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Implementation of Integrated Nuisances Action Plan

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In everyday life people are simultaneously exposed to several annoying sources (sounds, vibrations and odours), which emerge from background of considerable variability of land uses, infrastructures, residential patterns, topography, meteorology condition, and standards quality of life. The European Union has provided in recent years (and is going to update) several tools to harmonize noise mapping methodologies and relative Noise Action Plans through directives and guidelines. Unfortunately the same efforts have not been put in the harmonization of approaches in other annoying sources like odours. As a consequence, each European Member State at national or even at local level defined its own direct or indirect approach to limit odour impacts, usually considerably different one from the others. The most common approach to deal with noise impact at a policy, economic and strategy level is the use of priority indices focused to highlight areas more sensitive and where mitigation actions will be more advisable or urgent. Locations that for their specific land use are more sensitive to noise impacts (e.g. residential areas) are generally also sensitive to odour impacts. According these, the aim of the present research is to provide a brief review of the most used European strategies in noise action plans end try to extend their approaches for the definition of a nuisance action plan, able to control both odour and noise. Paper present a possible implementation of integrated nuisances action plan in the municipality of Palma Campania (Campania Region, Italy). The analysis underlines that is possible define, under the same set of nuisance indicators, the degree of sensitivity of areas according to population, land uses, levels of exposures and/or distance from the annoying sources. Nuisance acceptability levels are then definable according to the sensitivity degree of the locations. Factors related to vibrations and visual perception of the landscape can further contribute to control total sensorial annoyance in the land planning.

1. Introduction

Odour and noise affect the quality of life, many economic activities and land uses emit levels of odour and/or noise to the atmosphere that have the potential to compromise the liveability at the local or regional scale. Often in developed cities can be a real nuisance for communities and residents, especially those who are downwind from a particulars plants and/or activities (composting facility, wastewater treatment plant, fast food, restaurant, traffic, animals, solid waste management, etc). Complaints resulting from the impacts of such emissions are common (Belgiorno et al., 2013 and Zarra et al., 2013) and the task of ensuring that development proposals are compatible with neighbouring landuses is an important and often contentious responsibility for regulatory authorities (zarra et al 2010). Complaints often bring legal problems and in some cases can even lead to suspension of operations or even closure of the facility.

There are different definitions of both noise annoyance and odour annoyance, but the most common view of both is that they are indicators of nuisance, disturbance or disruption to intended or actual activities (Griffiths, 2014 and Guski et al., 1999).

Place and environmental context refers to the unique combination of physical characteristics that influence exposure along with sociocultural characteristics that may influence environmental perceptions in different communities. Understanding how the physical environment influences cumulative exposures can aid environmental management to reduce health risks.

In recent years the European Union has provided (and is going to update) several tools to harmonize noise strategies in urban planning through directives and guidelines. Unfortunately the same efforts have not been put in the harmonization of approaches in the standardization of other annoying sources like odours that actively participates to total nuisances of residents. As a consequence, each European Member State at

national or even at local level defined its own direct or indirect approach to limit and manage odour impacts, usually considerably different one from the others.
The most common approach to deal with noise impact is the use of priority indices focused to highlight areas more sensitive to annoying sources and where mitigation actions will be more advisable or urgent. Locations that for their specific land use are more sensitive to noise impacts (e.g. residential areas) are generally also sensitive to odour impacts. According these, the aim of the present research is to provide a brief review of the most used European strategies in noise action plans end try to extend their approaches for the definition of a nuisance action plan, able to control both odour and noise.

2. Noise control strategies

In 2002 the European Union issued the fundamental tool to tackle noise issues with a common approach between all the Member States: the European Directive 2002/49/CE, also called the END (Environmental Noise Directive) (European Union, 2002). The goal of this legislative instrument is "to define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to exposure to environmental noise". To this extent several actions are needed by each Member State: (i) evaluation of the population exposed to high levels of noise (not considering military activities, neighbourhood or occupational noise) by means of noise mapping activities; (ii) a proper information and communication campaign to increase the awareness of citizens and all the involved stakeholders about noise related effects; (iii) definition of common strategies to solve or mitigate noise problems and protect quiet areas; (iv) concerning noise mapping, the European Commission has decided to harmonise the methodologies that the Member States need to adopt by introducing CNOSSOS-EU (Common Noise aSSessment MethOdS) (Kephalopoulos et al., 2014). This common method should be fully operational for the next round of EU strategic noise mapping in 2017. In the international literature we can classify: (i) indices focus on the sound pressure level; (ii) indices on the land use (e.g. highest values are reached if schools or hospitals are included in the area); (iii) indices on the number of annoyed people and so on.

3. Material and methods

3.1 Case Study

The proposed methodology has been tested on the municipality of Palma Campania, a town of about 15,000 inhabitants in the County of Naples, that has the maximum extension of about 20 km. The application was made on the basis of geographic information system built for the development of the urban plan.
This activity was carried out as part of the agreement between the Municipality of Palma Campania and the Department of Civil Engineering of the University of Salerno.

3.2 Methodology

Different definitions, guideline and laws about both noise and odour underline that have the same receptors that could be subjected to nuisance, disturbance disruption. In other words odours and noises imply environmental pressures that could cause nuisance to people and ecosystems. The proposition of a Nuisance Action Plan, as an extension of the current and well regulated the Noise Action Plan, can provide a complete framework to manage environmental odours and noises and control they annoying effects. It also aims to protect quiet and healthy areas in agglomerations (large urban areas) where the quality is good. Proposed framework for the definition of the Nuisance Action Plan is reported in Figure 1 and includes the following steps:

(i) Assessment of the Degree of Land Sensitivity to Nuisances (S). S degree is calculated for each homogeneous area of the territory and represents its tolerance to nuisance pressures (odour and noise). S degree is function of both urban and environmental ecosystems (UEE) and of actual and future uses of the land according to the overall framework of planning (PP).
(ii) Evaluation of Nuisance Exposure Level (EL) of receptors (e.g. population) in each homogeneous area of the territory. This step is implemented downstream of monitoring of noise and odour levels representative of the area.
(iii) Definition of Nuisances Standard Limits (SL) for each homogeneous area of the territory according to National and Local laws;
(iv) Estimation of the Potential Nuisance Impacts (PNI) according for each homogeneous area of the territory according to S, EL and SL.
(v) Definitions of common strategies to solve or mitigate nuisances impacts and protect quiet and healthy areas according to the potential PNI.

Degree of Land Sensitivity to Nuisances (S) is function of the Urban and Environmental Ecosystems (UEE) according to the following indicators (Table 1).

Table 1: Criteria and indicators for the assessment of the degree of Land Sensitivity to Nuisances (S)

Criteria		Indicator	Class	Score
Strategic level (L)	LU	Land use destination or class of locations	Residential	30
			City Centre	20
			Commercial	15
			Agricultural	10
			Industrial	5
Abundance of Receptors (R)	Rc	Number of citizens	High	30
			Medium	20
			Low	10
	Rb	Sensitive building (*schools, hospitals, Cemetery, etc.*)	Presence	10
			Absence	0
	Re	Sensitive environmental location (*preserved area, National or regional park, protected ecosystem, etc.*)	Presence	10
			Absence	0
Environmental Pressures (P)	Pn	Noise impacting sources	Presence of relevant sources (*Airport, Rail, Highways, Industry, et similar*)	0
			Absence of relevant sources	10
	Po	Odour impacting sources	Presence of relevant sources (*Wastewater Treatment Plant, Landfill, Industry, et similar*)	0
			Absence of relevant sources	10

Degree of Land Sensitivity to Nuisances (S) will be expressed in percentages according to the following equation:

$$S = (LU + Rc + Rb + Re + Pn + Po) \quad (1)$$

Each indicator assumes in relation of its class a score according to the assessment matrix reported in the Table 1. To take into account the overall framework of planning (PP), the degree of Land Sensitivity to Nuisances is calculated in current scenario (t_0) and compared with the planned scenario (t_p).
The analysis was made under GIS environment (software Qgis 2.8) using a geodatabase built in the drafting of the quoted municipal development plan. This system is based on a cartographic support of the vector type to the scale 1:2000 made by an aerial digital survey (WGS84).

4. Results and discussion

It has been associated with a database containing information about, land use. As described in the methodology, the degree of Land Sensitivity to Nuisances is calculated as the difference of the index S between the planned and current scenarios (ΔS_{tp-t0}).The spatialization of the obtained values, identifies a scale of intensity of the phenomenon, for the homogeneous zone.

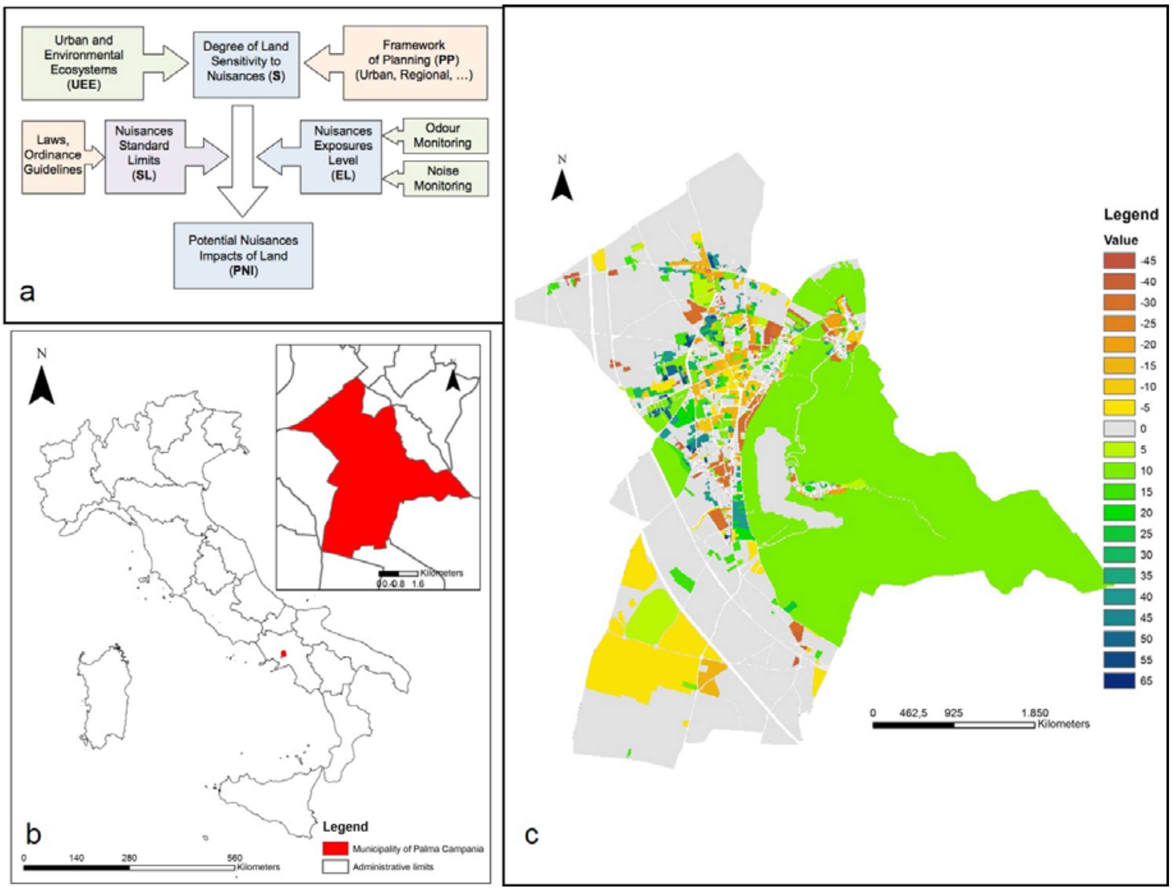

Figure 1: a) Framework for the definition of the Nuisance Action Plan; b)Geographic location of the study area, Palma Campania, southern Italy; c) Factor map representative of the spatial distribution difference ($\Delta S_{tp\text{-}t0}$).

The set of values obtained varies from [+65, -45]. The effect of the new plan produces an increase in the S value on 860 hectares, while a decrease of 200 hectares on the entire municipal area. The remaining area, instead, keeps unchanged the level of Land Sensitivity to Nuisances (Table 2 and Table 3).

Table 2: Descriptive results: difference of the index R and P between the planned and current scenarios.

Land use	ΔR (t_p-t_0)				ΔP(t_p-t_0)			
destination	min	max	mean	S.D.	min	max	mean	S.D.
City centre	20	45	8,39	8,54	0	20	1,36	4,86
Residential expansions	0	20	-11,78	8,80	0	20	1,08	4,17
Industrial expansions	0	0	0	0	-20	10	-4	8,28
agricultural	10	25	-11,16	8,96	0	20	1,80	5,67

The S Index decrease is due mainly to the conversion of agricultural lands to zones of residential and productive development. In particular, the maximum values of the decrease are due to the strategic level (LU) and to the number of citizens (Rc) in correspondence of the conversion to residential areas.

The increase of the degree of sensitivity is due, from one side, to the combination of the strategic level with the abundance level of the Rc and Re receptors, and on the other side, to the reduction of the component environmental pressure (Pn; Po).

Specifically, with regard to city centre destination, the analysis of the distribution of the variation index of Abundance receptors (ΔR), shows how its influence affect just on increasing of the index S. The most of the levels of pressure on the environment are equal to zero, however, in some situations, is it possible to register a growth of this ones. This increase of the sensitivity due to the functional reconversion of intended use of the soil, is also defined by the variation of the LU index, that presents some negative differences when the conversions of the soil use are mainly towards a residential and commercial areas.

Table 3: Descriptive results: difference of the index L and S between the planned and current scenarios

Land use	$\Delta L(t_p\text{-}t_0)$				$\Delta S(t_p\text{-}t_0)$			
destination	min	max	mean	S.D.	min	max	mean	S.D.
City centre	-15	25	8,91	11,31	-20	65	18,65	30,1
Residential expansions	0	25	9,49	10,38	-5	20	-5	13,7
Industrial expansions	-5	0	-4,33	1,75	-30	0	-11,66	16,1
agricultural	-20	-20	-8,01	10,3	-45	25	-24,23	20

The planned scenario provides the new residential expansions, confirming the expansion's areas of the previous planning instrument, that haven't been implemented yet, but changing the parameters of transformation and the settlement's loads.
For the new residential expansion areas it is possible to observe a decrease of the R index, due a reduction of the settlement's load in terms of new inhabitants to be placed.
With regard to the environmental pressures, the variation requires only positive values, thus underlining the sustainability of new residential expansions. Instead, the decrease of the LU index is due to the functional mixitè foreseen for such areas
The industrial expansions, defined by the new plan, will lead inevitably to an increase of the components of the environmental pressure. However, the choices of settlement respond to the socio-economic requirements that justify the prediction of the new plan.
For the agricultural area, it is possible to observe both, negative and positive values of R. The negative values are due to the Rc parameter that is reduced in correspondence of old predictions of the previous plan, that haven't been implemented. The positive values, instead, are related to the increase of Re parameter, due the localization of the ecosystem protection areas and of the preserved areas.
In brief, the results show that the new plan affects effectively on the reduction of the pressures, by combining the minimization strategy of the impacts with the socio-economic development strategy required for the area.

5. Conclusion

Noise Action Plan is well defined Europe and in literature there are several tolls for its sustainable implementation. In contrast odour emissions that often cause significative and negative impacts don't have a defined legislation. On other way noise annoyance and odour annoyance have the same target receptors and that could be managed under the same Action Plan. The framework of a Nuisance Action Plan was proposed as prosecutable solution based on the degree of land sensitivity to nuisances. Nuisance acceptability levels are then definable according to the sensitivity of the locations.
For the estimation of Potential Nuisance Impacts (PNI) is necessary define Nuisances Standard Limits (SL). If noise limits are easily to identify according to the National standards and laws, in contrast, odour acceptability levels are not universally defined and regulations are generally still lacking. On this point several studies are trying to standardize odour impact limits and European Union is ready for a standardization, then the definition of Nuisances Standard Limits (SL) will be immediate. Factors related to vibrations and visual perception of the landscape can further contribute to control total sensorial annoyance in the land planning.

Reference

Belgiorno, V., V. Naddeo, and T. Zarra (2013), Odour Impact Assessment Handbook, Wiley. ISBN: 978-1-119-96928-0

de Ruiter, E.P.J., (2009), A tool for environmental noise control in urban planning: the Population Annoyance Index. Proceeding of NAG/DAGA Conference, Rotterdam.

Griffiths, K.D. (2014), Disentangling the Frequency and Intensity Dimensions of Nuisance Odour, and Implications for Jurisdictional Odour Impact Criteria. Atmospheric Environment 90. Scopus: 125–132.

Guski, R., U. Felscher-Suhr, and R. Schuemer (1999), The Concept of Noise Annoyance: How International Experts See It. Journal of Sound and Vibration 223(4). Scopus: 513–527.

Kephalopoulos, S., Paviotti, M., Anfosso-Lédée, F., Van Maercke, D., Shilton, S., Jones, N., (2014), Advances in the development of common noise assessment methods in Europe: the CNOSSOS-EU framework for strategic environmental noise mapping. Sci. Total Environ. 482–483, 400–410.

Naddeo, V., Zarra, T., Giuliani, S., & Belgiorno, V. (2012). Odour Impact Assessment in Industrial Areas. Chemical Engineering Transactions, 30(i), 85–90.

Viccione, G., Zarra, T., Giuliani, S., Naddeo, V., Belgiorno, V. (2012). Performance study of e-nose measurement chamber for environmental odour monitoring. Chemical Engineering Transactions, 30, pp. 109-114.

Zarra, T., V. Naddeo, V. Belgiorno, M. Reiser, and M. Kranert (2009), Instrumental Characterization of Odour: A Combination of Olfactory and Analytical Methods, vol.59. Water Science and Technology.

Zarra, T., Naddeo, V., Giuliani, S., Belgiorno, V. (2010) Optimization of field inspection method for odour impact assessment. Chemical Engineering Transactions, 23, pp. 93-98.

Zarra, T., Reiser, M., Naddeo, V., Belgiorno, V., Kranert, M. (2014). Odour emissions characterization from wastewater treatment plants by different measurement methods. Chemical Engineering Transactions, 40, pp. 37-42.