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Hierarchal assessment of noise pollution in urban areas – A case study

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ABSTRACT

Noise pollution in urban areas has many harmful effects on the citizens. There are varieties of noise generation sources of which the traffic noise could be a major source. The point which is perhaps less noticed is that sound level is not the only parameter to indicate the extent and intensity of noise pollution. Situation of urban land uses, distribution of population centers and types of passages can deeply affect the concern on this environmental issue but not with a similar ratio. This article presents an overlaying technique to define noise prone areas using all different factors involved. A case study was carried out in the District 14 of Tehran Metropolitan City where there are busy streets and highways. For this purpose, the share of each criterion in noise pollution intensity was determined using Analytical Hierarchy Process (AHP). Afterwards, the map layers were overlaid based upon the relative importance of the criteria to get the final map on which the noise prone areas are specified. The developed method could be used as a tool for indirect estimation of noise pollution by which instead of direct measurement of the equivalent sound level, it would be possible to predict noise susceptible areas considering the most important influential factors.

Introduction

Noise pollution, in the recent years, has been well recognized as one of the major trepidations affecting quality of life in urban areas worldwide (Hunashal and Patil, 2012; Akan et al., 2012; Silva and Mendes, 2012; Frei et al., 2014). With the rapid development of urban areas, the traffic noise pollution has become increasingly serious. As stated by Trombetta Zannin and de Sant'Ana (2011), in economically developing countries, rising levels of noise pollution are associated with the accelerated growth of cities and the increasing circulation of automotive vehicles. Large-scale developments such as growing mechanization, mobility, and urbanization, an ever-increasing trend of the world's population exposed to everyday noise levels are considered potentially harmful. Although other noise pollution sources may give rise to complaints and annoyance, the long-term noise exposure, decisive to health effects, is due to general traffic noise so it could be the dominant source of the noise

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in urban areas (De Vos and Van Beek, 2011). Exposure to impermissible ambient noise levels can cause public health problems (Clark et al., 2013; Hohmann et al. 2013; Stansfeld and Clark, 2011; Jiménez-Tejada et al., 2012; Basner et al., 2014; Fyhri and Marit Aasvang, 2010). The spatial distribution of noise pollution in urban areas is related to various parameters which make up the urban fabric, such as construction density, open spaces, the shape and physical position of buildings, the type of passages and population distribution, etc. (Ariza-Villaverde et al., 2014). There are lots of studies focusing on noise pollution in urban areas. Mehdi et al. (2011) studied the spatial and temporal patterns of noise exposure due to road traffic in Karachi City, Pakistan, and found that levels of noise were generally higher during mornings and evenings because of the commuting pattern of Karachi residents. Suárez and Barros (2014) presented the most important aspects of the noise mapping project across Santiago, a city of nearly six million inhabitants. They concluded that the noise levels for the city of Santiago were high in a relevant percentage of the surface. Barclay et al. (2012) presented a method to quantify the interaction of building noise exposure with natural ventilation potential. They wanted to illustrate the importance of an integrated approach to both noise exposure and ventilation performance in urban buildings. Murphy and King (2010) explored methodological issues and policy implications concerning the implementation of the EU Environmental Noise Directive (END) across Member States. Vogiatzis (2012) presented a review of both assessment and action implementation procedures focusing on the dominant – in the area – aircraft traffic noise is presented, with emphasis to (a) a full calculation of Strategic Noise Map (SNM) scenarios of actual and future airport operation using the ECAC (European Civil Aviation Conference). ECAC describes how to calculate noise contours around civil airports (Murphy and King, 2014). CEAC (Conférence Européenne de l'Aviation Civile) Doc 29 methodology for both EU common indicators L_{den} and L_{night} in scales of 5 dB, (b) a full evaluation of results with emphasis to the Larnaka greater area land uses and the exposure of inhabitants in residences in various levels of environmental noise, and (c) a full evaluation of Noise Action Plans (NAP) introducing especially a new land use management scheme for the future Larnaka Town Land Use Plan. It should be mentioned that ECAC-CEAC Doc 29 is a report on standard method of computing noise contours around civil airports (ECAC.CEAC. Doc 29, 2005). Klæboe et al. (2006) presented a neighborhood sounds cape adjusted exposure indicator to map context sensitive noise impacts. Lee et al. (2008) used noise mapping for environmental impact assessment in a downtown redevelopment area of Seoul, Korea.

The present study is an analytical approach carried out to assess noise pollution in the District 14 of Tehran Metropolitan City. The research hypothesis addresses the fact that sound level is not the only parameter to indicate the extent of noise pollution. Situation of urban land uses, distribution of population centers and types of passages can deeply affect the concern on this environmental issue but not with a similar ratio.

Material and methods

The study area

The District 14 is situated in southeastern Tehran over an area of 64.23 km including 6sub-districts (low level administrative division in a district) (Municipality of Tehran, 2014). Fig. 1 demonstrates situation of sub-districts in District 16. With a total pupation of 445,138 people, the district is one of the most crowded areas of Tehran (SCI, 2006). According to the consensus released by Statistical Centre of Iran (SCI) in 2006, the Districts 10 and 14 of Tehran have the greatest land area dedicated to residential land use and districts 9, 21, 19 and 22 have the least (SCI, 2006). The Sub-district 2 with the population of nearly 130,047 people includes the largest share of the total population in the district which is equal to 445,138 people (SCI, 2006). military areas and in the Sub-district 6 as well as schools and residential areas far from the main streets wherein noise pollution issue is not that much significant were excluded from the analysis process.

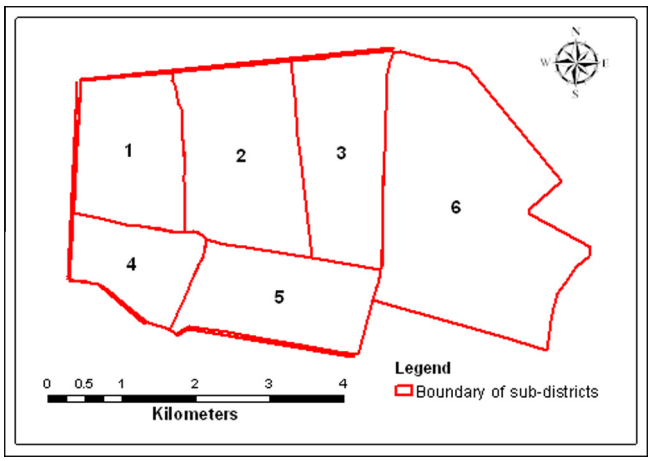

Fig. 1. Administrative division of the District 16.