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## Noise as Environmental Nuisance of the Seaport Activity

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**Abstract:**

**Purpose:** The aim of this article is to present noise as a serious threat to the environment, as well as to identify the obligations of EU Member States in the field of noise management and to attempt to present the specificity of the legal approach to determining and assessing noise levels in seaports using Poland as an example.

**Design/Methodology/Approach:** A few research methods were applied: literature review, legal regulations analysis and case study.

**Findings:** The legal regulations in force in the European Union have a strong influence on the management of seaports, which among other things is the result of demands to reduce noise generated by various forms of activities, and mainly transport and industrial ones, carried out at port areas.

**Practical implications:** A key factor stimulating noise reduction in the EU's seaports is legal and regulatory mechanism. The vast majority of European seaports comply with standards and legal regulations, resulting from the obligations of coastal states, arising from the EU membership.

**Originality value:** This research is attempted to determine the specifics of seaport management system in connection with the need to take into account the standards and legal regulations in this area.

**Keywords:** Traffic noise, measuring of noise emission, monitoring and assessing of port noise.

**JEL classification:** M48, O13.

**Paper type:** Review article, case study.

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## **1. Introduction**

Care of and concern for the quality of the surrounding environment, as well as the inhabitants' life, has definitely increased over the last several years (Irvine *et al.*, 2009; Fredianelli *et al.*, 2020). At present, these are the main priorities over the strategy for sustainable and smart economic and social development implemented not only in the EU countries, but also on a global scale (Wendling *et al.*, 2020; The European Green Deal, 2019).

Among many types of nuisances that accompany several types of broad human activity and forms of economic activity, including e.g., greenhouse gas emissions and deteriorating air quality, noise has also been identified as one of the most disturbing environmental nuisances (Ouis, 2002; Dratva *et al.*, 2012).

Noise pollution in Europe is regarded as the major environmental health concern. It is caused by noise coming from numerous sources, e.g., industry, growing transport activity etc., and is widely present not only in the busiest urban environments but increasingly in once natural environments. The adverse effects on those exposed to noise pollution include threats to the well-being of human population, the children's decreased ability to learn properly at school, and the resulting high economic price the society must pay, as well as the deteriorating health and distribution of wildlife on land and in the sea (WHO, 2018).

As a result, the World Health Organization (WHO) has classified traffic noise, including road, rail and air traffic, as the second most important cause of ill health in Western Europe, behind only air pollution caused by very fine particulate matter (WHO and JRC, 2011).

The prolonged exposure to environmental noise can lead to negative cardiovascular and metabolic effects, reduced cognitive performance in children as well as severe annoyance and sleep disturbance (Hänninen, 2014). Long-term exposure to environmental noise is estimated to cause 12.000 premature deaths and contribute to 48.000 new cases of ischemic heart disease per year in Europe. It is estimated that 22 million people suffer from chronic high annoyance and 6.5 million people from chronic high sleep disturbance (WHO and JRC, 2011; Hänninen, 2014).

As a result of aircraft noise, 12 500 schoolchildren are estimated to suffer from learning impairment at school. For this reason, in the environmental management strategies currently developed and the environmental management models introduced by organizations, noise is becoming a complicated issue that requires not only constant monitoring, which has been the case in the EU for several years, but also rapid implementation of solutions necessary to reduce the level of its emissions - especially in large agglomerations (European Environment Agency, 2021; Directive 2002/49/EC Of the European Parliament, 2021; and EEA, 2021).

## **2. Regulatory Requirements**

Effective actions to reduce noise and its effects for the environment, society and economy requires not only a precise, unambiguous terminology used in this area of research and the indication of adequate analytical methods, but also, at this stage of fighting against noise, coordinated measures applied by Member States and the EU, regarding the assessment of the existing state in this respect, as well as the indication of appropriate forms and methods for managing the environmental noise.

Such actions are authorized in the EU countries by the Environmental Noise Directive of 2002 (END, 2002/49/EC), which is the main instrument used to determine the noise pollution levels and take the necessary measures to reduce it. However, it was only 16 years after the adoption of this directive that the European Commission (EC) developed and adopted its own directive (Commission Directive 2015/996), establishing common, country-wide methods for assessing noise exposure levels which have been in force since 2018 (Commission Directive (EU) 2015/996, 2015).

Directive 2002/49/EC (Article 3(a) defined the environmental noise as unwanted or harmful outdoor sound created by human activities. Therefore, the adopted definition excluded from the monitoring area such types of noise as those caused by a person exposed to its effects and by neighbours, as well as those related to the performance of household activities and noise in the workplace. Moreover, noise arising inside the means of transport and noise arising from military activities in military areas are excluded (EEA, 2021; Noise pollution, EEA, 2024). In implementing the END/2002/49, the EC has been supported by the Noise Regulatory Committee (NRC) and the Noise Expert Group (NEG), as well as the European Environment Agency (EEA).

The END requires all Member States to prepare and publish, every 5 years, noise maps and noise management action plans for:

- agglomerations with more than 100 000 inhabitants,
- major roads (more than 3 million vehicles a year),
- major railways (more than 30 000 trains a year),
- major airports (more than 50 000 movements a year, including small aircrafts and helicopters) (Noise pollution, EEA, 2024).

According to Article 7 of the END, 'agglomeration' shall mean part of a territory, delimited by the Member State, having a population in excess of 100 000 persons and a population density such that the Member State considers it to be an urbanised area (Commission Directive (EU) 2015/996, 2015). Gdynia, as the seaport agglomeration, fully meets all these conditions.

The obligation of Member States to determine the public exposure to the environmental noise through noise mapping and the use of noise assessment methods common to all Member States, together with ensuring that the public has access to information on the environmental noise and its effects, also imposes on Member States the obligation to develop and adopt the action plan, based on data obtained from noise mapping (EEA, 2024; Directive 2002/49/EC, 2002). The action plan main objectives include:

- preventing the environmental noise and reducing its level where necessary, i.e., where the noise may cause harmful effects on health,
- preserving the quality of acoustic environmental climate where it is still appropriate.

Member States' noise maps and action plans can also be consulted in the European Environment Agency's ReportNet system. However, the END directive neither determines the limit or target values nor recommends measures to be included in action plans, thus leaving these issues to the competent authorities in Member States (EEA, 2024)

Noise emission, regardless of where it occurs, generates high external costs. This is confirmed by numerous studies conducted so far (including the epidemiological ones) and the WHO as well as the EU documents, clearly qualifying this nuisance for the group of particularly sensitive parameters of the environment quality assessment (Fredianelli, 2020; Power et al., 1999; Evandt et al., 2017; Cassina et al., 2018; Guskiet et al., 2017; Wendling, 2020). The external costs of noise mainly result from social losses caused by:

- decrease in human productivity due to the inability to concentrate,
- fatigue and lack of sleep and rest, which results in lower productivity and reduced quality of work performed in a burdensome environment,
- significant increase in healthcare costs.

### **3. Port Noise as an Environmental Nuisance**

As a component of external environmental costs which in addition to noise mainly include climate change, air pollution, well-to-tank and habitat damage, noise caused by transport operations contributes to one fifth of this group of costs generated in the EU transport sector (Sustainable Transport Infrastructure Charging and Internalisation of Transport Externalities, 2019; Update of the Handbook on External Costs of Transport, 2019; UNCTAD, 2016).

In turn, this group of costs already represents more than 44 per cent of the total external costs resulting from transport operations, estimated according to the current calculation methodology in the EU at 987 billion euro in 2018 (Sustainable and

smart mobility strategy, 2020). It should be noted that transport noise as a cause of losses is difficult to isolate from other sources of noise and from other negative factors affecting human health.

The concentration of noise which is the result of particularly intense transport operations (traffic noise), takes place in the hub multimodal transport infrastructure facilities. Such facilities, i.e., the so-called transport hubs, include primarily international airports and seaports. The latter are spatially extensive facilities, usually with an area of several hundred or several, and sometimes several thousand hectares, where various transport, logistics, as well as industrial and commercial operations are conducted.

Seaports and their terminals, mainly container ones, are also strongly integrated into the existing network of transport infrastructure, both national and international, which makes them a place with a particularly high traffic concentration regarding not only sea but mainly land means of transport (European Environment Agency, 2024; Murphy, 2014; Mańkowska *et al.*, 2021; Skiba, 2013). In most seaports, road transport is the dominant mode of transport, connecting them with the hinterland (Mańkowska *et al.*, 2021, Jakovljevic *et al.*, 2013).

Seaports also operate in a round-the-clock system (three-shift system), which means that the level of noise generated by their operations and the port immediate surroundings (access roads, parking lots, railway stations, warehouse centres, etc. persists, albeit with varying intensity around the clock (Jakovljevic *et al.*, 2013; Bernacki *et al.*, 2021; Mańkowska *et al.*, 2021; Madala *et al.*, 2020; de Kluijvera, 2003).

The port noise, as a serious environmental nuisance, affects not only the port workers and those working in its immediate vicinity, but also, to no lesser extent, people living in close proximity of the port. This is not a trivial issue since in most cases it affects large concentrations of people – dwelling districts located in the seaport immediate vicinity and communication routes leading to this facility.

Considering that 91 per cent of the European ports are located in or are very close to urban areas, this is one of the priority challenges most port authorities and port cities have to face (ESPO, 2020). The first, as the managing bodies, are mission-driven entities and for them the relationship with the local community is a top priority.

Therefore, they look for possibilities to reduce the noise: 1/ as part of their own environment management strategies, closely related to the Corporate Social Responsibility strategies implemented by port authorities, as well as 2/ in cooperation with other seaports within the European Seaports Organization (ESPO) and 3/ together with port cities.

The last aspect of cooperation is particularly important since many European port cities have set their own emissions reduction targets even more ambitious than those existing at the national level. Therefore, seaports are already working together with the cities to achieve the objectives of the environment strategies, intending to achieve the noise reduction goals agreed by both parties, too.

Moreover, they are going to comply with the requirements of the EU smart and sustainable mobility strategy since 2020 (Sustainable and smart mobility strategy, 2020). Within so perceived areas and forms of activity aimed to fight the environmental nuisance, including noise generated by the port, the organization itself, i.e., the port authority, as well as individual port companies conducting their handling operations, use not only legal, administrative and economic instruments, undertake technical as well as technological actions, and provide solutions based on the examples of good practice, drawn from the cooperation with port stakeholders and international industry associations (ESPO, BPO, FEPORT, IAPH and others) (European Environment Agency, 20204; (Sustainable and smart mobility strategy, 2020; 16 Neptunes Project, 2024; ESPO, 2020, Grzelakowski, 2020; Skiba 2019).

The above-mentioned issue of port noise, as one of the greatest environmental nuisances for the community living in port cities, constitutes the main subject of research undertaken by the authors of this publication. This issue, of a typically interdisciplinary nature, is very current and important from the theoretical – mainly methodological point of view, as indicated in numerous scientific publications and studies, expert opinions and reports of international organizations cited by the authors, but also from the practical viewpoint.

Since monitoring and control of port noise levels constitutes grounds for assessing the effectiveness of measures taken by port organisations to reduce one of the greatest environmental nuisances in port cities, significantly reducing the quality of life of the residents of port agglomerations and the possibility to transform them into smart cities.

#### **4. Methodological Approach to Measuring and Assessing Noise Emissions**

##### **4.1 Legal Aspects of Proceeding with Noise Pollution as Well as Its Measuring and Reporting in the EU –A General Approach**

Noise emissions at the source have been regulated in the EU for many years. Poland, as one of the EU countries, is obliged to monitor and control the level of environmental noise using the noise measurement methods and procedure to make the results generally available, corresponding to the established standards, procedures and principles set out mainly in the END and in the EEA regulation.

Maximum noise limits for motor vehicles, household appliances and outdoor equipment date back to the 1970s. More recently, measures to control noise from

operations and airports, and the regulation of industrial facilities noise levels have broadened the control of environmental noise (Noise pollution, 2024; Nastasi *et al.*, 2020; Guski *et al.*, 1999). The introduction of the END in 2002 sought to monitor the effectiveness of EU emission controls by requiring the assessment of environmental noise at the level of each individual Member State. The END introduced two key indicators for annoyance and sleep disturbance, which, if exceeded, require action plans to be drawn up, designed to reduce the exposure and protect the areas not yet polluted by noise (Directive 2002/49/EC Of the European Parliament, 2002).

Noise emissions is a priority work area in the EEA mandate. Most of the current activities relate to data reporting and assessment as required by the END (Directive 2002/49/EC Of the European Parliament, 2002); EEA, 2024). The Electronic Noise Data Reporting Mechanism (ENDRM) was devised by the EEA in 2007 in order to facilitate the reporting of noise data in line with the principles set out in the Shared Environmental Information System for Europe and in accordance with the specifications for a spatial data infrastructure for Europe. In assisting with the implementation of the END, the EEA works closely with the European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution and with EEA's country network, Eionet.

Data on noise exposure and associated action plans reported in accordance with the END have been used to assess the environmental noise in Europe. The same data is available for download via the EEA data service and can be viewed interactively on the EEA Noise Observation and Information Service for Europe. It also presents noise contour maps for major sources and cities in Europe.

The country-specific fact sheets illustrating END data and estimating the likely health impacts due to noise in EEA member countries have also been published (EEA, 2024; Commission Directive (EU) 2015/996, 2015). The EEA has also used END data to make an assessment of the likely extent of areas yet to be affected by noise pollution in a report entitled Quiet Areas in Europe (OAE).

These country fact sheets summarise the information on noise pollution for selected EEA member countries. The fact sheets are based on the latest official noise data reported every five years by EEA member countries under the END.

A detailed analysis of the last full five years (31 October 2019) published in the reports by EEA member countries indicates that:

1. Despite the fact that the noise pollution in the EU has significantly decreased recently, i.e., by 2020, it still remains a major environmental health problem in Europe,
2. Road traffic is the most widespread source of environmental noise, with more than 100 million people affected by harmful levels in the EEA-33 member countries.

Railways, air traffic and industry are also major sources of noise (EEA, 2024; Noise pollution, 2024; Stansfeld *et al.*, 2005; Evans *et al.*, 1995; Grzelakowski, 2020; Skiba 2019).

The report provided and the strategic noise maps compiled and analysed in accordance with the requirements of Article 5 and 7 of the END, are based on the common methodological database. These are two noise indicators (*Lden* and *Lnight*), values of which are determined using common noise assessment methods for all countries (Common Noise Assessment Methods in Europe (CNOSSOS-EU), 2024) *Lden* as the long-term average noise indicator which was already specified in END is the day-evening-night indicator. It is defined by:

$$L_{DEN} = 10 \times 10 \lg \left[ \frac{12}{24} 10^{L_{day}/10} + \frac{4}{24} 10^{(L_{evening}+5)/10} + \frac{8}{24} 10^{(L_{night}+10)/10} \right]$$

Where: 1. *Lday* (respectively *Levening* and *Lnight*) is the A-weighted long-term average sound level, as defined in ISO 1996-2: 2007, determined over all day (respectively evening and night) periods of a year, and obtained on the basis of *Leq,T* as defined in Section I.2.2 (Kephalopoulos *et al.*, 2012). 2. The day is 12 hours, the evening four hours and the night eight hours, and a year is a relevant year as regards the emission of sound and an average year as regards the meteorological circumstances. However, it should be emphasized that day, evening and night periods may be defined slightly differently at the national level.

In the EU countries, the indicators for noise pollution have been set at the following levels: 1/ 55dB for *Lden: day-evening-night*, and 2/ 50dB for *Lnight: night* (EEA, 2024; Commission Directive (EU) 2015/996, 2015; Noise country fact sheets, 2024; Paschalidou *et al.*, 2019). The national reports and analyses of noise maps presented show that:

- road traffic is the main source of environmental noise in Europe. Noise levels from roads that exceed 55dB *Lden* affect an estimated one in four people in Europe.
- in seaport city Gdynia, a total of 117 400 people is exposed to day-evening-night average sound levels of 55 dB or higher from road traffic.
- around one in six people are exposed to night time levels of road traffic noise exceeding the night 'sleep disturbance' threshold 50dB *Lnight* in Gdynia,
- number of people exposed to high level of railway traffic noise ( $L_{den} \geq 55\text{dB}$ ) in Gdynia amounts to ca. 6 400 people.
- The number of people exposed to high level of environmental noise from industry is low compared to other sources. At the national level, in Poland, there is only a total of 23 700 people exposed to high level of industrial noise. In seaport city Gdynia, a total of 1 700 people is exposed to day-



evening-night average sound levels of 55 dB or higher from industries (Noise country fact sheets, 2024; Noise pollution, 2024).

#### 4.2 Polish Legal Approach to Determine and Assess the Noise Pollution Level

As a result of the growing awareness of health and life threats resulting from the persistent noise level as one of the main sources of environmental pollution, with the concurrent strive to develop an effective environmental management strategy based on the paradigm of sustainable development, a few years before the accession to the EU, Poland adopted the environment protection act based on high ecological standards (Prawo ochrony środowiska. Dz.U.2020.0.1219, 2020).

It introduced quite strict standards regarding the environmental noise level with respect to its impact on human health. When setting the allowable levels of environmental noise, the following aspects were taken into account: 1/ various levels of noise impact on the human body, 2/ types of areas or vicinity of areas where noise occurs or is generated, 3/ time of day and the level of its severity.

Thus, due to different impact of noise on the body and the resulting different harm to human health, audible noise can be divided according to its level into the following five groups:

- below 35 dB – harmless to health, can be annoying or interfere with work that requires concentration;
- 35–70 dB – leads to the fatigue of human nervous system, distraction, seriously hinders speech intelligibility, falling asleep and resting;
- 70–85 dB – leads to a significant reduction in work efficiency, can be harmful to health and cause hearing damage;
- 85–130 dB – causes numerous human body disorders, prevents speech intelligibility even from a distance of 50 cm;
- above 130 dB – causes permanent damage to hearing, stimulates vibrations of human internal organs causing their disorders (Zagrożenie hałasem, 2012).

Taking into account the other two criteria, in accordance with Article 113 of the Environment Protection Act, in the Regulation of the Minister of the Environment on permissible noise levels in the environment, the permissible standards for noise pollution were determined. They are presented below in table (Table 1).

**Table 1.** Permissible noise levels in the environment

No.	Type of area	Time of day	Time of night
1	Single-family residential area	50	40
2	Multi-family and collective residential area	55	45

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2a	Residential and commercial areas		
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*Source: Environmental Law, Article 113. (Prawo ochrony środowiska. Dz.U.2020.0.1219, 2021).*

The list presented shows that the permissible noise level indicators in dB adopted in the Polish standard are much more stringent than the later established acceptable values in the END used by the EEA within the common European standard. As a result, it has a positive, stimulating impact on economic organizations, local governments and national institutions in terms of actions taken to reduce the level of environmental noise pollution.

## 5. Conclusions and Recommendations

Noise in seaports is a serious environmental nuisance that has a significant impact on human health and ecosystem. This environmental nuisance is a result of intensive port activity, including both ship traffic and port operations.

The article presents the essence of noise as one of the basic environmental nuisances, with particular emphasis on the specificity of economic activity of seaports as a source of noise generating. As a result of seaport activity, the levels of noise emissions have been increased, exceeding sometimes permitted standards, posing a threat to the health of port workers and local residents.

In order to minimize the impact of noise, it is recommended to implement modern technologies that reduce noise levels, for example quieter port facilities, more efficient traffic organization and the use of acoustic barriers. However, the introduction of appropriate legal regulations is crucial to ensuring the sustainable development of ports, taking into account the protection of human health and the natural environment.

Bearing in mind the presented postulates, the European Union, through its legislative bodies, introduces numerous legal regulations in this area, which the authorities of seaports in EU Member States are obliged to comply with.

In terms of recommendations, according to the assumptions, the regulations and legal standards concerning the regulation of noise levels generated by economic activities in the port area, perceived in terms of their impact on the comfort and quality of life of the port city residents, should contribute to reducing noise levels as one of the main environmental nuisances.

This, in turn, should lead to partnership relations in terms of deeper cooperation between the seaport authorities, residents and the port city authorities.

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