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# A Review on Environmental Impact Assessment on Noise Environment

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## Abstract

Noise is defined as an irregular and disorderly sound with strong and weak changes that has many adverse effects on people and the surrounding environment and is one of the forms of environmental pollution. Possible sources of noise include aircraft, automobiles, factories, construction sites, daily life, etc. Countries generally use environmental impact assessment (EIA) to assess the impact of noise generated by activities in different fields on the quality of the surrounding environment, to predict the extent and population affected by environmental noise for the next step in controlling it to prevent harm to people and the environment. Different countries' standards, methods, and technologies for assessing the environmental impact of noise may be similar, the same, or different during the assessment process. In this report, through a great deal of Internet searching for related academic papers and online consultation with some environmental assessment institutions, Review the theoretical knowledge of technical methods of environmental impact assessment in a noise environment, and discuss and analyse the advantages and disadvantages. The results show that the statistical method and the average method are common but require a lot of manpower and resources. The fuzzy mathematics evaluation method needs a lot of accurate calculation and requires high-quality personnel. The data in the noise map is intuitive and comprehensive, but the basic workload is large. Each method has its advantages and disadvantages, and the choice depends on the situation.

## Keywords

Environmental impact assessment, Noise effects, Noise impact assessment

## 1. Introduction

### 1.1 Background

The cause of sound is usually the vibration of objects. Sound exists in the environment in the form of waves, and will propagate in certain media, such as solids, liquids, gases, etc. We typically hear an aerial sound. The range of frequencies that are audible to the human ear under normal conditions is 20–20,000 Hz; frequencies lower than 20 Hz are referred to as infrasound; while frequencies higher than 20,000 Hz are referred to as ultrasound [1]. The noise refers to all the irregular signals, like radio transmission noise, electromagnetic noise, optical fibre communication noise, camera image shooting noise, and so on [2].

From the point of view of environmental protection, any "unnecessary sound" that affects people's normal study, work, and rest on some occasions is all called "noise." Such as the sound of a burning machine, all kinds of traffic horns, people's noise, and all kinds of sudden sounds, etc., are called noise [3]. From the point of view of physics, noise is a chaotic and irregular combination of sounds with different frequencies and intensities. Music is a harmonious sound. Physics alone cannot determine whether a sound belongs to noise. Subjective factors often play a decisive role [4]. Humans can detect sounds with fre-

quencies ranging from about 16 to 20,000 Hz [5].

As early as possible, it was known that noise made people uncomfortable, and gradually, it was also known that loud noise could harm people's health and even cause death; unnecessary noise can be even more harmful to patients [6]. So the importance of noise impact assessment is self-evident.

## 2. Environmental impact assessment (EIA) and noise environment

### 2.1 Definition of EIA

Environmental impact assessment (EIA) refers to the analysis and evaluation of the possible environmental impact of a hypothetical or ongoing human activity project and the subsequent proposal of measures to avoid or reduce the impact. Moreover, environmental assessment has different definitions and provisions in different countries. Matrix, checklist, and flow chart are the most mainstream impact identification techniques [7].

In addition, geographic information systems (GIS) and overlay maps can also be used in environmental impact assessments. In addition, monitoring projects are extremely important in EIA work, but economic and technical constraints in some backward and developing countries make it difficult to carry out monitoring projects.

### 2.2 Definition of Noise environment

Environmental noise refers to the noise generated in people's daily lives that interferes with the surrounding living environment, such as construction, traffic, and industrial noise. Ambient noise is permitted in each country [8]. Most countries adopt ISO as the standard, follow ISO's recommendations, and at the same time combine their own environmental regulations and situations to set up basic environmental noise standards. A specific area of the environment where ambient noise occurs is called a "noise environment" [9].

## 3. Noise measurement parameters and variables

### 3.1 Sound pressure levels

The sound pressure levels is used to express the size of the sound, and the unit is Pa (Pa), 1 Pa = 1 N/m2 (Newton/meter 2), and one atmosphere is equal to 1.013 105 Pa. Sound pressure can be expressed as peak, average, and RMS [10]. The effective value of sound pressure is the square root of the mean instantaneous sound pressure squared over a period of time, also known as the root, mean square value (RMS) [11].

At the same time, considering the (logarithmic) characteristics of the human ear's response to sound intensity, the logarithmic method is used to divide the sound pressure into 100 levels, which are called sound pressure levels [12]. Sound pressure level is defined as the common logarithm of the ratio of sound pressure to reference sound pressure multiplied by 20, in dB (decibels), i.e.

$$Lp = 20 \lg \frac{P}{Po}$$

### 3.2 Loudness level and loudness

When the loudness of a sound is the same as that of a standard sound, the intensity level of the standard sound is the loudness level of the sound. Using the equal-loudness experiment method, a family of equal-loudness curves with different frequencies and sound pressure levels can be obtained [13].

In the experiment, a specific frequency of 1000 Hz was used; the sound was compared to other frequencies (such as 100 Hz) using an audiovisual method. Plot these data on the coordinates and get a curve equal to 1000 Hz and 40 dB sound pressure levels [14]. The ISO loudness curve obtained through extensive testing and recommended as a standard by the International Organization for Standardization (ISO).

### 3.3 Sound levels and Weighted sound pressure levels

Because loudness level and loudness are difficult to represent people's subjective perceptions of sound, a weighted sound pressure level is proposed. Weighted sound pressure level is the sound pressure level measured by a certain frequency weighted network, which is referred to as "sound level." In the acoustic measuring instrument, a certain frequency metre power network is usually set up according to the equal loudness curve, so that the received sound can be filtered according to different degrees of frequency to simulate the human ear. Generally, three weighting networks (A, B, and C) are set [11].

### 3.4 Equivalent continuous Sound level

A problem in which noise energy is averaged over time to evaluate the effects of noise on people, i.e., equivalent continuous sound level, symbol "Leq" or "Leq.t." It uses a continuous and stable sound level equal to the sound energy at the same time to represent the size of the noise during this period of time [15]. For example, if there are two 85 dB sound level machines, the first one works continuously for 8 hours, and the second one works intermittently, the total effective working time is 4 hours. It is clear that the average energy applied to the operator is twice as large as that applied to the operator, i.e., 3 dB larger.

### 3.5 Noise rating (NR)

Noise evaluation number NR is the method recommended by the International Organization for Standardization in 1961.And noise evaluation number N is recommended for hearing impairment, session interference, and annoyance [16]. In recent years, various countries' noise standards have specified A sound level (or equivalent continuous A sound level) as the evaluation standard.

## 4. Noise environmental impact assessment techniques and methods

To control environmental noise, noise levels should be assessed on the basis of future operational data. For example, when assessing the noise from a road project in route selection, factors that may influence the noise, such as traffic flow and speed on the road, should be considered. For different types of environmental noise, there are various assessment methods based on acoustic principles or modelling techniques.

### 4.1 Statistical methods

The statistical methods of determining whether the measurement points fulfil the criterion and calculating the cumulative percentage level of the river to assess road traffic noise are frequently employed in the evaluation of environmental noise. The urban environmental noise monitoring method is generally used to divide a certain environmental function area monitored by the census into several squares of equal size, The grid should completely cover the area to be surveyed, and the total number of effective grids should be more than 100 [17].

### 4.2 The fuzzy mathematical evaluation method

The fuzzy mathematical evaluation method mainly refers to applying the clustering analysis method in fuzzy mathematics to the classification and evaluation of environmental noise quality, using the membership function to classify the noise quality, and describing the fuzziness of all levels of boundaries [18], so as to realise a reasonable classification of acoustic environments with different quality levels.

### 4.3 Noise map and GIS

A noise map is a data map that depicts the amount of urban noise by synthesising, analysing, and calculating noise source data, geographical data, building distribution, road condition, highway and railway traffic data, and pertinent geographic information using modern computer technology [19]. Take the case study of South Korea, as an example. Firstly, GIS is used to obtain the city's terrain and road data, while road traffic data, such as sections, traffic volume, speed, and vehicles, are collected from the city's traffic master plan and noise impact assessment reports [20]. Other population data are derived from community statistics, which are then used to calculate the population density of the floor area.

Then, people can using ArcGIS 9.3 to develop a GIS database, that can contain the terrain, buildings, transport related information, population, and so on for all of the data, a three-dimensional urban space model was established based on these data, followed by the use of digital maps for contour extraction, extraction, contour point generation on the elevation points, grid generation, interpolation, and lattice height value [21]. In USA, each land use and land cover has a noise map that can be used for various forms of noise levels, producing various indicator results, such as exposed areas and exposed people [22].

The terrain model is established by using grid points. Architectural models are generated using information from digital maps and sketches and are cropped periodically. The height values of the boundaries in the model are derived from sketches of specific buildings and can be used to generate terrain [23]. It facilitates the establishment of sound noise mitigation measures by establishing an appropriate noise level from a specific noise source. And the noise map can show the area ratio and the crowd exposed to a certain noise level, which is very convenient and efficient [24]. Europe, Japan, the United States, and other countries have established level prediction models to complete their regional noise maps.

## 5. Discussion and Result

For the advantages and disadvantages of noise environmental impact assessment methods, compared with other methods, the statistical method requires a long-term and large amount of noise environment monitoring work, which is a great test of material and financial resources, such as the establishment of a large number of monitoring points and the training of a large number of professional monitoring personnel, so as to analyse and evaluate the noise quality standards in this area. Its advantage lies in the fact that it can be combined with the network system to carry out long-term real-time monitoring, and the data transmission is more rapid, which makes it convenient to investigate and obtain evidence of the cause of excessive noise. The fuzzy mathematical evaluation method has lower requirements on the quantity of human and material resources and is easier to manage and analyse noise data.

But it requires more specialised people, who must be skilled in both noise assessment and mathematics. However, this approach is not yet mature enough; most system establishment methods continue to rely on experience and experimentation. The advantage of the noise source method is that the noise data is easy to monitor, and the existence of the noise pollution map shows that the noise distribution and evaluation index of the method are intuitive. The disadvantage of this method is that it focuses on the noise source but ignores the impact of noise near the source, and only evaluates the equivalent sound level without evaluating relevant parameters. The disadvantages of the average method and statistical methods are similar; they both require a large amount of material and work, but their advantage—that they can understand one area or the entire city's overall environmental noise level—simplifies noise evaluation work.

The main disadvantage of a noise map is the large amount of basic work, because it needs the support of many aspects of data, which also requires the participation of a large number of people and material resources. But it has the advantage of using modern calculator technology to put large amounts of data on a single map, comprehensive, accurate, and intuitive. And the simulation and prediction results of the noise map provide a better scientific decision basis for urban development. In addition, the general public could benefit from this in the future. Imagine a time in the near future when it will be easier to look at a noise map of your house and create a quieter personality. And with the noise map as a guide, choosing quieter areas to live in will become a reality. Each method has its advantages and disadvantages, and the choice depends on the noise environmental impact assessment process design situation, requirements, and specifications.

## 6. Conclusion

The importance of a noise environmental impact assessment following the implementation of planning and construction projects is obvious in light of the increasingly serious environmental noise pollution. We are currently conducting a noise environmental impact assessment in order to apply relevant natural science and social science principles and methods, fully analyse the advantages and disadvantages of various methods and techniques, make a scientific and reasonable selection using these methods and techniques that complement each other in a reasonable combination, and use the system science method. Environmental assessment, planning, management, and governance countermeasures, among other things, from the overall noise area, comprehensive control of environmental noise pollution, and seeking the best solution to environmental problems can all help to achieve the goal of improving the noise environment.

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