home and correspondence¹³.

⁸ D-NOSES: Tackling Odours, One Nose at a Time (2018). Waste Management World, International Solid Waste Association [November/December 2018 | E-paper | Waste Management World \(waste-management-world.com\)](#).

⁹ 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/>

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://odourobbservatory.org/>.

¹⁰ ADEME, 2005. Pollutions olfactives: origine, législation, analyse, traitement, Dunod, Paris, XII-388p.

¹¹ Bokowa A. et al., 2021. Summary and Overview of the Odour Regulations Worldwide. Atmosphere 2021, 12(2), 206. <https://doi.org/10.3390/atmos12020206>

¹² Air Quality Guidelines for Europe, Second Edition, 2000 (World Health Organization Regional Office for Europe Copenhagen WHO Regional Publications, European Series, No. 91). Criteria for consideration of sensory effects, Chapter 2, Page 20 [E71922.pdf \(who.int\)](https://www.who.int/publications/i/item/9789289103111_2)

¹³ European Court of Human Rights(2020) "Guide on Article 8 of the European Convention of Human Rights". https://www.echr.coe.int/Documents/Guide_Art_8_ENG.pdf (pag 38).

3. Multi-level Governance Model in Odour Pollution and the European Policy Context

There is no European Environmental Directive for odour levels in ambient air, nor European guidelines on the coordinated collection of odour data. This is a serious issue that affects not only citizens who have to deal with odour annoyance but also industries and environmental authorities that need a better framework to develop and manage their activities.

Regulating odour pollution is not a straightforward endeavour - one of the reasons is the complexity of reliably measuring odour emission and immission levels. In contrast to other air pollutants, **odorants can be difficult to detect with instrumental methods**, as the human odour perception threshold is usually related to very low concentrations for the main odorants¹⁴. For this reason, **sensorial measures are required** to quantify the odour concentration or the frequency of exposure perceived by individuals, rather than simply measuring the chemical concentration of the odorants present in ambient air. This makes the job of regulating odours more difficult than other environmental issues. For instance, free release of odour is no longer permitted for industrial activities in Germany, the Netherlands, Italy and France¹⁵. However, this has not led to the drawing up of a clear and harmonized Europe-wide framework on odour impact in the way it exists with noise, for example.

This section presents the current global and European regulatory framework and the urgent need for adopting a multi-level governance model for odour management which also contributes to Principle 10 of the Rio Declaration¹⁶ and the Sustainable Development Goals.

¹⁴ Even if every odorant could be analytically detected, this would not tell us the whole story, as some odorants are perceived as more pungent or unpleasant than others. In addition, odours perceived in ambient air are mixtures of multiple odorants that are not additive, but often have synergistic or antagonistic effects on each other, meaning that chemical analysis cannot provide a direct relationship with human perception.

¹⁵ 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>

¹⁶ For more information on the relationship between D-NOSES and Principle 10 of the Rio Declaration, visit: <https://dnoses.eu/2018/09/28/principle-10-and-the-right-to-create-data/>

3.1 The Odour regulatory framework trend worldwide and in Europe

As a broad overview, even though there has been a global environmental shift during the last decade, most of the countries worldwide still **do not have any regulations to deal with odour pollution**. Nonetheless, there are a few in which the regional or even local authorities are trying to provide a solution to this lack of regulation as seen in *Fig 1*. In these regulations, as analysed by the EU Horizon 2020 D-NOSES Consortium, most limits or guidelines are based on standardized techniques. At European level and South America, the most common way of regulating odours is based on **dynamic olfactometry**. However, dynamic olfactometry only allows to measure odour at the emission sources. Coupled with dispersion modelling, **it is becoming the predominant way of regulating in almost all countries worldwide**¹⁷, applied to define emission or immission limits. However, there is still little consensus on what odour concentration exposure levels, immission values or additional variables can represent the most effective and fair odour limits for off-site impacts^{11,18}.

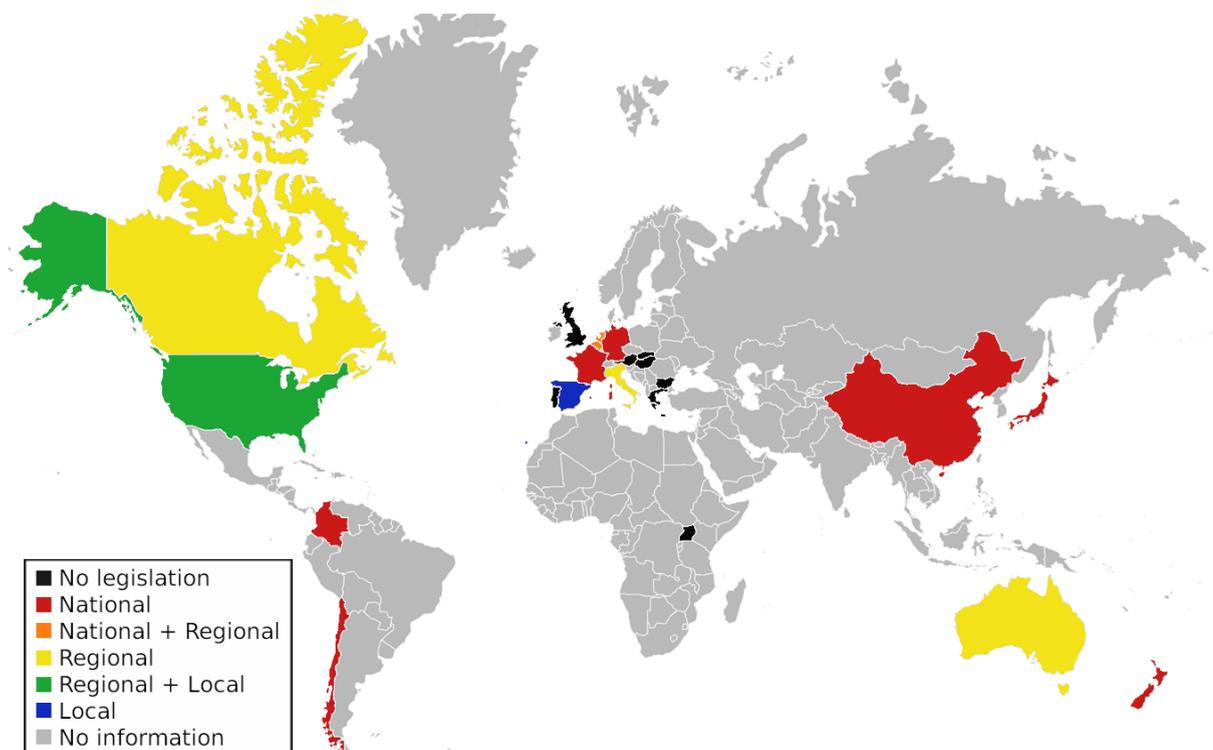


Fig 1. World map with the identification of the odour regulatory framework of the countries analysed, belonging to the D-NOSES Consortium and beyond. Source: D-NOSES ¹⁷.

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/>.

¹⁸ 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>.

But how are odours managed in Europe? To answer this question, let's briefly go back in time¹⁹. During a cold day back in December of 1991, 21 odour enthusiasts met for the very first time in Europe's history to discuss what later became the first European Odour Standard, following the work done in the Netherlands, where a quantitative air quality guideline for odours from industrial sources was introduced in 1984²⁰, and in Germany, where the VDI 3881 standard on olfactometry was published in 1986²¹. Other aspects²² were also discussed in this meeting and beyond, which led the way, twelve years later, to the standard EN13725:2003 Air quality - Determination of odour concentration by dynamic olfactometry²³.

Jumping more than one decade later, in December 2016, **Poland** encouraged the European Council to start working on an appropriate legislative European proposal to tackle the "increasingly serious" issue of odour pollution, which had become a national problem accounting for almost 60% of concerns related to air pollution. Poland considered that it is necessary to introduce a consistent interpretation at European level in this field in order to implement effective measures in Member States²⁴. In February 2017 the European Council recognized to Poland the lack of legislation, however, it was argued that since odours are a local problem, it should be treated accordingly.

Nowadays, in each member state of the European Union, odours are regulated by the **Directive 2010/75/EU**²⁵ of the European Parliament and the Council of 24 November 2010 on **Industrial Emissions (IED)**. This directive established a broad framework for determining limits, including odour limits for industrial activities. Among other things, it also rules that installations should operate only if they have a written permit whose conditions are based on the use of the reference documents for Best Available Techniques (BREF). There are more than 30 BREFs in Europe, covering several industrial sectors, but **only one, published in 2018, provides the first European odour limit: the (BAT) conclusions for Waste Treatment**²⁶. In the document, EN standards (EN 13725:2003 on dynamic olfactometry, EN 16841-1:2016²⁷ on

¹⁹ Olores. org. (30.07.2015). *How a European Standard about odours was born in 1991*. Retrieved from: https://www.olores.org/index.php?option=com_content&view=article&id=449:how-a-european-norm-about-odour-was-born-in-1991&catid=3:dynamic-olfactometry&Itemid=303&lang=en

²⁰ InfoMil (2000). NeR Nederlandse Emissie Richtlijn, Hindersystematiek Geur. (Netherlands Emissions Guideline. Framework for Odour Nuisance), InfoMil, The Hague, 2000. English translation available from: www.infomil.nl

²¹ VDI 3881:1986 Part 1, Olfactometry – determination of odour thresholds. (1986), Beuth Verlag, Germany.

²² Van Harreveld, A., Heeres, P., Harssema, H., (1998). A review of 20 years of standardisation of odour concentration measurement by dynamic olfactometry in Europe., J. Air & Waste Manage. Assoc. 49, 705-715, Pittsburg, USA, jun 1998. DOI: [10.1080/10473289.1999.11499900](https://doi.org/10.1080/10473289.1999.11499900)

²³ European Standards, BS EN 13725:2003 Air Quality. Determination of odour concentration by dynamic olfactometry. [BS EN 13725:2003 Air quality. Determination of odour concentration by dynamic olfactometry - European Standards \(en-standard.eu\)](https://www.bsigroup.com/Products/BS-EN-13725-2003-Air-quality-Determination-of-odour-concentration-by-dynamic-olfactometry-European-Standards-en-standard.eu)

²⁴ Council of the European Union, 6 December 2016. Odour nuisance - Information from the Polish delegation. 15267/16. ENV 772.

²⁵ Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (Integrated Pollution Prevention and Control, IPPC). Text with EEA relevance [EUR-Lex - 32010L0075 - EN - EUR-Lex \(europa.eu\)](https://eur-lex.europa.eu/eur-lex.europa.eu)

²⁶ Commission implementing decision (EU) 2018/1147 of 10 August 2018 establishing best available techniques (BAT) conclusions for waste treatment under Directive 2010/75/EU of the European Parliament and the Council. <https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32018D1147>.

²⁷ European Standard (2016) EN 16841-1, Ambient air - Determination of odour in ambient air by using field inspection - Part 1: Grid method, European Committee for Standardization (CEN), TC264 WG27, Brussels.

field inspections and EN 16841-2:2016²⁸ on the plume method) are referenced for odour monitoring, and an odour management plan is referenced to monitor frequency. A limit of 200 - 1,000 ou_E/Nm³ is established for all biological treatments of waste, excluding waste mainly composed of manure.

Nonetheless, **BREFs are not exhaustive, nor consider local contexts**, making permits difficult to obtain, and represent a huge barrier for citizens and industries to understand the regulative framework of odour pollution. For instance, as stated in the information from the Polish delegation, even though BAT conclusions on intensive rearing of poultry or pigs showed that the issue of odour nuisance is very important for Europe as a whole, regulations only apply to installations with more than 40,000 places for poultry, 2,000 for pigs of over 30 kg and 750 for sows, so there are limitations. Insofar as the current **scenario regarding odour regulations being heterogeneous across and within EU-member states, regions, and even municipalities**, sometimes without an accepted scientific basis, and giving the complex landscape of **competencies for regulating odours, which vary dramatically from country to country**, BREFs do not represent a solution to odour regulation for two main reasons: 1) because they hardly set thresholds for odour concentrations, and 2) because in comparison with other kinds of pollutants, such as noise, water or air, **odour pollution does not have any specific Directive that limits odour nuisances with clear thresholds** for different scenarios and techniques, **nor clear, Europe-wide definitions, terms and criteria**.

In addition, the European Environment Agency (EEA) publishes a report every year presenting an updated overview and analysis of **Air Quality in Europe (AQE)**. In 2018, the AQE report presented the progress towards meeting the requirements of the air quality directives, but unfortunately, it did not mention odours as a pollutant with a key impact on the air quality in Europe²⁹. The 2020 AQE again, did not include such information³⁰.

Other **challenges** related to the exercise of regulating odour pollution were identified during the execution of the EU Horizon 2020 D-NOSES project, and these are:

- a) odour pollution is difficult to measure and traditional techniques do not account for the real perception or nuisance over the population;
- b) odour pollution is a local problem and it only makes sense to be regulated when it affects the population;
- c) there might be industrial opposition to regulations due to the potential high cost of abatement measures;
- d) there might also be opposition from the public sector related to avoiding having a “stinky” image of the city, which might directly affect tourism revenues and loss of property values;
- e) as explained below, a different governance model for odour pollution has to be defined for each country due to variable competence frameworks.

²⁸ European Standard, (2016), EN 16841-2:2016, Ambient air - Determination of odour in ambient air by using field inspection - Part 2: Plume method. European Committee for Standardization (CEN), TC264 WG27, Brussels.

²⁹ European Environment Agency, (2018). Air quality in Europe – 2018 report No 12/2018. Air quality in Europe -2018 Report (Issue 12/2018) <https://www.eea.europa.eu/publications/air-quality-in-europe-2018>.

³⁰ European Environment Agency (EEA), (2020). Air quality in Europe - 2020 report. In EEA Report (Issue No 09/2020). <https://www.eea.europa.eu/publications/air-quality-in-europe-2020-report>

3.2 The need of a multi-level governance model to tackle odour pollution

Odour pollution has generally a local impact in affected communities and therefore **local regulations are often the most effective management strategy to improve odour issues**. Regulations at national and European levels, nonetheless, are crucial to provide a fundamental framework and are even required to deal with odour issues at the local level in some countries - such as in [Portugal](#)³¹ - where engagement at the national level has been crucial to advance in the local context. **This Green Paper on Odour Pollution advocates for a multi-level governance model in odour pollution deployed through a multi-level engagement strategy(ies)**. This means that each local odour issue is linked to a local, regional, national and European policy context with different approaches in environmental matters, correlated with the global framework in odour pollution. Each local context, therefore, needs to be addressed differently depending on how local, regional and national odour frameworks work in each country - so a **governance model needs to be defined for each country**. This is the way in which the EU Horizon 2020 D-NOSES project implemented its pilot case studies in Europe and beyond³². In Figure 2, the D-NOSES multi-level governance model to tackle odour pollution using multi-level engagement strategies is presented.

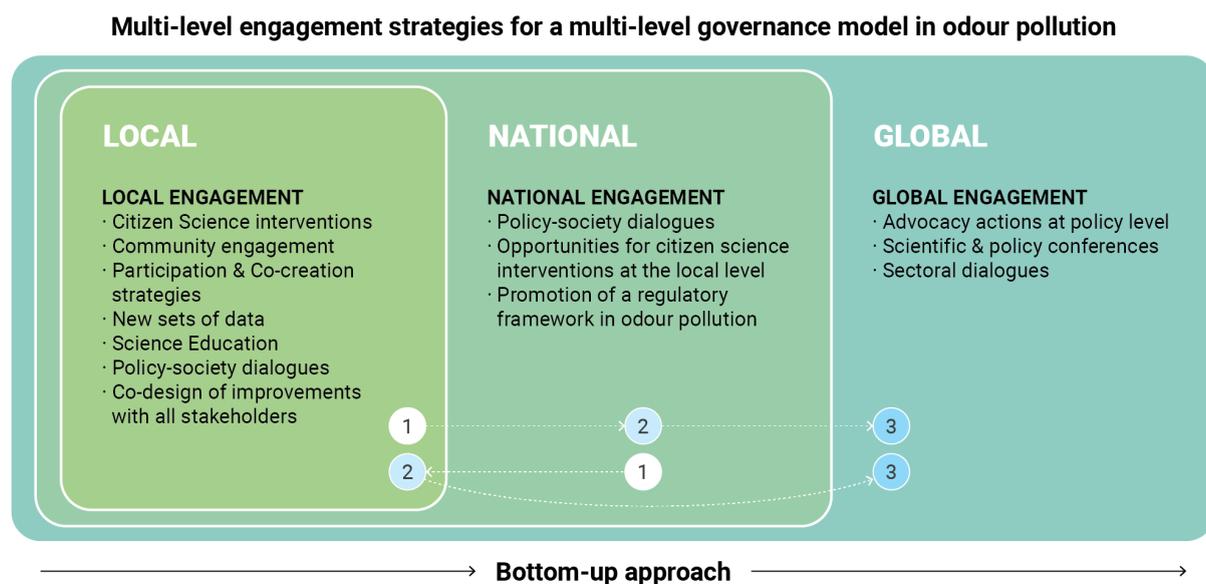


Fig. 2. The multi-level governance model to tackle odour pollution

The EU as a whole and environmental authorities in particular face a complex challenge when developing odour regulations or guidelines and during their implementation. It is absolutely true that there are as many approaches for regulating odour pollution as countries (or noses!), and this lack of clear and harmonized regulations across Europe leaves local authorities, citizens and industries exposed, obliging them to act with barely no guidance or support.

³¹ Diário da República n.º 111/2018, Série I de 2018-06-11 Estabelece o regime da prevenção e controlo das emissões de poluentes para o ar, e transpõe a Diretiva (UE). 2015/2193 <https://dre.pt/application/conteudo/115487878>

³² For more information about the D-NOSES pilot case studies, please visit: <https://odourobservatory.org/case-studies-pilot-updates/>

The **EU Horizon 2020 D-NOSES multi-level engagement model for governance in odour pollution** aims at involving 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 involve **quadruple helix stakeholders** by using a **bottom-up approach** based on the promotion of a **dialogue**³³ among affected stakeholders: from citizens, public institutions and industries to academia. **Citizens**, at the same time co-producers of odours, are **co-responsible** for odour emissions in some cases (e.g. waste and wastewater treatment processes). Their inclusion in local decision-making and management processes enables them to increase their awareness of environmental challenges, change their behaviour and co-create local improvements to increase their quality of life and inform evidence-based regulations for sustainable communities. Through the inclusion of citizens, **industries can improve their relationships with communities**, and **local authorities can increase their transparency, accountability and confidence of the communities in public institutions**³⁴.

3.3 Odours, Principle 10 of the Rio Declaration and the SDGs

Regulations in odour pollution would not only help to reduce the environmental impact of odours, but also contribute to most of the Sustainable Development Goals (SDGs) defined in the United Nations (UN) 2030 Agenda for Sustainable Development³⁵, and to the implementation of the **Principle 10 of the 1992 Rio Declaration**³⁶ by allowing public participation in decision making, access to information and access to justice in odour pollution.

Indeed, Principle 10 features a lot in odour pollution and management. It promotes the idea that **all people should have adequate access to information, be adequately involved in decision making, and have access to an open and fair justice system**. When all three are in place people's ability to have a voice in environmental decisions should be secured.

Within the current context of odour management, there are systemic failings that can prevent Principle 10 from being effective. To start with, odour studies funded by privately owned emitting industries or environmental authorities, generally do not transparently share the results with the public. This essentially blocks people's access to the data that could be used to demonstrate the real problems. Even with this data, **the lack of consistent regulation on environmental odours can also block citizens' and industries' access to legal recourse**.

³³ D-NOSES has deployed a model of **policy-society dialogues** that has been described in two deliverables: D4.2: D-NOSES Consortium (2020), Documentation of Policy-Society Scientific Dialogue 1, D-NOSES, H2020-SwafS-23-2017-789315. Forthcoming - Available at <https://odourobbservatory.org/>.

D4.4: Rufenacht S., Woods T., Salas Seoane N., Arias R., Francis L., Stockwell H., Alonso M., Roniotes A., Abou A., Paz L., Righi V., Valkova K., Bozhankova K., Schleenstein G., Vlachos S., Capelli L., Santos P., Albergaria R. D-NOSES Consortium (2021) Documentation of policy-society dialogues 2, D-NOSES, H2020-SwafS-23-2017-789315. Forthcoming - Available at <https://odourobbservatory.org/>.

³⁴ D-NOSES consortium (2019). Odour Pollution - A growing societal concern. D-NOSES Policy Brief #1. Retrieved from [Policy-Brief -Digital-A4-Europe EN.pdf \(dnoses.eu\)](#)

³⁵ Resolution by the UN General Assembly on September 25, 2015. [United Nations Sustainable Development - 17 Goals to Transform Our World](#).

³⁶ UN Environmental Programme (2016). "UNEP Implementing Principle 10 of the Rio Declaration". [UNEP Implementing Principle 10 of the Rio Declaration](#).

Introducing citizen science for adherence to Principle 10 (and the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters) not only addresses the right to access data, but a right that is perhaps even more basic to sustainable development - the **Citizen's Right to Contribute to Data**³⁷. Inasmuch as a transparent and accountable democracy demands the ability of all to produce understandable, valid data, this cannot only be within the purview of scientists, acting as gatekeepers of what information will be produced and considered in decision making. In applying this approach, citizens do not only have access to environmental information on odour pollution³⁸, but they actively contribute to generating data on matters of concern to them that are negatively impacting their quality of life.

The EU Horizon 2020 D-NOSES coordinator, Ms. Rosa Arias, addressed the *22nd meeting of the Working Group of the Parties to the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters* in 2018³⁹ saying that when concerned citizens wish to contribute to environmental information our duty is to hear them, and we must explore new ways to include the “Right to Contribute to Data” in the Aarhus Convention. In this way, **we would not only enhance policy-society relations, but also strengthen environmental decisions through participatory democracy, as well as the accountability and transparency of our public institutions** - from supranational, to local ones.

In October 2021 an important development that EU Horizon 2020 D-NOSES project can claim to have contributed to (along with many other citizen centered initiatives lobbying to include the missing citizen science approach from the Convention), was the adoption at the 7th Meeting of the Parties to the Aarhus Convention (18-21 October 2021) of a set of **Recommendations on the more effective use of electronic information tools**. There are many recommendations for the use of citizen science (mentioned ten times at least), while the addendum includes relevant definitions, such as citizen science or citizen observatories. Even if not a binding document, it constitutes an instrument of significance to promote citizen science with governments and agencies of the United Nations Economic Commission for Europe (UNECE), including in terms of addressing odour nuisance .

³⁷ For further information on Citizen's Right to Create Data, visit [The role of Principle 10 in the D-NOSES project. | DNOSES](#).

³⁸ Following the [10 Principles of Citizen Science by ECSA](#), citizen generated data should be open, and we cannot forget that it belongs to the citizens producing it. Project data and meta-data are made publicly available and where possible, results are published in an open access format, in compliance with Principle 10 of Rio Declaration.

³⁹ The D-NOSES project presented a Statement at the “22nd Meeting of the Working Group of the Parties to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters” in Geneva on the 19th of June 2018 (See Annex 8.2). The Statement was well received and D-NOSES coordinator, Ms. Rosa Arias, invited the countries to contribute with available information on odour issues, in order to ensure the implementation of Principle 10 in environmental governance on odour pollution, which is an under-regulated issue affecting communities and creating socio-environmental conflicts globally. For further information see Annex 8.2.



Fig. 3. The 17 UN Sustainable Development Goals.

Last but not least, the data generated from citizens through citizen science practices can be used for **SDGs reporting and monitoring**. Through a systematic review⁴⁰ of the metadata and work plans of the 244 SDG indicators, as well as the identification of past and ongoing citizen science initiatives that could directly or indirectly provide data for these indicators, it was concluded that citizen science is already contributing to the monitoring of 5 SDG indicators, and that citizen science “could contribute” to 76 indicators, representing 33% of the total.

⁴⁰ Fraisl, D., Campbell, J., See, L., Arias R. *et al.* Mapping citizen science contributions to the UN sustainable development goals. *Sustain Sci* 15, 1735–1751 (2020). <https://doi.org/10.1007/s11625-020-00833-7>

4. Citizen Science as a Necessary Methodology to tackle Odour Pollution

Regulating odour pollution entails the necessity of complementary methods for odour measurement and odour impact assessment to account for real nuisance.

Odour characterization and measurement are subject to control and regulation in many countries. However, measuring odours is not an effortless issue, since it entails the necessity of objectifying a sensation. In recent decades, several techniques have been studied and developed for the characterization of environmental odours. This chapter provides an overview of traditional methods that are available for measuring odours, thereby focusing on their applicability and limitations and the need for a **paradigm shift towards a more inclusive methodology** with the participation of the receptors of this type of pollution.

4.1 How have odours been traditionally managed?

As mentioned above, odour pollution has repeatedly been ignored in environmental regulations, 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.

Odour measurement methods can be classified into different categories⁴¹, depending on whether:

- a. they are sensorial, i.e. they use the human nose as the receptor, or instrumental;
- b. they can be applied in order to measure odours at the emission level, i.e. at the odour source, or at the receptor level, i.e. directly where the citizens live and complaints come from.

⁴¹ 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](#)

Therefore, it is possible to distinguish⁴²:

1. **sensorial methods applied at the emission level:** this is the most standardised way of measuring odour using the human sense of smell, and it is called olfactometry. The measurement of the odour is related to the sensation caused by the sample directly on a panel of selected people with a standard sense of smell. The outcome of this measurement is the odour concentration of the sample, according to the standard EN13725:2003, expressed in European odour units per cubic meter (ou_E/m^3). This represents the number of times the sample has been diluted with neutral (odourless) air to reach its odour detection threshold concentration. There are other derivations of olfactometry, described in German guidelines VDI 3882-1:1992⁴³ and VDI 3882-2:1994⁴⁴, which describe how to apply olfactometry measurements for the determination of odour intensity and odour pleasantness/ unpleasantness (hedonic tone).
2. **sensorial methods applied at the receptor level:** the reference sensorial method for measuring odours in the field is “field inspection”, which is standardised in Europe by the EN 16841:2016. This method relies on trained assessors, with a standard sense of smell, to evaluate the frequency of perception in the impact area in terms of “odour hours”, based on the recognition of the odour perceived (i.e. the odour type or quality). Citizen science also belongs to this category of methods, although it allows more flexibility being able to map any perceived odour at any location and at any time.
3. **instrumental methods**, which can be applied both to emissions and ambient air. This category includes the chemical analysis to identify and quantify specific odorous chemical compounds in an odour sample. It is an “instrumental analysis” because it investigates odour using instruments. The “electronic nose” is also part of this category, which is a piece of scientific equipment designed to mimic the mammalian olfaction in the detection and characterization of simple or complex odours. Many regulations fix concentration limits of single gases odorants in order to protect workers and citizens from exposure to hazardous or toxic compounds or that can generate annoyance. Although some of the instruments are useful to detect certain odorous molecules that can act as tracers, they are limited to recognize complex mixtures of odours in ambient air and to correlate sensor signals with human perception.

Odour measurement methods belong to the wider category of odour impact assessment methods, which also includes mathematical methods that typically use the outcomes of olfactometric analyses as input to evaluate ambient air odour concentrations and thus the average impact over the population. This is currently the preferred regulatory approach in most countries to evaluate the odour impact on surrounding communities exposed to odour emitting activities; **but the real perception of the affected citizens is not included (yet).**

⁴² Capelli L., Arias R, Uribe-Echevarria J., Sironi S. (2020) Overview of odour measurement methods: the odour observatory as an informative tool for citizen science based approaches to odour management. *Detritus*, Vol. 12; p. 169-175. <https://doi.org/10.31025/2611-4135/2020.14003>.

⁴³ VDI 3882 Part 1: Olfactometry: Determination of Odour Intensity. (1992) Beuth Verlag GmbH, Berlin.

⁴⁴ VDI 3882 Part 2: Olfactometry: Determination of Hedonic Odour Tone. (1994) Beuth Verlag GmbH, Berlin.

These methods are not always useful for evaluating situations with complex odour emitting sources, such as diffuse sources (e.g. landfills, refineries), or several sources with potential interactions between the different types of odours co-existing in the same area. Mitigation of odour pollution is challenging, multifaceted and locally-specific *per se*, and it is often more complex with certain environmental laws, local regulations and socio-economic backgrounds. **The few existing regulations differ from one another, making this global -social and environmental- problem difficult to manage and in dire need of an urgent common framework.** The limitations of the main traditional methods for measuring and managing odour pollution are the following ones:

1. Uncertainty of sampling odour emissions and limitations of dynamic olfactometry

Sampling odours is complex and limited. How to select the correct moment for sampling to be representative of the average emissions? There are many scientific studies that have made it possible to improve sampling methods, but there are still significant differences between them. Sampling from complex sources, such as area sources in landfills⁴⁵ or diffuse emissions, still remains an open issue. The storage time of the samples, which influences potential chemical transformations of the sampled odours, also varies. The German standard VDI3880:2011⁴⁶ limits the samples to be analysed to 6h, while the EN13725:2003 gives an expiration time of 30h⁴⁷. Sampling methods, the representativeness of the samples, the selection of average-sensitivity panellists and the uncertainty associated with olfactometry analysis are factors clearly influencing the estimation of odour emission rates and the reproducibility of results. Recent advances in the design and operation of olfactometers are gradually increasing their accuracy and precision. Olfactometric Interlaboratory Comparison Tests are also fundamental to increase the reliability of results. But in many cases, sampling is not part of the process, and sampling uncertainties such as the presence of chemical compounds that can chemically alter the sample, its effect on the panellists, the diffusion through the bag, potential cross contamination, chemical release from the container, or reactions with high humidity levels that require specific sampling procedures cannot be assessed⁴⁸. This leads to the conclusion that there are still many factors affecting measurement uncertainty.

Besides, dynamic olfactometry presents an **intrinsic limitation when applied to sampling ambient air**, related to the fact that it does not allow to discriminate the background odour from the odour under study⁴⁹, making it impossible to determine the emitting source. We cannot forget that panellists assess the concentration independently of the odour type. In addition, odour concentration in ambient air is usually in the range of the detection limit of the olfactometer, and thus analyses are inconclusive, limiting its application to emission sources.

⁴⁵ Capelli L., Sironi S. (2018). Combination of field inspection and dispersion modelling to estimate odour emissions from an Italian landfill. Atmospheric Environment, 191, 273-290, <https://doi.org/10.1016/j.atmosenv.2018.08.007>

⁴⁶ VDI 3880:2011. Olfactometry - Static sampling (2011). Beuth Verlag GmbH, Berlin.

⁴⁷ Capelli L., Sironi S., Del Rosso R. (2013). Odour sampling: techniques and strategies for the estimation of odor emission rates from different source types. Sensors (Basel). Jan 15;13(1):938-55. DOI: [10.3390/s130100938](https://doi.org/10.3390/s130100938).

⁴⁸ Higuchi T, Masuda J. (2004). Interlaboratory comparison of olfactometry in Japan. Water Sci Technol. 147-52. <https://doi.org/10.2166/wst.2004.0247>

⁴⁹ Bokowa A. (2012). Ambient Odour Assessment Similarities and Differences Between Different Techniques. Chemical Engineering Transactions. 30. 313-318. <https://doi.org/10.3303/CET1230053>

2. Atmospheric dispersion modelling of odour impacts and odour regulations

Most odour regulations all over the world are defined based on the application of dispersion modelling to evaluate the average exposure of affected citizens to odours, using odour emission rates as inputs -obtained through dynamic olfactometry- together with meteorological data, topography, land use and other variables. In some cases, odour regulations fix acceptability standards in terms of the frequency with which a given odour concentration is exceeded. In other cases, odour regulations specify the minimum distance from the closest inhabited area where possible odour-producing industrial or agricultural facilities can be located. In general, different types of models can be used to simulate the dispersion of odours into the atmosphere (Gaussian models, puff models, Lagrangian particle models, Eulerian grid models (3-D models) or fluid dynamic models). The choice of the most adequate model for a given application should be evaluated case by case based on critical factors, such as: low winds (calm conditions), complex terrain, locations of the sources and receptors, source types, available meteorological input for at least one complete year, complexity and variability of the meteorology, computer time requirements, desired accuracy of the results, and expertise of the modeller⁵⁰. Independently from the model used, model validation is fundamental in order to evaluate model reliability, which contributes to the overall uncertainty of the results (i.e. the average odour impact over the affected community).

Currently, reports on studies for validation of odour dispersion models are limited⁵¹. In this way, the possibility of measuring odours in the field is very important, both as a way for directly assessing odour annoyance or for verifying that modelled odour concentrations correspond to the real odour perception by citizens. Likewise, there are still no common criteria to establish impact odour thresholds, and ultimately, to determine the related level of annoyance.

3. Limitations of the continuous monitoring of odour emissions

As explained above, the estimation of the average impact over the population requires the use of dispersion modelling coupled with olfactometry results. Dynamic olfactometry involves punctual sampling at the emission sources and does not allow for continuous monitoring. This limits the understanding of the problem and hinders the representativeness of the samples regarding potential variations in odour emissions associated with the industrial process.

In the case of continuous sensors (electronic noses or chemical sensors), results do not reflect human perception because they do not take into account synergistic and masking effects between different odorants influencing human perception. Additionally, chemical analyses, although reliable and consolidated, are not effective for the characterization of complex odours and are mostly unsuitable for odour assessment⁵². Another limitation is the complexity and high price of most sensory and instrumental techniques used to continuously monitor odour emissions.

⁵⁰ Capelli, L., Sironi, S., Rosso, R.D., & Guillot, J.M. (2013). Measuring odours in the environment vs. dispersion modelling: A review. *Atmospheric Environment*, 79, 731-743 <https://doi.org/10.1016/j.atmosenv.2013.07.029>.

⁵¹ Hayes, Curran, Dodd. (2006). A dispersion modelling approach to determine the odour impact of intensive poultry production units in Ireland. *Bioresour Technol.* DOI: [10.1016/j.biortech.2005.09.019](https://doi.org/10.1016/j.biortech.2005.09.019)

4.2 Is it possible to change the paradigm? Citizen Science to improve odour pollution management

Considering the complexity of measuring odours as explained in the previous section, the D-NOSES project has detected several challenges when it comes to the exercise of monitoring, controlling and, subsequently, regulating odour pollution. Thus, we propose a change of paradigm to monitor odour pollution through citizen science by involving affected citizens, taking advantage of the fact that the human nose is the best sensor to measure odours.

1. Accounting for the annoyance potential of odours

The human perception of odour is inherently subjective, which makes it difficult to accurately assess odour annoyance. Hence, there is not a simple procedure to evaluate actual and future odour annoyance in an objective way. Some aspects that have to be considered in relation to the receptors are the personal connection to the odour emitting industry, the olfactory memories and the psychological state and physical attributes of the person. **Citizen science for the monitoring of odour nuisance can be applied to have a more robust understanding of the annoyance in a community as a whole, and to provide continuous monitoring.** Especially in complex impact situations, the preferable option is the combination of different methodologies for odour assessment. FIDOL factors, i.e. frequency, intensity, duration, hedonic tone and location, can be used to quantify the overall odour nuisance⁵².

2. Implementing solutions to mitigate odour impact

Addressing odour pollution can be expensive for the generating industry, which is usually the one required to implement both good practices and corrective measures to reduce odour impact. These activities should be evaluated and monitored continuously. Therefore, in these cases electronic noses are useful, but present a high cost for their acquisition and maintenance. **Citizen science can also be used to demonstrate the positive effect of the measures uptaken.** In addition, through the correlation of industrial operations and odour emitting processes with citizen odour observations, Odour Management Plans can be defined to reduce the impact over the population, at a reduced cost for the emitting activities.

3. Transparency of the process

The evaluation of the impact of odour pollution over the population is usually a non-transparent, private process involving either the odour emitting industry or the local city council, with no citizen involvement and poor access to data and information. Due to this, it is difficult to access emission data or citizen complaints when nuisance arises, or to better understand the odour problem. **Citizen science can reverse this process by providing access to environmental information and continuous monitoring capabilities to objectivise the impact situation over a community from the receptors' point of view.** Involvement of quadruple helix stakeholders (i.e. the odour emitting activities, the environmental authorities and involved municipalities, the affected community and odour experts) is also crucial to increase transparency and generate dialogues to address the issue.

⁵² Invernizzi M., Capelli L., Sironi S. (2016). Quantification of odour annoyance-nuisance, Chemical Engineering Transactions, 54, 205-210. [DOI: 10.3303/CET1654035](https://doi.org/10.3303/CET1654035).

For all the reasons above, there is a clear need of a new methodology to reverse the way in which odour problems are tackled, and positioning citizens as the driving force for change towards policy outcomes favouring odour regulations. Using citizen science to quantify and evaluate the extent of the odour problems affecting communities will produce new sets of data to account for impact monitoring in real time, complementing the results obtained through traditional methodologies. **The noses of citizens are the best sensors to measure odours.** Olfactory acuity (the ability to smell a certain odour), with 96% of the population having a “normal” sense of smell⁵³ allows communities to record the type of smell perceived, the intensity and the hedonic tone at any time and any point of the map, combine the individual observations of many, and build a clear understanding of the issue. The more citizens are involved in sharing their findings and data, the more robust the result is.

Citizen science as a method represents an excellent tool to collaboratively tackle so called ‘wicked’ odour societal challenges locally and globally⁵⁴ for many reasons. Some of them are: **1)** increasing availability of open and affordable technologies that allow the collection, geotagging and analysis of new large datasets, which take into account the receptor’s perception, as in the case of the App OdourCollect; **2)** citizens’ willingness to collaborate in tackling complex tasks by contributing and sharing knowledge and expertise; **3)** digitally enabled borderless collaborations⁵⁵ and new scales (in range and nature) of collaborators due to technologies like cloud computing; and **4)** increased awareness and co-responsibility about environmental issues and wellbeing, and many more. In addition, UNESCO⁵⁶, the European Environment Agency⁵⁷, national level policy bodies such as the UK Environmental Observation Framework⁵⁸, and the European Commission^{59,60}, have recognised the importance of citizen science for their present activities and future policy directions.

In addition, **Citizen Science is in accordance with Principle 10 of The Rio Declaration**, which states that environmental issues are best addressed with the involvement of participants affected by odour issues in all related actions, regardless of their socio-economic and socio-cultural realities, gender, literacy level, religious affiliation, age, and disabilities, among other attributes.

⁵³ Environment Agency, United Kingdom (2011). H4 Odour Management - how to comply with your environmental permit. IPPC H4 Horizontal Guidance for Odour, Part 1 - Regulation and permitting. Available in: [Environmental permitting: H4 odour management - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/264242/Environmental_permitting_H4_odour_management_-_GOV.UK_(www.gov.uk).pdf).

⁵⁴ 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>

⁵⁵ Prem, Erich & Sanz, Francisco & Lindorfer, Martina & Lampert, D. & Irran, Joerg (2016). *Open Digital Science*. Project: Open Digital Science Study for the European Commission.

⁵⁶ United Nations Educational, Scientific and Cultural Organization (UNESCO), 2013. WSIS+10 Working Papers. Paris, France: UNESCO

⁵⁷ European Environment Agency, 2020. Assessing air quality through citizen science. European Environmental Agency. Retrieved from: [Assessing air quality through citizen science – European Environment Agency \(europa.eu\)](https://www.eea.europa.eu/en/assessing-air-quality-through-citizen-science)

⁵⁸ Scottish Environmental Protection Agency (SEPA). Citizen Science portal. Retrieved from: [Citizen science portal | Scotland's environment web](https://www.sepa.gov.uk/citizen-science).

⁵⁹ Commission staff working document, SWD(2020) 149 final (2020). [Citizen science for environmental monitoring](https://ec.europa.eu/commission/presscorner/detail/en/working_document_sw_d2020149).

⁶⁰ Citizen Science and Citizen Engagement. Achievements in Horizon 2020 and recommendations in the way forward (2020) European Commission. Retrieved from: [ec_rtd_swafs_report-citizen_science.pdf \(europa.eu\)](https://ec.europa.eu/commission/presscorner/detail/en/working_document_sw_d2020149)

The volume of environmental knowledge generated by citizen science initiatives across the EU offers a unique opportunity to help achieve the Green Deal objectives and other EU priorities, and to involve the public in decision making towards participatory democracy. In fact, one of the key objectives of the EU H2020 [D-NOSES project](#) was to place odour pollution in the policy agendas, as well as to support citizens to co-create local solutions together with industries, regional and local authorities, and odour experts - i.e. with the quadruple helix of stakeholders.

Other benefits of citizen science are that it enhances the knowledge base by co-designing evidence-based policies aligned with society and provides timely feedback and proactive approaches. This increases the social relevance of policy measures. It is also one of the most rigorous methodologies for public policy evaluation⁵⁹.

4.3 Benefits to quadruple helix stakeholders when using Citizen Science to monitor odour pollution

The involvement of quadruple helix stakeholders⁶¹ is key for promoting a dialogue towards achieving common agendas to facilitate change. The following classification lists how citizen science helps to overcome odour issues for each of the quadruple helix stakeholder groups:

Citizens and affected communities

- Improve quality of life and the overall air quality of their neighbourhoods
- Contribute to co-creating improvements and actions towards reducing perceived odours - a matter of concern to them
- Increase their level of science education in odour pollution, digital tools and beyond
- Increase their level of co-responsibility regarding waste or wastewater management
- Better understand the processes that generate the odours from which they are suffering, and the actions needed to reduce this impact
- Contribute to creating more sustainable communities, including all social realities and all genders
- Participate in local decision-making processes and eventually in the co-creation of odour management plans or local regulations to control the impact over the population

Odour-emitting activities

- Obtain real-time data from citizens' observations from the receptor's point of view
- Optimise industrial processes and implement good practices, protocols and affordable odour management plans in relation to the collected odour observations
- Improve their relationship with communities and environmental authorities
- Contribute to their corporate social responsibility efforts
- Compare the results of applying the D-NOSES methodology (e.g. observations in OdourCollect within the impact area) with traditional odour studies, potentially reducing the costs of future odour studies

⁶¹ The quadruple helix in the framework of the D-NOSES project is composed by affected citizens, CSO and NGOs; local and environmental authorities; emitting industries and SMEs, odour and citizen science experts.

- Evaluate the effectiveness of odour management plans or abatement measures set in place to reduce the impact over the population

Local policy-makers

- New datasets to inform them about the impact of odour pollution and related nuisance in their municipality, with the collaboration of citizens, to facilitate decision making
- Increase transparency
- Improve relationships with the community and the emitting industries
- Increase trust from the community, demonstrating that their issues are important and addressed by their political leaders
- Set a good example on how to include citizens in local policy-making

Environmental authorities

- Continuous monitoring of odour pollution via new datasets from the receptor's point of view, considering the real impact over the population, to facilitate decision making
- Determination of the most plausible origin of odours and the main contributors
- Improve air quality in communities
- Increase transparency
- Improve the relationship with the community and local authorities
- Increase confidence in public institutions
- Co-design of potential improvements with the communities, the local authorities and the odour-emitting industries to minimise odour impacts over the population

Odour managers

- Put odour pollution on the map, demonstrating its importance
- Obtain valuable data to measure and monitor the impacts of odour pollution
- Validate / compare results of dispersion modelling or field studies to evaluate the impact of odours in affected communities
- Verify the effectiveness of abatement measures already taken
- Propose corrective measures, protocols and odour management plans to reduce the impact over the population based on the real perception of the issue
- Advance state-of-the-art of odour management through gathering real-time odour observations, taking affected communities into account.

Overall, there are substantial benefits for each stakeholder group in co-creating improvements for the reduction of odour impacts in affected communities with the collaboration of affected communities. This was mainly the philosophy behind the EU Horizon 2020 D-NOSES project that can be described as follows: *Co-creation processes, and balancing the interests of quadruple helix stakeholders, can lead to 'win-win', affordable interventions that improve the situation on all sides. Achieving this requires transparency, dialogue, knowledge, tools and guidance - and citizens, through citizen science, should be involved in decision making about their own environment.*

5. The Odour Observatory: The civic right to contribute to environmental information

Also in odour governance, citizens have the right to produce their own data in order to have a place in the policy debate.

Tackling odour pollution and its management involving the quadruple helix model for stakeholder engagement and multi-level engagement strategies for governance in odour pollution, is all about inclusion. Inclusion in the broadest sense is not just about inviting people to the table. It is paramount that when they come to the table they can fully understand and contribute to the discussion. Otherwise, no one is truly represented. **The [Odour Observatory](#) was created to provide useful information about odours for all stakeholders, to begin to level the playing field and increase awareness and knowledge in odour pollution.** The Odour Observatory and the tools therein ([OdourCollect](#), [the Affected Communities Map](#), [the Odour Regulations Map](#), among others) are aligned with Principle 10 of the Rio Declaration in the sense that they support participatory democracy and social cohesion, building trust in the adopted decisions co-created with the citizens, eliminating asymmetries and preventing socio-economic conflicts in communities suffering from odour nuisances. **Access and the right to contribute to odour information is possible through the Odour Observatory.** It is the first odour observatory of its kind, promoting public engagement at all levels and facilitating access to justice in odour pollution by promoting a bottom-up and multi-level governance model.

5.1 The Odour Observatory: access to information, inspiration and engagement.



The Odour Observatory is a web-based platform that includes information on odour issues, regulations, research, data collection methods and potential mitigation measures or solutions. Developed by the EU funded Horizon 2020 D-NOSES project, it has been co-designed to fill the

gap in accessing information in relation to odour pollution for individuals and communities, policy makers and regulators, researchers and industries - with their active participation, using co-creation strategies. All the data that has been collected by OdourCollect and Community Maps is publicly available through the Observatory's website, which was constituted as a community mapping tool, strengthening access to environmental information and public participation in odour pollution for a healthy and sustainable environment, in compliance with Principle 10 of Rio Declaration and the Aarhus Convention. In fact, the Odour Observatory tools go one step further by enabling the right to create data from citizens affected by odour issues through its different tools and interactive capabilities.

Despite being a major source of environmental complaints, very little is known about odour pollution and its extent. By bringing together all the information in one place the Observatory builds a comprehensive picture of how big a concern on odour pollution is and how we can tackle it at a local, regional, national and European level. It presents information in an accessible format, using plain, non-technical language allowing stakeholders to gain a better understanding of odour pollution and its challenging management and regulation.

For further information, please visit: [Odour Observatory | Putting Odour on the Map!](#) and [The Odour Observatory offers information, advice, inspiration and tools. | DNOSES.](#)

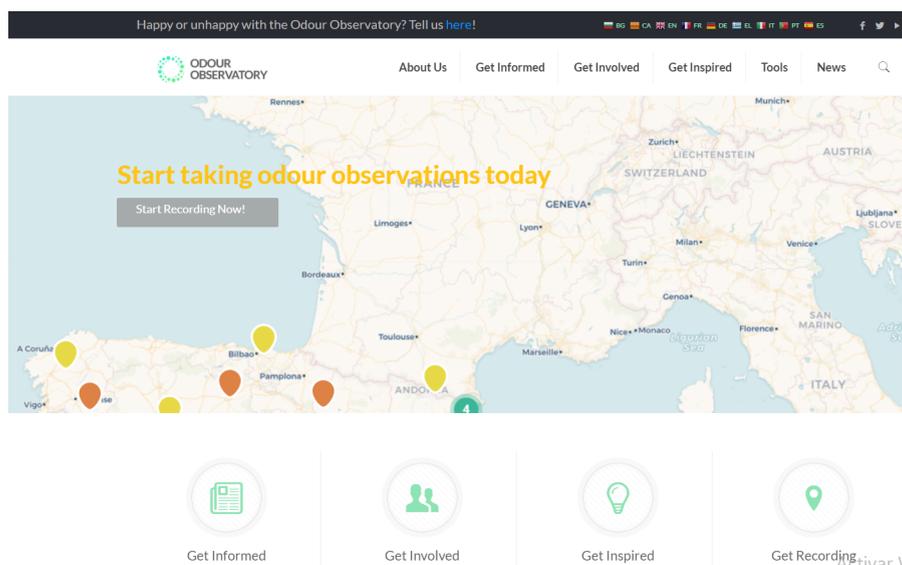


Fig.4. A screenshot of the Odour Observatory webpage

5.2 Co-creating collaborative odour maps: The App OdourCollect



[OdourCollect](#) is a software product that enables the co-creation of collaborative odour maps and facilitates data analysis of odour observations reported by affected communities via a phone app, webapp or manual upload in CSV data format.

It is a free and user-friendly App that collects odour data in real-time and only requires users to identify odours perceived in ambient air (mapping them by type and subtype) and rate their intensity and hedonic tone (is it a pleasant or unpleasant smell?), using the standardised scales from VDI 3882 Part 1 and Part 2. The system automatically geolocalizes the user, associating time and space stamps to each report, which allows a reliable analysis based on the frequency and impacted area of odours from the real perception of the receptor. Because of the real-time component, it is also possible to build in extra validations by trusted experts to ensure the reliability of the data. Transparency is ensured through available open data through the web or the App. OdourCollect's methodology is inspired by the German standard VDI 3940:2006 (current CEN 16841:2016) on field observations, but overcomes its limitations by empowering citizens to map odours at any point in a worldwide map, at the moment they are perceived. Data can be studied, filtered and coupled with meteorological data to assess the plausibility of the potential origin of the perceived odours. Data can also be correlated with industrial processes to identify odour sources and the moments of maximum impact. This allows to co-design corrective measures, protocols and odour management plans with the involved stakeholders that eventually will reduce the odour impact over the affected communities.



Fig.5. The OdourCollect app in action

To access the recorded odour observations and use the App, please visit: [OdourCollect en App Store \(apple.com\)](#), [OdourCollect - Apps on Google Play](#) or <https://odourcollect.eu/>.

For further information, visit:

<https://dnoses.eu/2021/07/07/download-the-free-odour-collect-app-today-and-become-active-in-your-odour-environment/>

6. The way forward: Introducing Odour Pollution in the Policy Agendas

“Current odour impact criteria have been based on considerations from the emission side which were too much monopolized by discussions on aspects of atmospheric modelling rather than actual citizens’ data observed in the real world.”

Ms. Rosa Arias, Chemical Engineer, EU Horizon 2020 D-NOSES Project Coordinator, CEO & Founder of Science for Change

Odour pollution is linked to socio-environmental and health issues in affected communities and therefore needs to be more closely regulated in Europe. **The inclusion of citizens in odour regulation and management processes - who own the local knowledge of the issue and can provide unique sets of new data - is beneficial for all stakeholders, as it promotes scientific education, improves transparency and relationships with emitting activities, and increases confidence in public authorities⁶².** In fact, the interaction between science, society and policy has never been straightforward, and this has been aggravated by the current “fake news” momentum. This crisis is a challenge not only for scientists, media and policymakers, but for the whole of society. For this reason, we all need to learn from former failures and successes in building policy on evidence and answering actual societal needs. As linear thinking cannot be applied to relationships between science, society and policy anymore in the XXI century, the quadruple helix stakeholders are in dire need of new models to develop new thinking(s) and to communicate with each other. This process, of course, requires more openness and real compromise of involvement from all stakeholders, from the design, to the final outcome.

One of the EU Horizon 2020 D-NOSES project main objectives has been to work on the **interface of science, society and policy** to 1) introduce odour pollution in the policy agendas and 2) produce citizen generated data to make informed decisions, allowing citizens to

⁶² D-NOSES consortium (2019) Odour Pollution - A growing societal concern. D-NOSES Policy Brief #1

participate in decision making processes. The project's conclusions and findings, based on the implementation of the multi-level governance model, result from applied participatory and co-creation strategies with quadruple helix stakeholders, citizen science interventions, policy-society dialogues at local, regional and national levels and roundtables with key stakeholders, among others. The advocacy actions of the project have also greatly contributed to a better understanding of the current policy framework situation in the different D-NOSES countries, whereby community actions have acted as promoters of change.

This final section of the *Green Paper on Odour Pollution* puts forth some recommendations towards an improved policy framework for odour pollution in Europe (and beyond) in the medium to long term, inspired also by recent progress at various governance levels. In parallel, the *Strategic Roadmap for Governance in Odour Pollution*⁶³ complements the present document conveying current regulatory frameworks in odour pollution to inform policy-makers about the context and situation in different countries that have been part of the EU Horizon 2020 D-NOSES project. The Green Paper closes with a set of questions as an invitation for further discussion and consultation.

6.1 Recent advances at the national level

In **Portugal**, a high-level policy group was created in 2019 to support the development of a National Law to regulate odour issues. Members of the D-NOSES Advisory Board are among the members of this group from the public and private sectors and together with the contribution of [APEA](#), the Portuguese Association of Environmental Engineers, and other D-NOSES partners, several meetings to present the D-NOSES **multi-level governance model** to monitor odour pollution using citizen science took place between 2019 and 2021 – and in policy roundtables, several stakeholders from the waste and water sectors highlighted the valuable results of the D-NOSES methodology to monitor odour issues. At the moment, **the First draft of a National Law to regulate Odour Issues (2021) is being discussed.**

In **Spain**, to cover for the limitations of currently standardized methodologies at European level (e.g. dynamic olfactometry and field inspections), and account for real time odour observations from the receptors' point of view, the need arose to standardize a citizen science methodology to map and evaluate odour pollution. In light of this, since May 2019 a **Spanish standard to monitor odour pollution through citizen science** is under way. The working group includes consultancies, laboratories, public administrations, industrial managers, owners of odour emitting activities, associations, and citizen associations. The participation of the D-NOSES team has ensured that the concept and basic principles of citizen science are included in the technical standard; the first one that will include “citizen science” in its title. In fact, **the standardization of the methodology is of utmost importance to promote its official uptake by environmental authorities and municipalities at regulatory levels, 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.

⁶³ The D-NOSES Conference in “Odour Management and Citizen Science”: check programme and speakers here: <https://dnoses.eu/news/events/>

Chile's draft of a first national odour emissions regulation covering the swine sector could be a blueprint for further regulations in the fisheries and papermill emitting activities, the next sectors to be regulated in Chile. The odour impact should however be assessed using citizen's participation and the competent authorities have expressed their willingness to test the D-NOSES methodology for providing a tool for municipalities to monitor odour pollution with the participation of local communities. Similarly, **Colombia**, which also has specific odour regulation and standards, is considering the improvement of the procedure for the analysis of odour nuisance through surveys using Apps such as OdourCollect. The OdourCollect App provides **improved effectiveness and efficiency in handling odour complaints and ensures data quality, facilitating its collection and further analysis.**

6.2 Recent advances at the local level

Odour issues directly affect communities at the local level - The strategies followed must therefore be **adapted to each social context within the impacted area following inclusiveness and diversity principles.** Stakeholders from the **quadruple helix model** must be engaged and participate in co-creation workshops to co-design citizen science interventions and contribute to data collection and analysis, and also in science education and odour training activities with the objective of contributing to the creation of **new data sets on real-time odour pollution monitoring** that can inform (in complementarity with traditional odour monitoring methods) local environmental authorities, municipalities and odour emitting activities with reliable citizen generated data to facilitate evidence-based, informed decision making. This will **increase citizens empowerment, promote dialogue, transparency and trust among stakeholders, and lead to co-designed improvements and potential solutions.**

In **Spain**, the creation of a Working Group to work towards a **model municipal ordinance** to guide city councils to regulate odours locally is taking place. To harmonize European regulations, it is crucial to take into account such local regulatory experiences that directly impact the local odour pollution issues affecting communities and the key stakeholders involved, such as local authorities and emitting activities. **It is important to reiterate that the D-NOSES method does not need to replace the current system of odour management, but can enhance it at a reasonable cost.**

When **applying in practice the multi-level governance model on odour pollution**, the following prerequisites and related challenges have to be taken into consideration:

- **Engagement of quadruple helix stakeholders.** Undertaking real stakeholder engagement is a demanding task, as it is time consuming and requires well planned *ad hoc* engagement strategies and diplomacy. It also requires working with interdisciplinary teams and citizen science experts, with expertise in the social sciences, to make the messages and methodologies understandable for communities.
- **Deeper understanding of the wider social context** (socio-political, economic interests, socio-cultural and socio-economic realities of the odour affected communities, potential conflicts of interest, etc.). Again, interdisciplinary teams are key for success.

- **Communication strategies** to overcome barriers such as trust in the citizen science approach (e.g. by local authorities, affected communities or emitting activities). At the same time, issues with data collection tools, data analysis, plausibility and visualization need to be improved to boost uptake of the methodology by public authorities.

6.3 Recent advances at the supranational level

Further steps to harmonize odour regulation frameworks can draw from the significant findings and outcomes produced by the EU Horizon 2020 D-NOSES project, where a series of events covered **the supranational sphere of engagement, promoting policy-society scientific dialogues as well as scientific conferences**, involving citizens, policy-makers and experts (as the NOSE Conference 2018 & 2021⁶⁴), sectorial workshops and roundtables (as the “Citizen Science for Odour Monitoring in Waste and Waste Water Sectors”⁶⁵). Most noteworthy is the **D-NOSES Final Conference “Odour Management and Citizen Science”** with the following sessions: “D-NOSES project at a glance!” (October 14th 2021); “D-NOSES methodology and results to tackle odour pollution using citizen science” (October 18th 2021) and “Introducing odour pollution in the policy agendas” (October 20th 2021). An **event at the European Parliament has been organized entitled “Revisiting Odour Pollution in Europe”**⁶⁶ (October 28th, 2021) **hosted by MEP Maria Spyralis**, Co-chair of the European Parliament Intergroup on ‘Climate Change, Biodiversity and Sustainable Development’, where a common European regulatory framework and community regulations will be encouraged to act as promoters of change to protect communities affected by odour pollution all throughout Europe.

6.4 Towards an improved policy framework for odour pollution. The way towards the White Paper.

Environmental odours are widespread yet localized, complex and multidimensional and this *Green Paper* has shown that there is a **lack of a proper, unified response to this problem in Europe**. To fill this gap, citizen science and policy-society dialogues become crucial to better tackle odour pollution challenges and more specifically, a **multi-level approach** that encompasses the different views and needs of the **quadruple helix stakeholders**, empowers citizens to participate in decisions made about their environment, and supports policy-makers and odour emitting activities to make informed decisions and better manage odour pollution.

Driven by the European Green Deal, and in light of the recent adoption by the 7th Meeting of the Parties to the Aarhus Convention of the draft updated recommendations on the more effective use of electronic information tools (submitted by the Chair of the Task Force on Access to Information in October 2021), monitoring of odour issues (Odour Management Plans within Environmental Management Systems) using also citizen science **should be introduced in relevant EU legislation and guidelines including in BATs and BREFs**. Combined with a multi-level engagement strategy for multi-level governance in odour pollution, the

⁶⁴ NOSE Conference 2021, in which a panel dedicated to the D-NOSES methodology was conveyed:
<https://www.aidic.it/nose2020/>

⁶⁵ “Citizen Science for Odour Monitoring in Waste and Waste Water Sectors”:
<https://dnoses.eu/2021/04/19/international-webinar-citizen-science-for-odour-monitoring-in-the-waste-and-water-sectors/>

⁶⁶ Event at the European Parliament “Revisiting Odour Pollution in Europe”:
<https://ebcd.org/events/online-event-revisiting-odour-pollution-in-europe/>

approach may enable Europe to successfully manage its odour pollution problems (and perhaps also other unregulated problems, as the proposed methodology is highly replicable).

This *Green Paper on Odour Pollution* genuinely wishes to prompt a constructive discussion on a **harmonized odour policy given that it has not been given the priority it deserves**. A set of questions are provided below for future open and inclusive consultations with all stakeholders linked to the odour pollution challenge, so as to eventually reach the endorsement of a future White Paper on odour pollution.

Take-Home Questions for a policy debate and future White Paper

- 1) Can odour pollution be appropriately dealt with in the existing EU legislative frameworks for Air Quality or Industrial Emissions, or does the existing legislation need to be adapted?
- 2) How can measures to promote better odour management best be designed so as to ensure positive impacts for societal and competitiveness enhancement?
- 3) What measures would be appropriate to promote odour management plans? Would a regulation that includes odour limits from the receptor point of view be a proportionate solution or would a tax burden be sufficient?
- 4) Would further voluntary action(s), particularly from odour emitters, be a suitable instrument for achieving better resource use in odour management plans?
- 5) What type of information would be considered necessary to empower affected communities, and citizens in general, to make a direct contribution to odour pollution management and regulation?
- 6) Which changes to the emitter industries of odour pollution could improve their responsibility and accountability on this matter?
- 7) How could information on odour pollution be made further available to all stakeholders?
- 8) How can challenges arising from the varying odour regulatory frameworks at different governance levels be best addressed?
- 9) Could new rules on eco-design(s) be of help in reducing odour pollution? Or are they perhaps aggravating the current situation?
- 10) Should market based instruments be introduced in order to accurately reflect environmental odour pollution costs to final products?
- 11) What actions, other than those described in this Green Paper, could be envisaged to reduce odour pollution in Europe?
- 12) Should the EU attach a higher priority to odour pollution within existing frameworks so as to reduce disparities in Member States' relevant legislation?
- 13) How could the EU promote more effectively international action(s) to improve odour pollution management worldwide and recognition of odour as a pollutant?

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8. Annex

8.1. Acknowledgements and project participants

The EU Horizon 2020 D-NOSES project 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. Without their contribution this Green Paper on Odour Pollution would not have existed.

8.2. D-NOSES Statement presented during the Aarhus Convention meeting celebrated in Geneva in 2018

22nd Meeting of the Working Group of the Parties to the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters

Geneva, 19th June 2018 (10-13h)

Intervention up to 5 minutes from the floor within the General Segment; Item 3-Substantive issues; (a) Thematic session on Access to information; (f) Dissemination of real time, up to date, accurate and functional environmental information in forms and formats meeting the needs of different users.

STATEMENT by Rosa Arias (D-NOSES Project Coordinator, Ibercivis, Spain)

Thank you, Chair, for this opportunity to present information about the D-NOSES project to the Parties and stakeholders. My name is Rosa Arias, and I am joined by my colleagues Nora Salas and Professor Stephen Stec, who is one of the members of our Advisory Board.

D-NOSES (Distributed Network for Odour Sensing, Empowerment and Sustainability, <http://D-NOSES.eu/>) is a European Union's Horizon 2020 project that started in April 2018 and will last for three years, with a 3,1M budget and a total of 15 partners from 9 countries (**Spain, UK, Portugal, Greece, Germany, Austria, Bulgaria, Italy and Chile**). It is coordinated by the Ibercivis Foundation in Spain, the main authors of the European White Paper on Citizen Science. D-NOSES will implement **Principle 10** to provide access to information, public participation and access to justice for sustainability and governance in **odour pollution**, an under-regulated environmental issue that accounts as the second cause of environmental complaints after noise at a global level.

Yet, odour pollution has repeatedly been **ignored in environmental regulations** leaving citizens defenceless. Due to the lack of regulation, situated technical studies are rarely conducted and data and statistics on odour pollution are scarce or difficult to access.

Frequent odour pollution in populated areas can cause nuisance, headache, stress, anxiety or respiratory problems. It can also be related to other health and sanitary issues.

Odour pollution also acts as a sign of alert of larger environmental issues, such as poor waste management, polluted water, inadequate industrial management or illegal dumping, amongst others.

In addition, one of the main odorants (methane, CH₄) is a powerful greenhouse gas (GHG) mainly produced in landfills and livestock facilities (a sector that accounts for the 25% of the total GHGs emissions, according to Intergovernmental Panel on Climate Change, IPCC). Reducing odour emissions will increase global sustainability and contribute to the fight against **climate change**.

How will the project ensure public participation? D-NOSES works with a quadruple helix approach to involve all relevant stakeholders (society, academia, industry and policy makers) that will be applied at **local, national and global levels**. We will use co-creation, participatory and engagement strategies at all levels and provide citizen science tools for generating odour data and ensure a high level of engagement across at least six European countries (Spain, Italy, Portugal, Greece, UK and Bulgaria) and Chile, plus 4 extra countries to be determined. To reinforce the project's international dimension, we encourage other countries to engage with our **10 citizen science interventions**.

How will the project provide access to information? Citizens participating in the project will not only have access to information, but will become **data generators** thanks to citizen science. We all have the best sensor to measure odours, our own nose, and we have created a simple App, **OdourCollect**, to co-create collaborative odour maps and identify conflicted areas. This will allow, for the first time, to gather **real time data** to tackle odour pollution in collaboration with the emitting industries and the relevant environmental authorities. **Accuracy** of the generated data will be guaranteed by odour experts to verify the origin of each observation and co-design local solutions. All data will be open and freely available (<https://odourcollect.societize.eu/#!/>). We will also create the **International Odour Observatory** to gather and make available all information in relation to odours, such as the regulatory framework, odour emitting industries and any other data of interest. The odour observatory will be available by the end of 2018.

How will the project provide access to justice? The ultimate goal of D-NOSES is to introduce odour pollution in the policy agendas. Results from the ten citizen science interventions could generate community-based regulations that will follow the recommendations of the European White Paper on Governance (http://europa.eu/rapid/press-release_DOC-01-10_en.htm). Advocacy actions, together with the project results, will produce **DIY Guidelines for project replicability, scientific standards and guidelines for policy making** and **The Green Paper on Odour Pollution** by 2021. A '**Strategic Roadmap on Odour Pollution**' will pave the way for bottom-up, multi-level governance for increased sustainability in the medium to long term. D-NOSES also considers the six dimensions of **Responsible Research and Innovation (RRI)**, which include access to information, public engagement, ethics, science education, gender and governance.

D-NOSES will also contribute to the **UN 2030 Agenda for Sustainable Development** as it is aligned with several **Sustainable Development Goals** within the **Environmental, Social, Economic and Cross-cutting Dimensions**, especially SDG3 (Good health and well-being), SDG13 (climate action), SDG15 (Life on land), SDG6 (Clean water and sanitation), SDG16 (Peace, justice and strong institutions) and SDG5 (Gender equality).

To conclude, D-NOSES aims to engage European countries at a high political level to pave the way for the creation of the **first European Regulatory Framework in Odour Pollution**. In December 2016, **Poland** encouraged the European Council to start working on an appropriate legislative proposal.

We welcome countries interested in contributing to odour pollution advancements to engage with D-NOSES and contribute to the implementation of Principle 10 with their particular cases studies. Please contact me for more information at the e-mail rarias@bifi.es. I will also be available during the networking breaks. You can get one project brochure and engage. Thank you.