Development of GIS based Noise Simulation Software (DGNSS)

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ABSTRACT - The objective of the study is to develop GIS based noise simulation software for heterogeneous traffic conditions in metropolitan cities. In the present study traffic noise simulation software has been developed for sound level calculation. The software covers the following five input variables i.e., noise sources (point and mobile), vehicle speed, distance, honking and noise attenuation while noise Leq is the output of the software. The software is implemented for traffic noise level prediction at eight selected locations of Nagpur city. The field data is collected for a period of 15-minutes during the morning and evening rush hours. The correlation coefficient between measured and predicted noise Leq found to be 0.84. Results show that the software performs reasonably well for heterogeneous traffic condition and could be implemented in other region for noise level prediction.

Keywords: Honking, heterogeneous traffic conditions, prediction, traffic noise

1.0 Introduction:

With increase in traffic volume, urbanization, industrialization and associated infrastructural development has resulted in increase noise pollution.

Noise pollution has become a prominent problem and need urgent attention (Banerjee, 2012). Therefore, it is important to assess and quantify the noise pollution from various sources and also develop measures to mitigate its impact. Various noise prediction models have been reported in literature including the CRTN model, FHWA model, and the ASJ model (Steele, 2001). A common criticism of these existing models is that, they are not user friendly and the results are not always presented in a format that can be easily visualized. Visualization is particularly important in analyzing and predicting the noise levels. For assessment of traffic noise the information and data required are road schemes, landuse/landcover, noise barriers and buildings etc. All these data are having three dimensional spatial characteristics which traditional noise models are not able to handle. In order to resolve problems related to user interactive and spatial database handling, GIS based noise simulation software is designed and developed based on Indian conditions (Sharma, 2009). The applicability of the software is demonstrated through a case study where noise levels are simulated and visualized spatially and temporarily.

2.0 Material and Method:

The noise simulation software is a user-interactive and platform independent application developed in VB.NET framework (Holzner, 2005). Fig. 1 illustrates the overall architecture of the software which comprises of following modules:

1) Inputs required
2) GIS analysis
3) Noise computation
4) Noise level visualization

GIS based noise simulation software includes three stages of noise processing and computation. Stage I and III include GIS analysis and visualization of noise while, Stage II includes noise computation based on GIS analysis performed in Stage I.

Stage I: In this stage, various thematic layers and inputs like landuse pattern, vehicle inventory, and sources of noise, simulation points and metrological data are analyzed for noise simulation. These inputs are prepared and processed on GIS platform as shown in Fig. 1. After GIS analysis, the processed data in the form of distance between sources of noise and simulation point, vehicle inventory (various types of roads), various noise attenuation based on landuse and meteorological data are provided to GNSS.

Stage II: In this stage, user has to login with user name and password to start the software. After successful login, software main interface appears as shown in Fig 2. User can select 'File' option on main interface for noise computations. Inputs required for noise computations are provided by various interfaces as shown in Fig 3-5.

Inputs required for noise computation includes noise sources and simulation points (points where the noise level are to be simulated by the software), distance file which comprises of distance between simulation points and noise sources, various attenuations (noise barriers, ground absorption etc), metrological data (temperature, humidity, frequency of noise sources) and constants. Fig. 3 provides interface for point and mobile sources noise calculation with 'POINT SOURCE' and 'VEHICLE INVENTORY' buttons. Fig.

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4 illustrates the noise level computation for point sources like aerators of waste water treatment facility, pumping station etc. User can enter N numbers of point sources with their noise intensity, its distance from simulation points.

After noise level computation due to the point sources, the software stores the result for further computations. Similarly noise level due to mobile sources are estimated based on vehicle inventory, speed of vehicle, frequency of vehicles (hourly vehicle inventory) and their respective noise intensity (Fig 5).

After these computation, cumulative noise level due to point as well as mobile sources are estimated on simulation points based on logarithmic additions of noise levels from point and mobile sources. The results are saved in the excel format as shown in Fig 6. The average period for day and night time noise simulation is considered as 6:00 to 20:00 and 20:00 to 6:00 respectively as per Central Pollution Control Board, New Delhi guidelines (Noise Standards, 2000).

Stage III: The simulated noise levels are exported to GIS platform for spatial and temporal visualization as shown in Fig 7. The results illustrates that the software is able to visualize the impact of point sources like WWTF, SPS etc and mobile sources on highways and major roads etc (Fig 7a). In order to demonstrate the applicability of GNSS the software is tested for real time noise data, which was observed at various locations of the study area (Fig 7b). The co-relation coefficient between observed and simulated noise level is found to be 0.81.

3.0 Conclusion:

The applicability of software is demonstrated through a case study of urban metro environment with reasonable well correlation between observed and simulated noise. Application and features of the software are illustrated below:

The noise simulation software is standalone, platform independent and user friendly.

Software provides spatial and temporal visualization of noise level based on local climatic and geographical conditions.

Software can simulate and predict noise level due to various developmental activities.

The software can also be used as a decision making tool for designing of noise barriers and green belt.′

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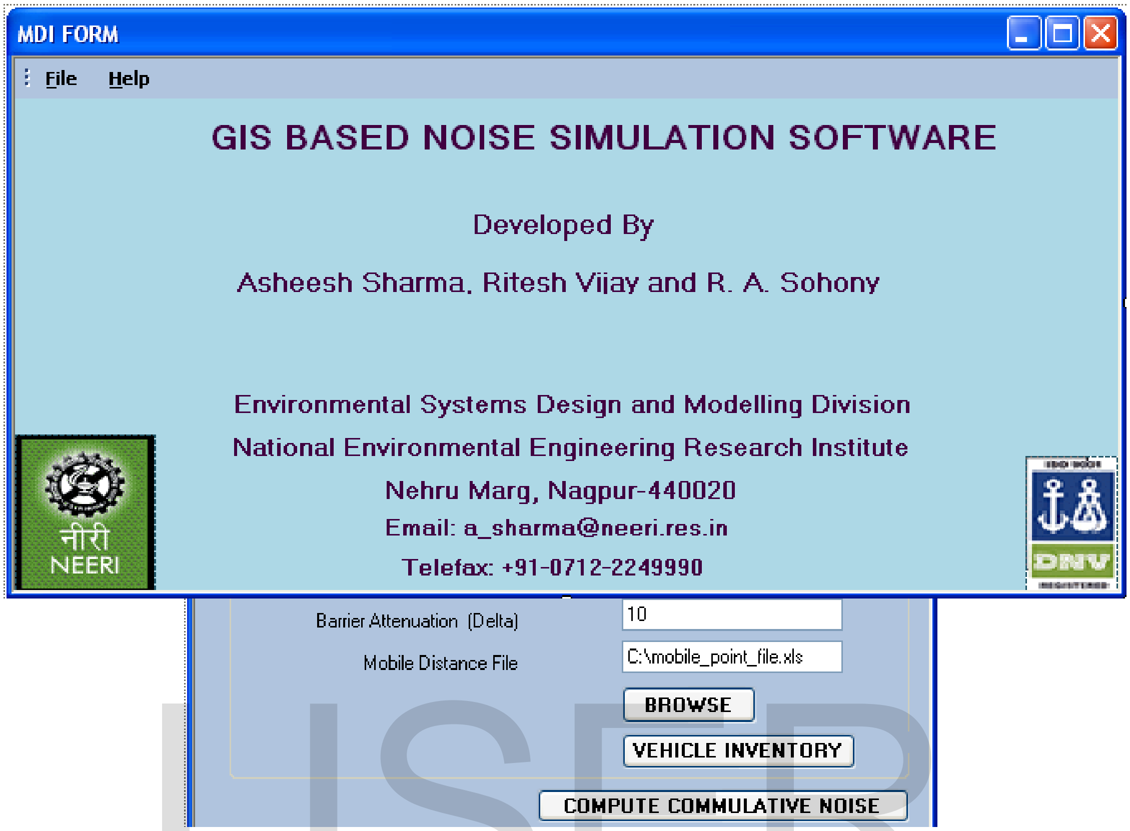
Fig 1. Overall architecture of GNSS



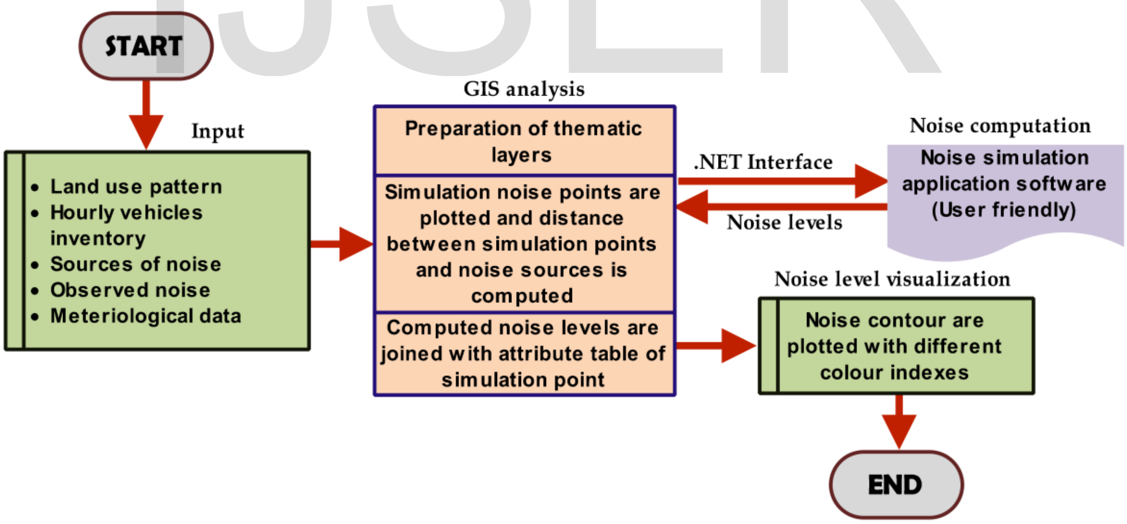


Fig. 3 Cumulative noise computation

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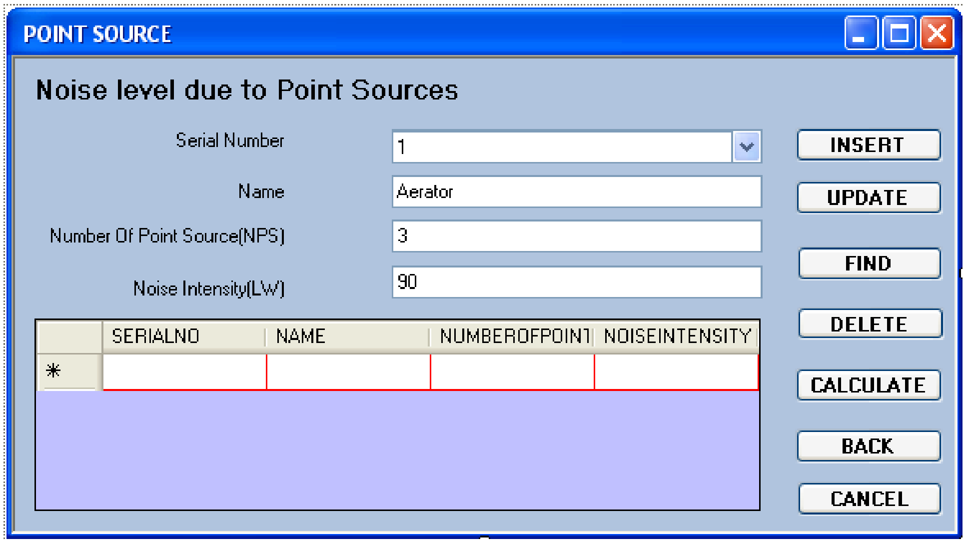

Fig. 4 Noise computation due to point sources

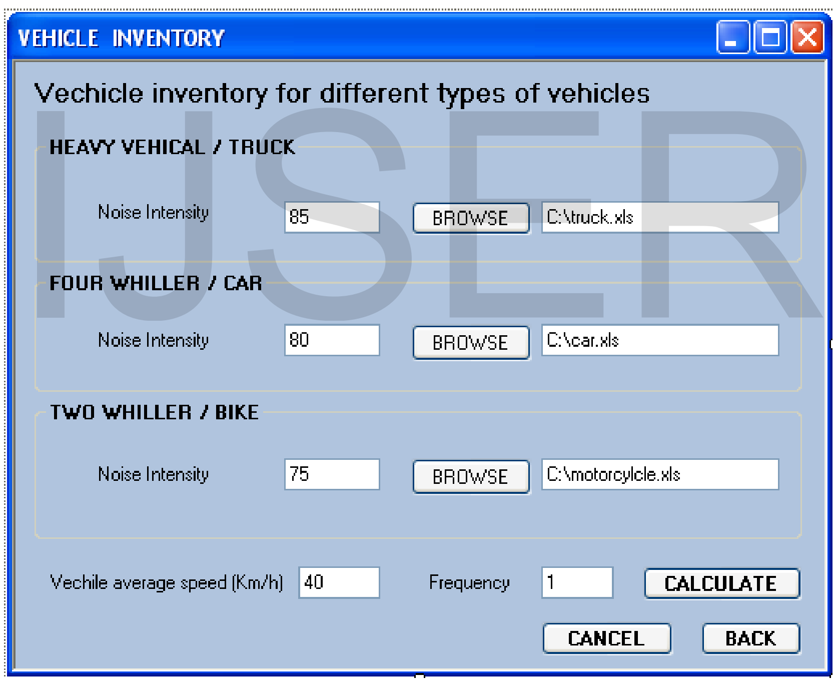

Fig. 5 Noise computation due to mobile sources

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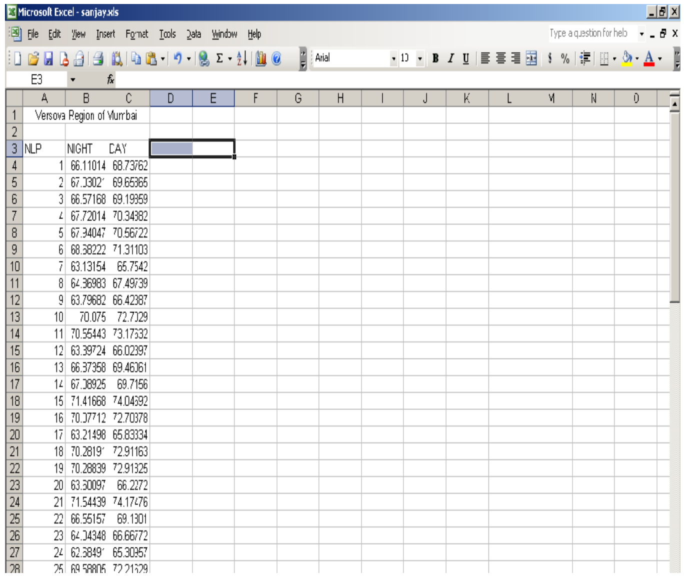

Versova Region of Mumbai

NLP	NIGHT	DAY
1	66.11014	68.73762
2	67.3302	69.65365
3	66.57168	69.19359
4	67.72014	70.34382
5	67.94047	70.56722
6	68.68222	71.31103
7	63.13154	65.7542
8	64.36983	67.49739
9	63.79682	66.42387
10	70.075	72.7029
11	70.55443	73.17632
12	63.39724	66.02397
13	66.37358	69.46061
14	67.08925	69.7156
15	71.41668	74.04692
16	70.07712	72.70378
17	63.21498	65.83334
18	70.2819	72.91163
19	70.28839	72.91325
20	63.60097	66.2272
21	71.54439	74.17476
22	66.55157	69.1301
23	64.04348	66.66772
24	62.6849	65.30957
25	69.58805	72.21629

Fig. 6 Cumulative Day and Night time noise levels

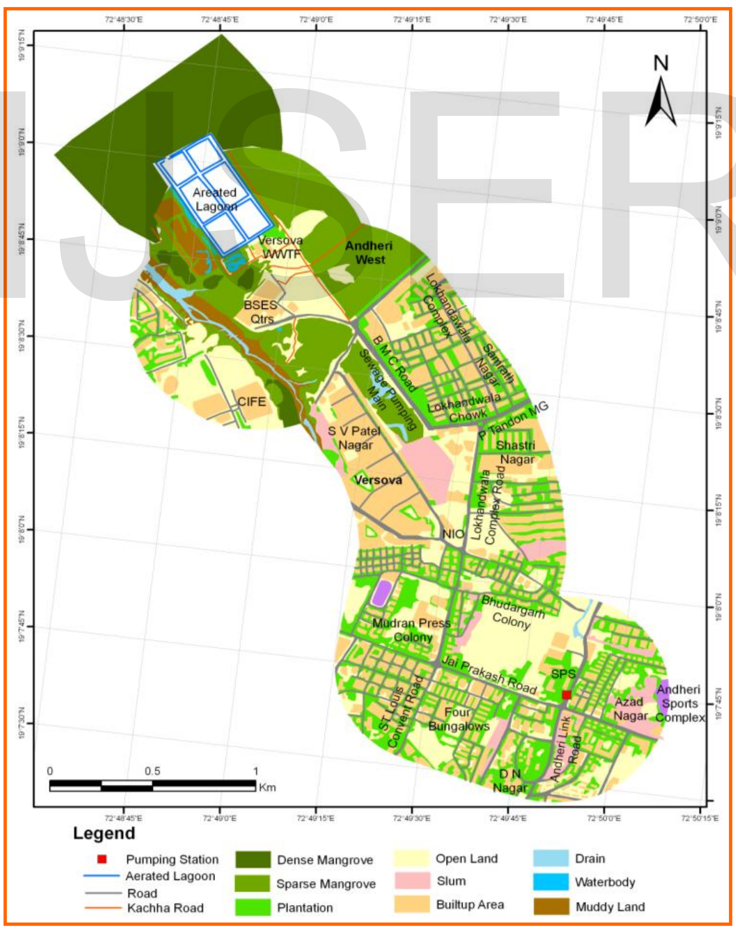

Fig. 7 a) Case study with various noise sources

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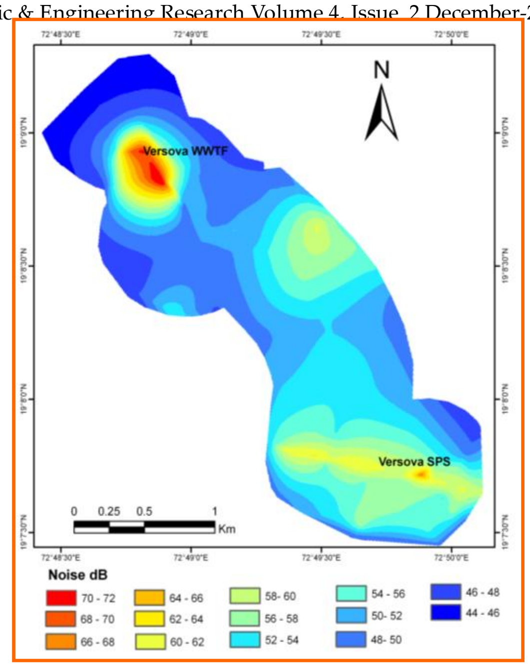

Fig. 7 b) Simulated noise in the study area

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