Spatial and Temporal Variations of the Obtained Database of Environment Pollutant using GIS and Remote Sensing - A case study of Metropolitan City of India.

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Abstract: The present paper is focused on the analysis of the spatial and temporal distribution of outdoor noise in Mumbai City, India. The database is built by primary field survey. A total number of 200 samples were surveyed, out of which 70 samples are selected for the preparation of isodecibel maps in the present paper. For the latest landuse and vegetation of Mumbai, satellite imageries are used and for air quality, isoline maps of MMRDA prepared on Arc Info are used. The maps are prepared by using GIS techniques like Map info, Autocadd and Arc view. Several overlays of vegetation, relief, population density, landuse, traffic corridors and air quality is attempted in this paper along with analysis and concluding notes.

Key words: isodecibel map, ambient noise, hazardous noise levels, layering techniques, WHO,landuse, vegetation, traffic corridors, air quality.

1 Introduction

During the last two decades, research on community and outdoor noise has made considerable progress to find out what is going on in people's mind about noise pollution. Much of the literature reviewed emphasize on scientific and mathematical calculations and measurement of noise (Beranek, 1992) (Harris 1979, Arnold & Petterson 1972), involving many sophisticated noise measurement systems. An important development in noise related studies is the shift in emphasis from carrying out many large, expensive and time-consuming filed surveys to compiling and more thoroughly analyzing the already existing ones. (Ragnar Rylander in 1978). Most of the noise surveys catalog people's response to noise. A study of survey of outdoor measurements of noise levels is explained in detail by Harris 1979 and Beranak 1971. Details on the noise studies with spatio-temporal frame is also not attempted by most authors. To control noise in the outdoor environment, the role of land use planning needs to be stressed. The use of landuse management models and land use and highway simulation models (Galloway et al 1969) are increasingly being used by the planners and decision makers to obtain a quieter environment in the western countries.

2 Hypothesis

The present paper is focused on the analysis of the spatial and temporal distribution of outdoor noise in Mumbai city. The paper attempts to :

1. Clearly bring out the differences between the ambient noise level standards given by WHO and the existing noise levels.
2. Map the spatial pattern of noise over the city of Mumbai.
3. Evaluate different noise zones and identify noise hazardous areas for planning measures.
4. Find an explanation for the spatial noise pattern.
5. Examine the association between noise and other attributes like land-use, population density, and air pollutants.

3 Methods

The study area shown in Fig. 1 covers island city of Mumbai, extending from Navy Nagar (1) in the southern tip of the island city up to the city limits of Mahim and Sion causeway (13). The Mahim creek forms a narrow neck on city connecting the city with the suburbs. All the intra-city and inter-city transport, converge at this point causing repeated traffic bottlenecks. The other areas are shown in the map with a legend. To cover this area with complex internal diversities, a broad based primary survey was conducted in some selected sites in the city to represent distinctive urban functions, transport focal points and wealthy and poor economic areas. The site selection was mainly based on empirical knowledge of the city. The primary survey confirms the spatial variation of noise levels in the city of Mumbai. With this experiment, in the next phase a detailed survey was undertaken to determine the noise level, which cover 70 selected points in the city.

3.1 Rationale behind the selection of sites

The locations of survey points were selected by taking into consideration the following factors: i) urban "land use" namely administrative, commercial, residential, industrial, dock areas, recreation & open spaces, vegetation and marshy areas and defense. ii) The traffic arteries, the railheads, subsidiary roads, small lanes iii) the accessibility to the sites and iv) vehicular intensity. Further it should be noted that the number of survey points was greater where noise levels is generally high and where fluctuations of noise level is also expected to be high.

4 Analysis

Fig. 2 shows the distribution points of 70 sampled points, which are distributed from the southern tip of city to the northern Municipal boundary of the city. Survey points were concentrated in the southern parts of the city especially in administrative and old commercial areas where the distance between the two points is generally 5 to 7 meters.

However the selection of the points was not necessarily determined by systematic spacing. In fact in a city like Mumbai, geographical orientation of the city, and micro-level diversity in intra-city land use function, is one of the predominant deciding factor for the selection of sites.

With Arc view software, isoline map is prepared in Fig No. 3 for Mumbai city with 5-decibel contour interval. Fig No. 4 show the different gradations of noise areas and is called as isodecibel map. The following features can be identified from the map..

a) There is a systematic gradation of noise level from the southern tip of the island towards the north. From the southern tip of the island up to a distance of 2.5 kms, the noise level remains invariable.
b) Beyond the 50-decibel limit, the noise level increases systematically northward over the next 1 to 1.5 Km. until it reaches 65 dbA. The next belt 65 to 70 dbA belt is comparatively wider. It is pertinent to point out here that the 70-decibel line passes through the administrative area of the city of Mumbai.
c) In the northern boundary of the administrative zone, the noise level further increases and it reaches up to 75 dbA. Beyond that there is a sudden increase of noise level, which reaches up to 85 dbA and creates a high noise loop almost covering the narrow neck of the island city. The high noise belt of 85 dbA covers an area about 2.5 Kms and that is the old commercial core of the Mumbai city beyond which high noise level subsequently falls.
d) The noise level remains continuously high in the central part of the island city around 80

dbA covering more than 80% of the total area.

e) The exceptions, which can be identified within this high noise belt, are pockets of high noise levels above 85 dbA. Four such pockets can be identified. Three of them are in the northern part of the island and one of them in the southern part. Similarly there are also two areas where noise is below 70 dbA. Thus there are co-existing areas of very high noise and comparatively low noise levels.
f) Between the eastern and western coast of the island city there is some distinction. In the western coastal area the gradation of the noise level is prominent in the southern part of the island where the average noise level remain above 60 dBA. However, in the eastern coast, noise level is much higher varying between 75 to 80 decibels.
g) In case of the old island city there is a north-south variation in the noise level. The east-west variation is not so prominent

5 Landuse and Noise

The urban functions in Mumbai are complex resulting in multi-functional zones. The land use map Fig 5 shows the broad functional zones of the city, namely industrial, old commercial, residential, and other areas, based on the latest satellite imagery IRS IC 2000 of Mumbai. When the land use map is overlaid on isodecibel map, the following points are highlighted.

1. Noise levels are low in areas associated with defense and upper income residential use. The southern tip of the city, a defense area (1) and two low pockets in the west coast (5 & 8) representing, upper income residential area show low noise levels.
2. The old commercial area, the current Central Business District (2) is associated with high to moderate noise in southern parts of the city.
3. The wholesaling district (3) of the city and old middle and lower income residential core (4) areas show very high noise levels, exceeding 87 dbA.

6 Association between vegetation and Noise Levels

Fig 6 shows the vegetated areas of Mumbai. The map was prepared from Satellite imagery IRS 1C 2000. The vegetation areas of Mumbai is separated from the rest of the landuse using Photoshop. The vegetation pocket are scattered in the city of Mumbai due to its intense built-up structure. One can find vegetation in the southern tip (1), northern-eastern section, south-western section (5), and pockets of vegetation in the north. Most of the vegetation are evergreen with broad leaves and good branching system. Generally the noise levels are lower in areas of good vegetation. This can be confirmed in the southern tip (1) associated with low noise, northwestern section (5) - low noise, northeastern section (9) - moderate noise and northern municipal limits – low and moderate noise. It is interesting find that even within a high noise zone of (10) pockets of low noise is observed such as in (9). None of the vegetation area show high noise levels. The thick canopy of the vegetation does help in the absorption of noise reducing the noise by 5 to 7 decibels..

7 Association Between Air Pollutants and Noise Levels

The large number of automobiles, public transport vehicles, taxis; municipal trucks, lorries, tankers etc. are one of the main causes of high air pollution in city of Mumbai. The most significant air pollutants in Mumbai are SO2, SPM, AND NOX. These pollutants are studied and analysed in detail by MMRDA. Isoline maps of air pollutants were obtained from MMRDA Fig. No. 7. show the isoline map of SO2 .

The close scrutiny of the these maps and the isodecibel map highlights the following:

1. Three to four pockets of high air pollution areas emerge in the city in the west (Worli-7) center (Dadar-10_ and east. (Sion-13).
2. Worli in the west is also a high noise level area.
3. Dadar, in the center is identified as the worst air polluted area and it is also a high noise level area.
4. Sion, in the east, another air polluted areas is also a very high noise polluted area.

Repeated traffic convergence, traffic bottlenecks and jams are closely associated with high air pollution and high noise pollution.

8 Conclusion

In the old island city of Mumbai, there exists a systematic gradation of noise from south towards north. Typically noise levels increase from 50 dbA

at the southern tip of the island to 80 dbA within a distance of 2.5 km towards the north. However in the central parts of island city there are certain low noise pocket also. Towards north of island there is a sudden rise in noise level which reaches above 80 dbA. This high noise belt is located at the northern edge of island city, cross the boundary of city and enters into the suburb, an area further north.

Thus a distinct four levels noise hierarchy can be identified in Greater Mumbai.

1. Very high noise belt 80-90 decibels
2. high noise belt 70-80 decibels
3. Moderate noise belt 60-70 decibels
4. Low noise belt less than 60.

8.1 Impact of Noise

The comparison of the recommendation of WHO 1980 and the Noise Pollution Act 2000 India, given Table 1 and 2 with the existing noise levels in the city of Mumbai of various land uses such as industry, commercial, residential area reveals the following likely impacts in noisy areas such as commercial area, of the old city, Sion causeway-and Worli-Dadar area an inter-city transport node,

a) Exposure to noise levels above 75 dbA continuously for 8 hrs or more may regularly can lead of shift in threshold of hearing.
b) The indirect impact include speech interference, lack of concentration, sleeping problems.
c) Clinically, exposure to noise at higher values can also lead to increased blood pressure and hyper tension.

This is the general situation or normal days. The anthrapogenic noise produced during fairs and festivals alter this pattern bringing about abnormal deviations. Few of the festivals of 10 days duration, each, namely the Ganesh Festival, Navaratri and Diwali becomes noisy (90-100 dbA) due to the use to high powered microphones and loud fire crackers and beating of drums, especially during night. Such high noise levels have a negative impact of humans and wildlife.

TABLE 1
Summary of the recommended noise exposure limits - WHO 1980

Environment	Recommended max	Effects
1. Industrial	75 dbA – leq (8 hrs)	Risk of loss of hearing at higher levels.
2. Community	Day 55 dbA Night 45 dBA	Annoyance increases Sleep disturbance
3. Indoor / Domestic	Day 45 dBA Night 35 dBA	Speech interference. Sleeping Problems

TABLE 2
The Noise Pollution (Control and Prevention) Act 2000 recommendations.

	AREA	DAY	NIGHT
1.	Industrial	75 dbA	70 dbA
2.	Commercial	65 dbA	55 dbA
3.	Residential	55 dbA	45 dbA
4.	Silence zones	50 dbA	40 dba

DAY time is between 6 a.m. to 10 p.m.
Silence zone area around hospitals, courts and educations Institutions.

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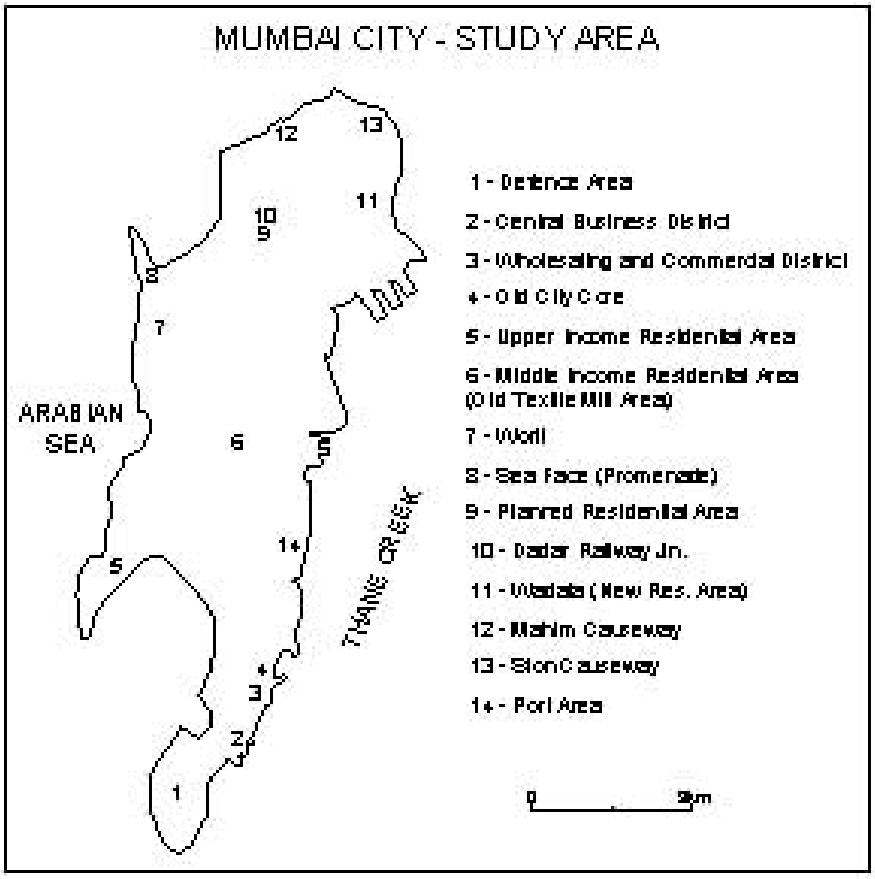

Fig. 1

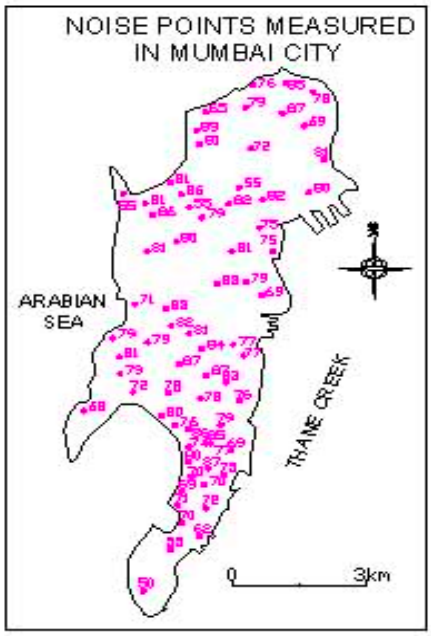

Fig. 2

Fig. 3

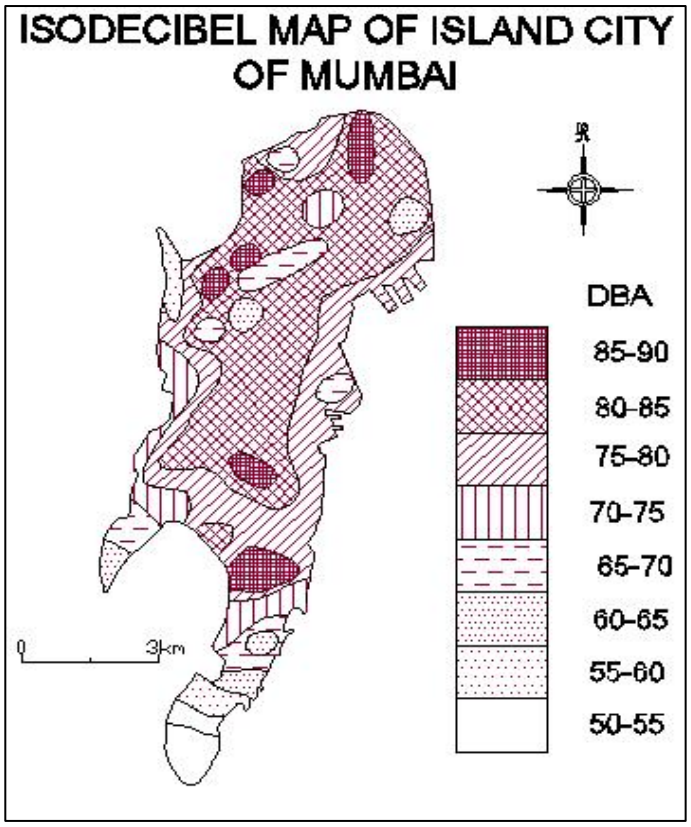

Fig. 4

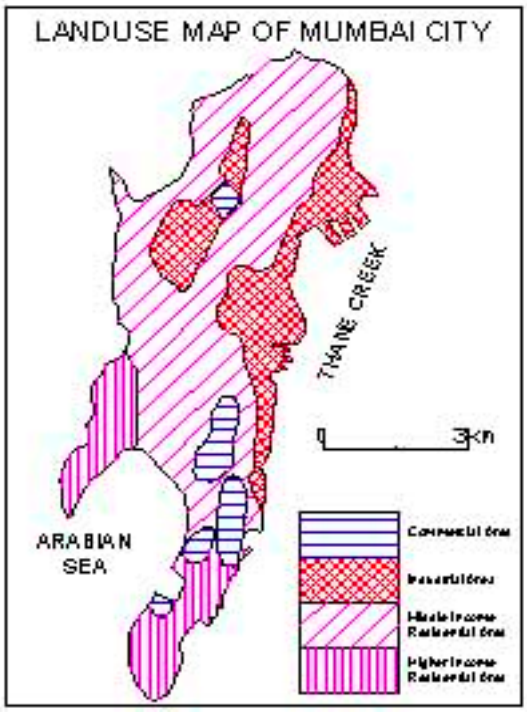

Fig. 5

Fig. 6

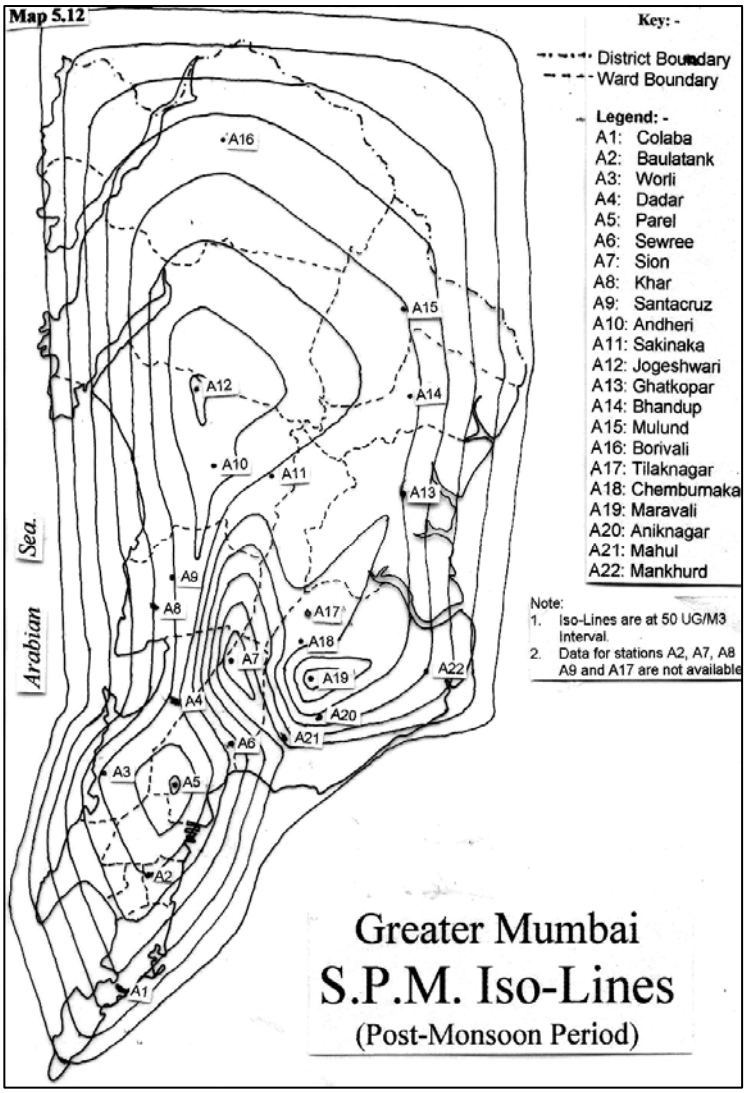
Map 5.12
Key: -
District Boundary
Ward Boundary
Legend: -
A1: Colaba
A2: Baulatank
A3: Worli
A4: Dadar
A5: Parel
A6: Sewree
A7: Sion
A8: Khar
A9: Santacruz
A10: Andheri
A11: Sakinaka
A12: Jogeshwari
A13: Ghatkopar
A14: Bhandup
A15: Mulund
A16: Borivali
A17: Tilaknagar
A18: Chembumaka
A19: Maravali
A20: Aniknagar
A21: Mahul
A22: Mankhurd
Note:
1. Iso-Lines are at 50 UG/M3 Interval.
2. Data for stations A2, A7, A8 A9 and A17 are not available
Arabian Sea.
Greater Mumbai
S.P.M. Iso-Lines
(Post-Monsoon Period)

Fig. 7