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Noise mapping in urban environments: A Taiwan study

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ABSTRACT

This study analyzed the spatial characteristics of urban environmental noise by using noise maps produced at 345 noise monitoring stations in Tainan, Taiwan. Noise data were collected at varying intervals: morning, afternoon, and evening in both summer and winter. The spatial distributions of the noise levels during each time interval were evaluated and visualized by geographic information systems. The analytical results indicated that the highest and lowest average noise levels were 69.6 dB(A) and 59.3 dB(A) during summer mornings and winter evenings, respectively. Comparison of monitored noise levels with regulatory standards revealed that noise standard violations, which usually occur on summer evenings, are as high as 23 dB(A). Furthermore, the results of noise exposure analysis showed that over 90% of the Tainan City population are exposed to unacceptable noise as defined by US Department of Housing and Urban Development. The findings of this study show that noise maps can be useful for investigating noise in urban environments.

1. Introduction

Excessive noise is a major environmental complaint in residential areas. According to statistical data of Environmental Protection Administration in Taiwan (TWEPA), resident petitions to reduce noise pollution are more common than those for air pollution. Noise disturbance significantly impacts many areas with high population density and affects the inhabitants in their daily life, sleep, work and study. Petitions to reduce noise in Taipei City, Taipei County, Taichung City, Tainan City and Kaohsiung City account for 70% of total cases in Taiwan, indicating that noise problems are very serious in these metropolitan areas.

Before proposing noise control policies, noise maps are needed to survey existing distributions of noise levels, examine noise level regulations and identify primary noise sources. Noise mapping is one of the best ways of understanding environmental noise. A noise map can be used for the following purposes [1]

(1) Quantify main sources of noise.
(2) Clearly illustrate environmental noise exposure to provide a reference for policy makers.
(3) Facilitate the development of policies for controlling noise and enforcing the control of noise.
(4) Draft a cost-benefit plan to assist districts desiring to reduce noise levels.
(5) Adopt theory to examine the effect of environmental improvement plans.
(6) Improve the enforcement of regional or national plans to decrease new noise resource as well as to protect new noise sensitive and tranquility needed areas.
(7) Monitor noise reduction schemes and their effectiveness during the enforcement process.
(8) Monitor changing trends in environmental noise.
(9) Provide a research platform for studying the effects of noise on the human body.

This study utilized geographic information systems (GIS) to analyze monitoring data collected at 345 noise monitoring stations in the Tainan metropolitan area, including areas of Tainan County. Noise maps of the Tainan metropolitan area were produced to investigate its current noise distribution. Noise levels of different land use zones, including residential, commercial, cultural and educational districts were investigated and compared with related noise regulation standards.

2. Previous studies

The concept of noise mapping has been in development for many years. The most advanced research in noise mapping has been performed in European countries. For example, Germany has conducted relevant research for more than 25 years. Based on the results of previous studies, traffic noise is frequently identified the main noise source. Urban areas near busy road systems are usually selected for initial implementation of mapping systems

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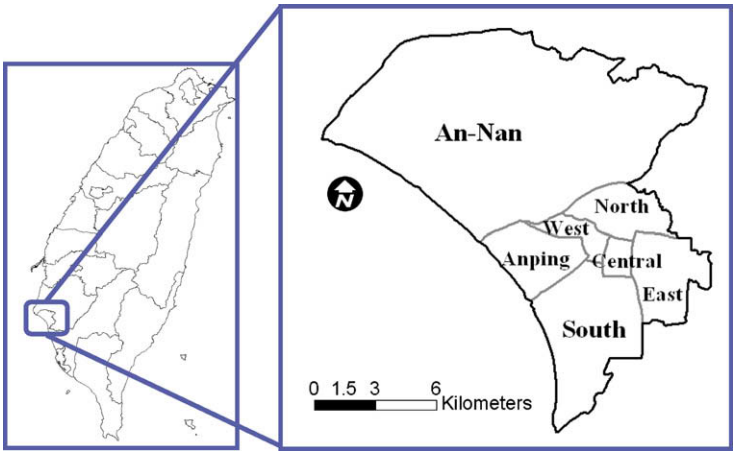

Fig. 1. Geographic location of Tainan City.

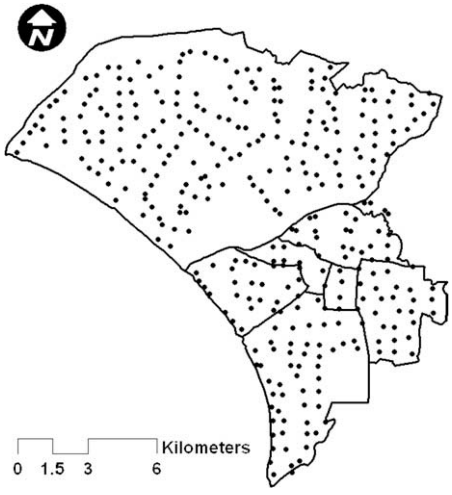

Fig. 2. Spatial distribution of noise monitoring stations.

needed to draft noise control schemes. In 2002, the European Union (EU) passed Directive 2002/49/EC [2] for the Assessment and Management of Environmental Noise, which stipulated that, by July, 2008, all EU members must draw up noise for the main areas of population aggregation and primary road systems for public reference. England then published the London Noise Map in 2004, which is the first noise map produced by a national government, as a reference for London citizens to avoid noise nuisances.

Compared to other environmental issues, noise mapping is a newly emerging issue which is drawing substantial public attention. Steele [3] argued that researchers conducting Environmental Impact Statements (EIS) should consider not only noise levels, but also other potential factors such as population distribution and surrounding land use [3]. de Kluijver and Stoter [4] illustrated and underlined the essence of standardized noise mapping tools, and considerations for the development of these tools, sun as accuracy; cost-benefit criteria for noise measures; and presentation of uncertainties in results, were also described. Furthermore, they concluded that an appropriate use of GIS in mapping noise effects makes it possible to optimize quality and efficiency of noise effect studies [4]. Klæboe et al. [5] investigated cognition of the citizens

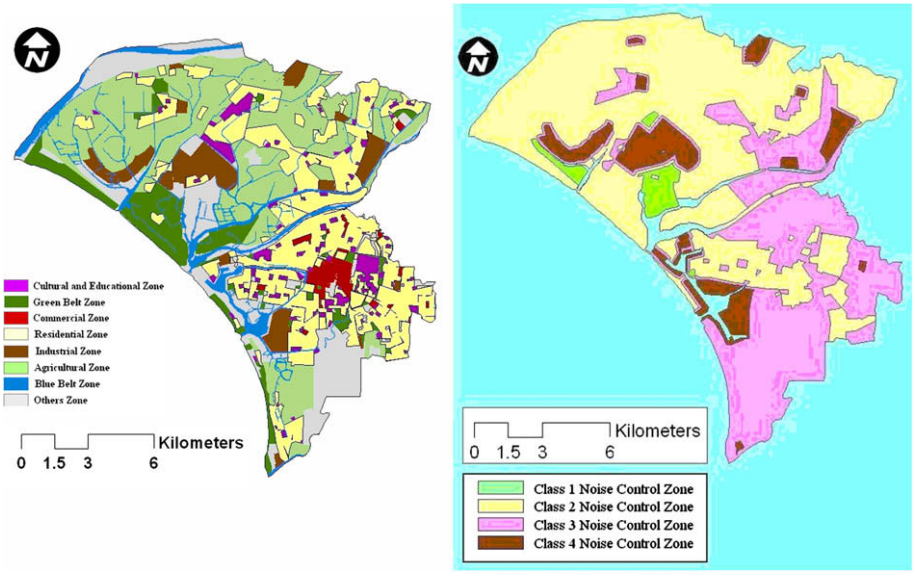

Fig. 3. Spatial distribution of land use zones and noise control zones in Tainan City.