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GIS based Assessment of Noise Pollution in Guwahati City of Assam, India

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ABSTRACT

A GIS based noise assessment was carried out to study the noise pollution scenario of Guwahati city at various locations, i.e. commercial zones, residential zones and silence zones (educational institutions and hospitals and nursing homes). Sound Level Meter (SLM) was used for assessment of noise levels and noise mapping was done using Geographic Information System (GIS) technique. From the study, it was observed that noise environment of the Guwahati city is deteriorating and unsafe in various locations for human and it exceeds the noise standards suggested by the Central Pollution Control Board (CPCB) and Bureau of Indian Standards (BIS). This study also highlighted the noise polluted and vulnerable areas through the diurnal noise mapping. It was also observed from the study that, places with high traffic congestion, narrow roads, heavy constructional activities and poor traffic management areas are more vulnerable to high noise levels. Some of the educational institutions, hospitals and nursing homes are also in the grip of high noisy environment. Highest noise levels ranging between 80-90 dB (A) recorded in commercial locations, 65-75 dB (A) in residential areas, 65-75 dB(A) in silence zone in the city.

Keywords: noise level, dB (A), Commercial zone, residential zone, silence zone, sound level meter (SLM), ArcGIS, noise mapping

1. Introduction

A noise is an unwanted sound with random intensity of signals that bears no information (*Encyclopedia America*na). It is generally defined as a 'sound in the wrong' place at the 'wrong time' that causes general feeling of annoyance and irritation, fatigue and damage to the auditory mechanisms. The word 'noise' is derived from Latin word "nausea" implying 'unwanted sound' or 'sound that is loud, unpleasant or unexpected' (Pawar *et al.* 2010). It is one of the most immediate and identifiable environmental problem associated with rapid industrialization, urbanizations and population growth. However due to its invisible impacts and associated health problems, people are least concern about noise pollution and ignore its menace. Generally, high exposure to noise level can causes feeling of annoyance and irritation, damage to auditory mechanisms, number of health related effects like physiological disorders, psychological disorders, disturbances of daily activities and performances, hypertensions and ischematic heart diseases (Canter, 1996). The most serious health hazards associated with high level of noise exposure is deafness which initially causes temporary hearing problem or deafness while prolonged exposure to high noise level causes permanent hearing damage. Primary cause of hearing loss due to exposure to noise is termed as Temporary Threshold Shift (TTS) and due to very high level exposure to noise may cause Noise Induced Permanent Threshold Shift (NIPTS) (Canter, 1996; Mahesh *et al.* 2001). Various studies have been carried out in India (Mohan et. al. 2000; Naik and Purohit 1999; Gupta and Chakraborty 2003; Kumar and Somsekhar 2002) revealed that some of the Indian cities are having high noise level than the standards prescribed by CPCB (Central Pollution

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Control Board) and MoEF (Ministry of Environment and Forest, Govt. of India). The extensive noise assessment carried out recently showed high noise levels in various locations of Guwahati city (Deka and Alam 2006). The study carried out by CPCB revealed that noise levels exceeded 109 dB (A) in commercial areas, 92 dB (A) in residential areas and 91 dB(A) in silence Zones during Dewali, Dushera and other religious and cultural festivals (CPCB, 2000). Assam Pollution Control Board (APCB) also indicated higher noise levels in many locations of the city than the noise standards prescribed by CPCB.

2. Study Area

The Guwahati is the capital city of state of Assam, situated in the North Eastern Region of India. This city is the largest and fastest growing commercial, industrial, educational centre in the North Eastern region of India. Geographically, it is located in the southern bank of the River Brahmaputra between 26º 05' to 26º 15' N Latitude and 91º 35' to 91 º 55' E Longitudes covering an area of 264 Sq.Km. It is located on an undulating plain with varying altitude of 49.5 m to 55.5 m above mean sea level (MSL) (*Guwahati Metropolitan Development Authority, 2006*). The climate is sub tropical with semi-dry summer and cold in winter. The average maximum temperature is about 29.3 ^{0}C in summers and average minimum temperature is about 19.1 ^{0}C. The average annual rainfall is 1717.7 mm with average humidity of the city is about 75%, (*Source: Climatological Table, Indian Meteorological Department).*Guwahati is recently recognized as one of the most critical city in North East India (GMDA, 2006) due to its fast economic, industrial and population growth among the all other city of the region. It is also considered to be the "Gateway" to the North Eastern Region of India as it is the Junction of many national highway railways and airways of the region. These national highways connect the region with rest of the country through state highways of the neighbouring states. A broad gauge railway line passes through the heart of city and connects major parts of the country. Guwahati international airport is the largest and busiest airport in the region which also connects major cities within the country and also some of the neighbouring countries. It is a fastest growing city in the region with rapid urbanization and industrialization. These have resulted in great influx of people from different parts of the country and from within the state this city resulting an exponential growth in population in last few decades. The population of the city was about 0.89 million (Census 2001) and it has grown up to 6.5 times from 1971 to 2001. The decadal population growth in Guwahati metropolitan area is nearly 37.85%, which is substantially higher than that of the national decadal growth of 21.35% (*Census Statistical Hand Book and Zoning Regulations for Guwahati*). At this decadal growth rate, the projected population by year 2011 is 1.19 million and by 2021 is 1.75 million (NIUA, New Delhi 2006). Among all other cities in the state,Guwahati is the largest urban center in Assam with 23.89% of the total urban population of the state and it alone contributes 55% of the combined population of the significant towns within the state (*Source: Various issues of the Census India*).The traffic scenario of Guwahati city indicates a exponential increase of all types of vehicles in the city road. The average of 71,824 vehicles entered and exited the city area at the outer cordon (OC) on an average day (GMDA, 2007). The inadequacy of internal linking roads, subways, existing narrow roads and lack of parking space has deteriorated the traffic scenario of the city to a great extent. Limited road networks and lack of sufficient road space has resulted in perpetual congestion on the main as well as arterial roads within the city leading to pathetic condition of traffic and uncontrolled noisy environment in various locations. The length of surface road within city is presently 218 km and major corridor roads suffer from insufficient space problem due unauthorised construction and improper planning and design (ARSAC, 2008). The roads in residential areas are extremely narrow causing problem to both traffic and infrastructure

development. The city is very well connected to adjoining region by bus services. Paltan Bazaar, Adabari and Inter State Bus Terminus (ISBT) at Betkuchi are major nodal points within the city.

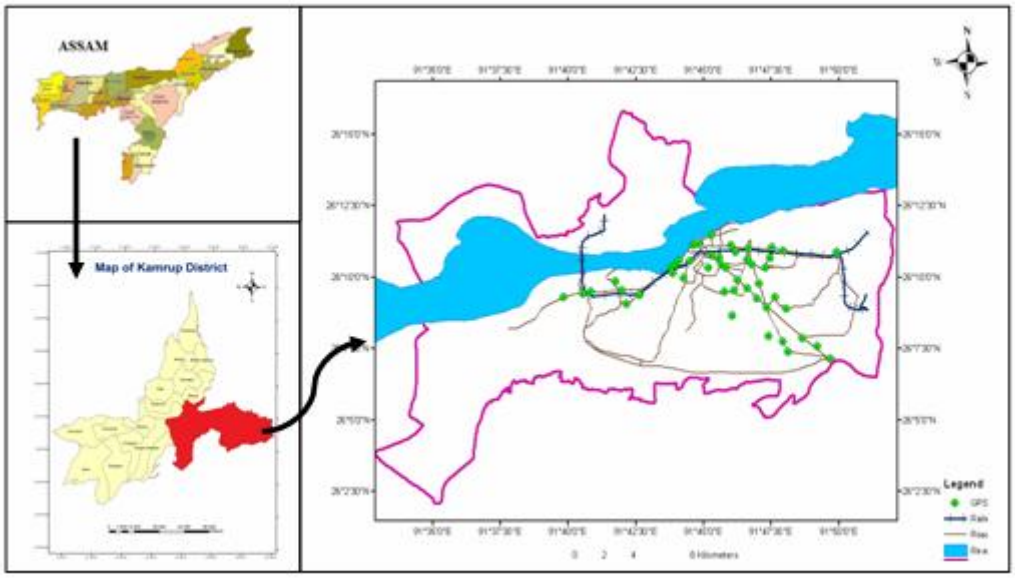

Figure 1: Map showing Sampling Locations of Study Area of Guwahati city with Road and Rail connectivity

3. Materials and Method

A noise level survey was carried out to assess the noise environment of Guwahati city in the south bank of River Brahmaputra. The study was carried out in some selected locations of the city i.e. in heavy traffic zones, highly populated areas and areas with educational institutions, hospitals and nursing homes. The noise levels were assessed with Sound Level Meter (SLM) (model: 8928 Digital Sound Level Meter). This instrument measures the sound pressure level in dB (A) i.e. decibels in A-weighted scale. The sound pressure level or sound level measured in decibel (dB) is a logarithmic measure of the effective sound pressure of a sound relative to a standard reference value. The dB (A) Leq denotes the time weighted average of the sound pressure level in decibels on scale 'A' which is relatable to human hearing. The Leq is calculated using the following equation:

$$L_{eq,T} = 10\log\left(\frac{1}{n}\sum_{i=1}^{n} 10^{\frac{L_i}{10}}\right)$$

A-weighting is the most commonly used curves defined in the International standard IEC 61672:2003 and various national standards relating to the measurement of sound pressure level. The sound level meter consists of microphone or receiver, preamplifier, weighting network, amplifier, rectifier and digital LCD display meter.

Parameters measured

Assessment of noise level or sound pressure level in dB(A) (A- weighted decibels) was carried out using Sound Level Meter (SLM) in different zones of the study area including 24 commercial locations, 20 residential locations, 18 educational institutions, 16 hospitals and

nursing homes. The sound level meter used, can measure the sound frequency from 300 Hz to 8 kHz and from 40 dB to 130 dB in A-weighted scale at four ranges. *i.e.* 40 to 70 dB(A) for low; 60 to 90 dB(A) for medium; 80 to 110 dB(A) for slightly high and100 to 130 dB(A) for higher intensity of sound.

Period and regularity of measurement

The noise level were measured at different locations of the city covering different zones viz. commercial, residential and silence zones (educational institutions and nursing homes & hospitals) for few consecutive months. Average time of 20 minutes was followed for measuring noise levels at each location at different time of the day. The sound level meter was handled at proper orientation to receive the maximum sound intensity at 3 m height above the ground. The same procedure was maintained for all the survey points in the city. The noise assessment was conducted during morning (7 to 9 am), noon (12 to 2 pm) and evening (7 to 9 pm) of the day. The GPS points were also collected for each location for accurate coordinates of the sampling points for the purpose of noise mapping. An appropriate distance and proper orientation of microphone of the sound level meter (SLM) was maintained for each sampling locations.

Noise mapping

Noise mapping was prepared using ArcGIS 9.3.1 software for better visual information of the noise environment of Guwahati city and it's diurnals variations. ArcGIS 9.3.1 software used to plot the noise levels contours using interpolation (krigging) technique. Interpolation is an effective technique used by various researchers for the purposes of noise mapping (Pamanikabud 1996, Anile *et al*. 2003, Yilmaz *et al*. 2005). In this interpolation technique, krigging is done considering to assess the acoustic behaviour of the geographical area. The noise level maps were prepared in ArcGIS for different times of the day to show the diurnal variation of the noise environment in the city. ArcGIS, appropriately gives better visual information of the regions with higher noise levels and traffic accumulations and also identifies the more vulnerable areas under the noise pollution threat.

4. Results and Discussion

This noise survey reveals that noise environment of the Guwahati city is not so satisfactory as per the standards prescribed by CPCB and BIS "The Noise Pollution (Regulation and Control) Rules, 2000" (Table 1). The scenario is deteriorating day by day with exponential increase in population as well as the number of vehicles in city road. Moreover, inappropriate traffic management, lack of parking space and poor road condition has contributed a lot to the noisy environment of the city.

Table 1: Ambient Air Quality Standards in respect of Noise
(Source: The Noise Pollution (Regulation and Control) Rules, 2000)

Area Code	Category of Area/Zone	Limits in dB(A) Leq	
		Day Time	Night Time
(A)	Industrial Area	75	70
(B)	Commercial Area	65	55
(C)	Residential Area	55	45
(D)	Silence Zone	50	40

In Table 1 day time mean from 6.00 am to 10.00 pm and night time from 10.00 pm to 6.00 am. The silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority (The Noise Pollution (Regulation and Control) Rules, 2000). From the noise survey results, it was observed that the noise level in commercial locations of the city during the day time at 12 noon to 2 pm is higher due to plying of more vehicles and huge accumulation of traffic than the noise level at morning (7 to 9 am) and evening (7 to 9 pm). Some commercial locations like Paltan Bazar, Guwahati Club, Ganeshguri, Khanapara, Maligaon Charilali showed higher noise levels (more than 80 dB(A)) than other commercial places as these places are always crowded with all type of vehicles, narrow roads and poor traffic management system. Apart from these, in all other commercial places noise levels exceeds the noise standard prescribed by CBCB i.e. 65 dB (A) at all sampling time of the day. Commercial areas are having noisier environment in noon time (12 to 2 pm) than the morning (7 to 9 am) and evening (7 to 9 pm) time of the day. Similarly, residential areas also showed higher noise levels than the prescribed noise standards. In some residential areas like Hegerabari, Rehabari, Rajgarh, Bamunimaidan Railway colony and Hatigaon situated nearby roadside showed higher noise level i.e. more than 75 dB(A). Most serious problem associated with high noise levels of the study areas are in silence zones of the city. The study showed that the silence zones including hospitals, nursing homes and educational institutions in the city are in the grip of heavy traffic noise and disturbances. According to "The Noise Pollution (Regulation and Control) Rules, 2000, the silence zone is an area comprising not less than 100 metres around hospitals and educational institutions but it was found that most of the hospitals, nursing homes and educational institutions do not follow this norm and they are situated in either in commercial places or nearby heavy traffic plying roads. Most of the hospitals and nursing homes premises are having higher noise levels than the prescribed noise standards of 50 dB (A). Graph 5. shows that the educational institutions of the city are also in the grip of heavy traffic noise and are not safe from noise induced disturbances. Most of the institutions are situated in the heavy traffic zones and commercial places of the city and heavy vehicles plying through or nearby these institutions are inducing high noise levels resulting in a noisy environment around the institutions.

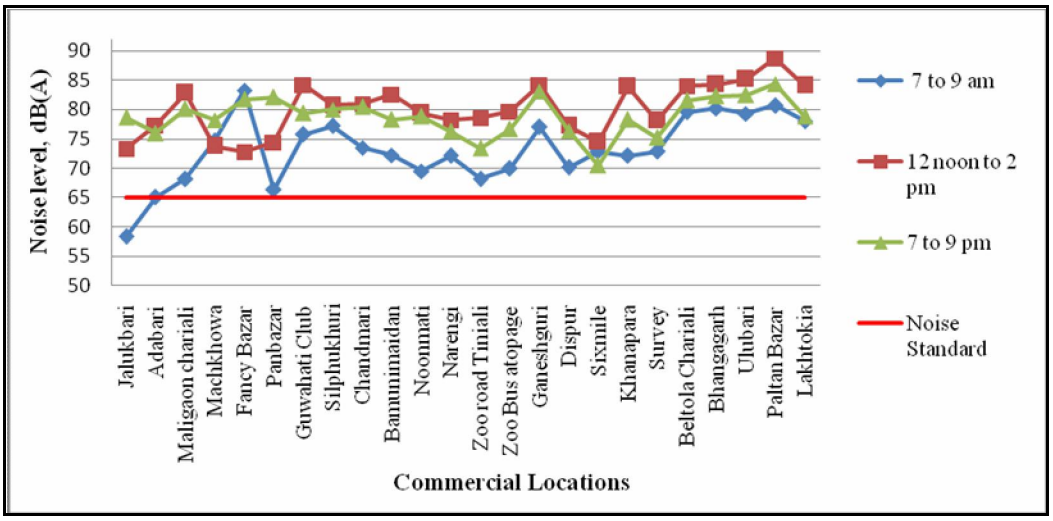

Figure 2: Noise Levels in some Commercial Locations of the Guwahati city

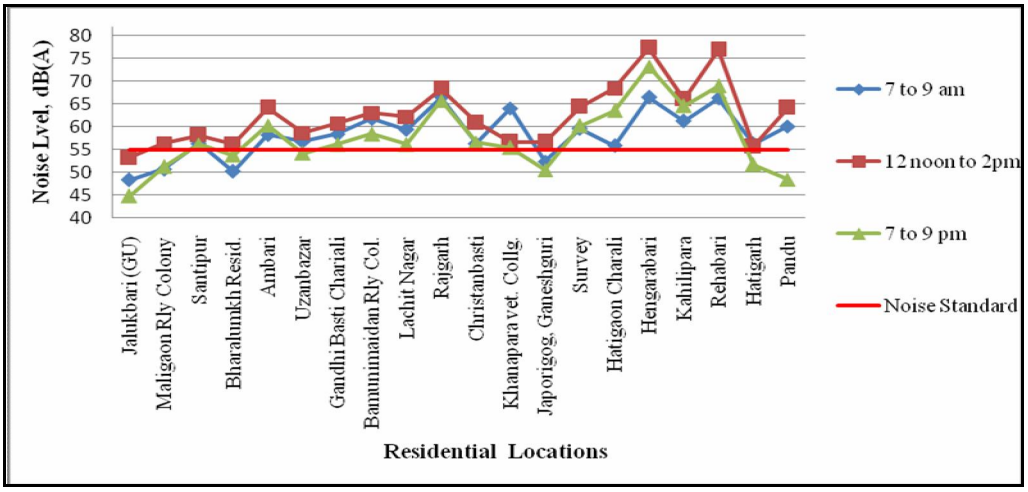

Figure 3: Noise Level in some Residential Locations of the Guwahati city

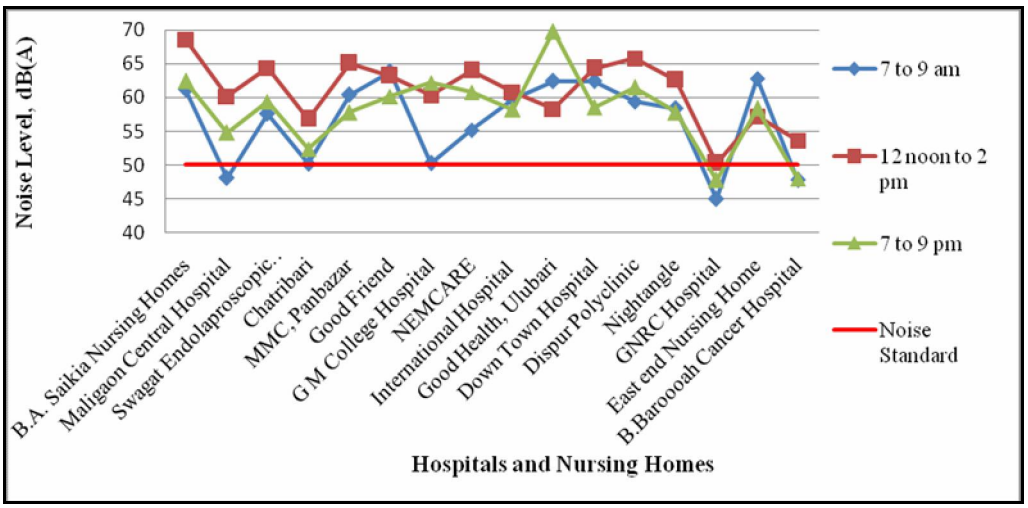

Figure 4: Noise Level in some Hospitals & Nursing Homes (Silence zone) of Guwahati city

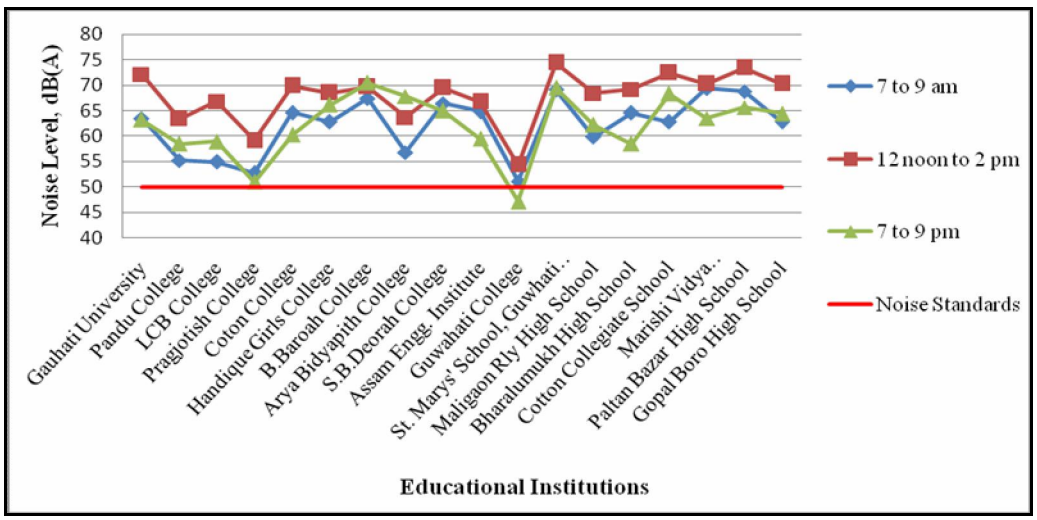

Figure 5: Noise level in some Educational Institutions (silence zone) of Guwahati city

Noise mapping

Noise level data obtained from various locations of the Guwahati city along with geographical coordinates collected with GPS were plotted in ArcGIS 9.3.1 software. Interpolation (krigging) technique was applied for noise mapping, considering the distances between the sampling locations and noise levels at each location. The diurnal noise maps were prepared of the study area comprising of three zones *viz*. commercial, residential and silence zones.

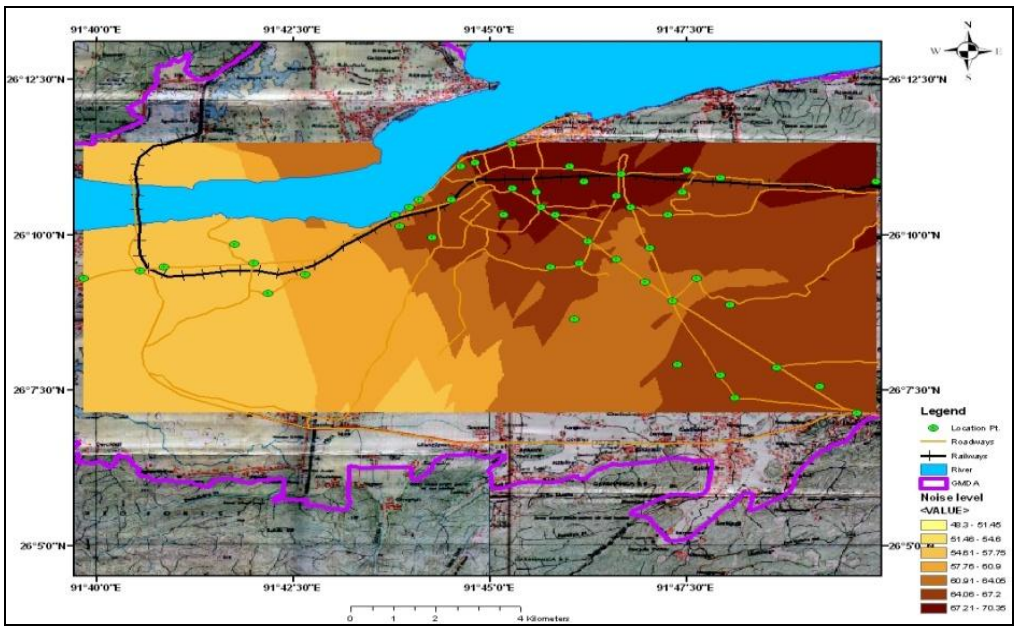

Figure 6: The map showing noise level in dB(A), between 7 am to 9 am (morning)

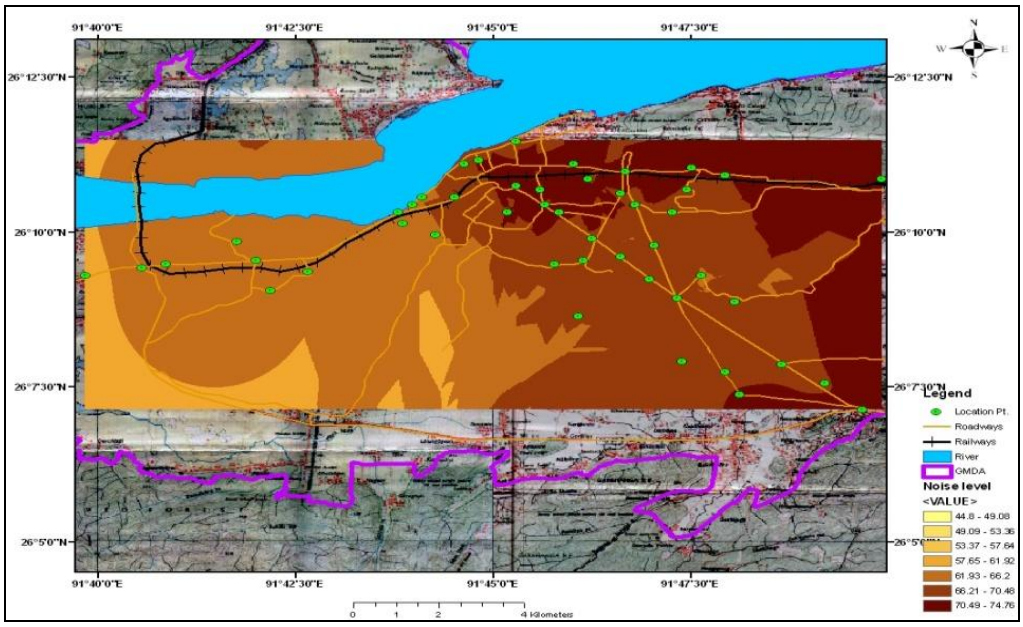

Figure 7: Map showing Noise Level in dB (A), at few locations of the city during 12 noon to 2 pm. (noon)

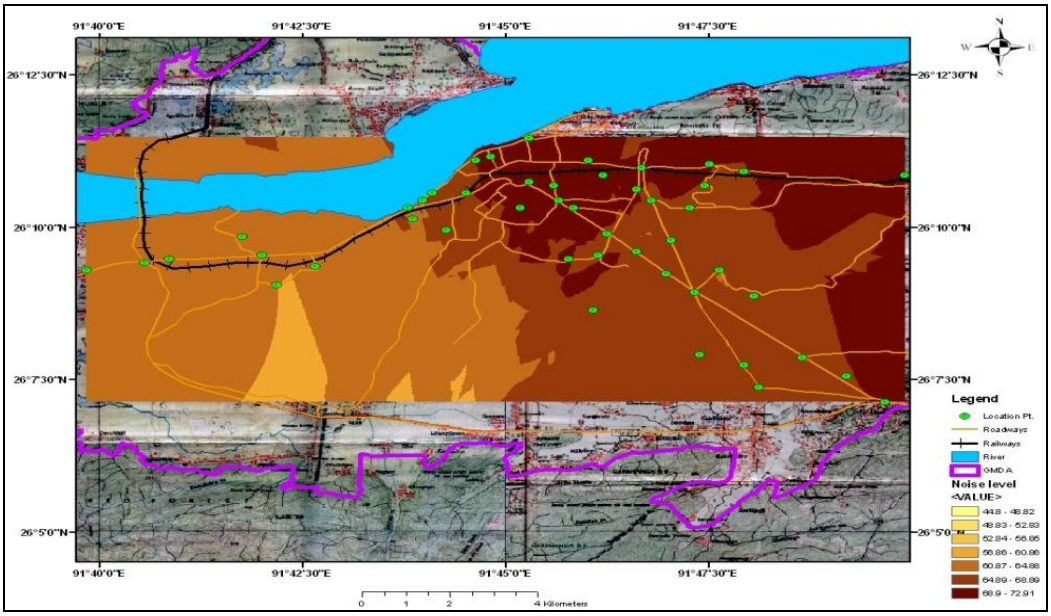

Figure 8: Map showing noise level in dB (A) at different locations of Guwahati city during 7 pm to 9 pm.

Noise maps of the city (Fig 6 to Fig. 8) show that, as one move towards the heart of the city i.e. from Jalukbari towards Maligaon, Fancy Bazar, Paltan Bazar, Ulubari, Bhangagarh, Guwahati Club, Silphukhuri, Noonmati, Narengi and towards Ganeshguri, Sixmile, Khanapara side, the noise level also increases. This is because of fact that these places are highly populated, with most of the commercial establishments and narrow and crowded roads with all types of vehicles plying. All the large commercial and trading establishments, government offices and establishments, hospitals, nursing homes and educational institutions are mostly situated in this part of the city. Therefore, these places are comparatively having high noisy environment than the other parts of the city. The other factors for escalating noise levels is parts of the city is due to narrow subways, which are always crowded with large number heavy vehicles like city buses, goods carrying trucks, private and public vehicles, cars and other two-three wheelers. Improper traffic management, lack of parking spaces, subways and flyovers also leads to heavy traffic congestion leading to a noisy environment.

5. Conclusion

The noise assessment of the Guwahati city indicated that the noise levels in the city is escalating at a very fast rate with growing population and heavy traffic accumulation. Noise levels obtained at different locations of the city *viz*. *commercial, residential* and s*ilence zones* are found to be exceeding the noise level /limits prescribed by the CPCB and "The Noise Pollution (Regulation and Control) Rules, 2000". It was also observed that in many commercial areas of the city, the noise level exceeded 80-90 dB (A) whereas in residential areas highest noise level recorded between 65-75 dB (A). In silence zones noise levels exceeded 65-75 dB (A). It was also observed that higher noise level in the city is due to rapid and unplanned urbanisation resulting in great influx of people from all parts of the region and country, improper management of city roads and traffics, lack of sufficient parking spaces and exponential growth of both private and public vehicles in the city. The greenery and forest cover decreasing at alarming rate due to unplanned growth and urbanisation has

resulted in reducing noise cushion in the city. Narrow linking roads, absence of arterial roads and lack of flyovers & over bridges in some locations of the city are responsible for huge gathering of vehicles resulting in a chaotic and noisy environment.Thus it is felt that noise environment of Guwahati city may pose as a great threat to the health of dwellers of Guwahati city in long term. This is because high level of noise may not cause serious or immediate effects but if, such noisy environment prevails, it may impact the population in many ways. Therefore, a strict enforcement of law and regulation is felt in this regard. Also, creating diversion for heavy vehicles outside the city, planting of more trees in roadside for sound cushion, constructing noise barrier wherever necessary, broadening the roads, constructing flyovers and over bridges, creating more parking spaces are some remedial and preventive measures which can be considered for improving the noise environment of the Guwahati city.

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