CHAPTER-3

RESEARCH METHODOLOGY

Prediction is a very important part of noise impact assessment. The basic prediction procedure involves consideration of the nature and noise level of the sources, propagation along the paths between sources and receivers and the location of the receivers. The traffic noise model, predicts the 1-hour average noise level for flow of vehicles travelling along an infinitely long line. Many prediction methods are source specific and empirical. In his study, the author has defined light vehicle number per hour, heavy vehicle per hour and average speed as an effective factor in modeling road traffic noise (Manatakis E.K. 2011).

Each vehicle in the stream with mixed traffic system has a specialnoise generation characteristic and this fact makes the road traffic noise problem little complex (Gupta, et al 1984).The traffic volume at all the locations have been summarised in the form of total traffic volume for both directions for every hour. The traffic speeds have been summarised in the form of average traffic speed values calculated for every hour. The basic noise data was obtained using sound level meter placed 1.2m above ground. A field data collection programme was chalked out for collecting data regarding traffic volume, speed, ambient noise level, geometric parameters like road width, number of lanes, lane width etc.

At the onset of the project, measurement of traffic noise levels from several selected locations was carried out. The factors that affect traffic noise can be categorized as Traffic factors, Metrological factors and Measuring Site factors. A brief description of these factors that are relevant to this work is given below.

Traffic Factors: In this work the traffic is divided into eight main groups, Bus, Car,Double cab, Jeep, Lorry, Motor cycle, Three-wheeler and Van. It was assumed that only these vehicle types contribute to the highway traffic noise and that all vehicles can be categorized into one of these classes. It should be noted that the noise levels can vary even within the selected categories. Mode of operation of vehicles also affects the noise levels. An accelerating vehicle may produce a different level of noise than a vehicle moving at steady speed. Traffic volume and condition of the vehicles can also increase the noise level.

Metrological Factors: Sound levels are affected by meteorological conditions such as wind, temperature and humidity. A special windscreen made out of porous polyurethane sponge was used over the microphone for minimizing the Aeolian effect. Atmospheric attenuation of the noise reduces the noise level when travelling through the air. Ambient temperature, relative humidity and ambient pressure influence the noise levels too. In all measuring sites air temperature was within the range of 10°C to 50°C and humidity was approximately 90%.

Site Factors: The measuring site may have different conditions that couldaffect the noise measured. The condition of the road, the adsorption of noise waves by the ground and obstacles such as buildings, walls, trees that reflects sound would affects the measurement. The residual noise generated by other sound sources in the measuring area is a major influence to the noise level and should be minimized as possible.

When selecting the measuring site all possible precautions should be taken to minimize some of the effects mentioned above. These factors are,

a. Minimum influence of reflection
b. Minimum residual noise
c. Good road conditions
d. Good free flow of traffic

Methodology of the proposed research work is depicted in the form of a flow chart shown inFigure3.1.

The methodology of this research includes the following stages:

Stage 1: Identification of noise pollution problem and its adverse effects on people

Stage 2: Review of existing studies on noise pollution modelling and GIS applications

Stage 3: Formulation of objectives of research

Stage 4: Chennai selected as the study area which is a combination of residential as well as commercial with heavy volume of traffic.

Stage 5: Traffic volume, noise levels, spot speeds are collected at edge, and at distances 5m, 10m and 15m from source of noise. Noise levels are recorded from 8.01 am to 9.00 pm. The Noise levels are measured using Sound Level Meter in Ground Floor as well as First Floor to show variation of Noise levels at different heights.

Stage 6: Analysis of data, development of GIS and multiple linear regression models

Stage 7: Comparison of the two models and

Stage 8: Results and discussion of study and conclusion

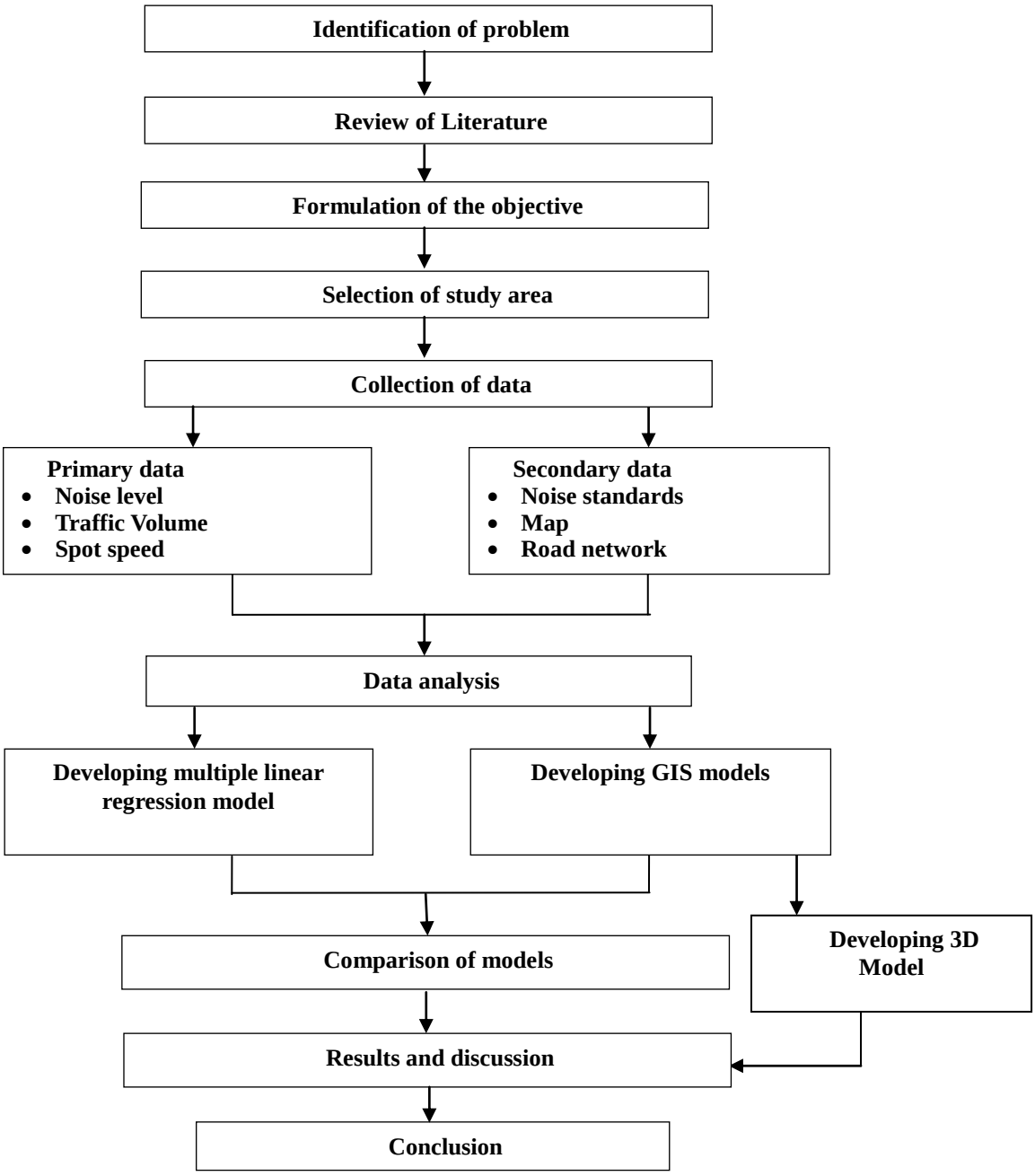


Figure 3.1 Methodologyof Proposed Research Work

In modern days, the most distressing environmental problem is noise pollution. Noise pollution may be due to many causes like Road traffic, Railways, Airports, Industrial machinery and loud speakers during meetings and festivals. Out of the above sources, noise due to road traffic is the highest and affects the people and animals to great extent, hence the noise due to road traffic has to be analysed to suggest preventive measures.

Noise control regulations have been implemented in UK and other foreign countries, but in India, not much effort has been taken to control noise pollution. Review of literature has been collected regarding the noise levels in different places both in India and abroad and various modals developed using GIS for prediction of noise levels were studied from the literature collected from the research done in this area.

After studying the results of part studies conducted, the objectives of this research project were formulated.

The next step in the selection of the study area is that the study area should be a combination of residential and commercial with heavy volume of traffic during peak and non-peak hours.

After selection of the study area, two types of data should be collected namely primary data and secondary data. The secondary data consisting of noise standards, map of the area and road network details which are obtained from relevant Government Department guidelines.

The primary data consists of the following,

I. **Noise level:** It is measured using sound level meter

II. **Traffic volume:** Number of vehicles per hour for a stream of traffic is obtained through manual count method.

III. **Spot speed:** Speed of a vehicle at any instant of time at a particular point is calculated.

The primary data of volume and speed are used for developing multiple linear regression modal. The R^2values of 0.7 to 0.9 is the appropriate value (Nirjar et al, 2003).

The next step is to develop GIS models by using the noise levels in the different locations and preparing noise map of the area.

The area affected by noise for the 15 locations are calculated from 6.00am to 9.00pm. GIS maps are individually prepared for all the locations and a combined map is also generated for time intervals of 8.01-9.00am, 9.01-10.00 am and 5-6pm.

Maps based on noise levels in Multiple Linear Regression analysis are also prepared and both the models are compared.

Results from both the models are obtained to show the extent of noise impact on people.

The total extent of noise pollution in Chennai city from the both models is found out.

3.1 Description of Study Area

Chennaiis the capital of Tamil Nadu, formerly known as Madras.It is located on the Coromandel Coast off the Bay of Bengal. In South India, it is the biggest industrial and commercial centre and a major cultural, economic and educational centre. It is known as the "Detroit of India" due to the presence of a number of units in the automobile sector (**The Financial Express 2014**).

It is the sixth most populous city in India as per **Census of India 2011.**Its population is 4,681,087.The population density in the city is 24,682 per sq.km.It is one of the most densely populated cities in the world. Chennai has a sex ratio of 986 females per 1000 males. The average literacy rate in the city is also very high at 80.14%, whereas the overall literacy rate of India is only 64.5%. Traffic noise is a function of traffic volume only if the plying distance remains the same(Chakrabarty D. et al 1997).

The city is host to the third largest expatriate population in India after Mumbai and Delhi, with 35,000 in 2009 and steadily climbing to 82,790 in 2011.Chennai is the only city in South Asia and India to figure in the "52 places to go around the world" (**The New York Times 2014**).Various studies carried out core noise levels found that it is higher than prescribed limit (Chauhan et al 2010).

In 2011, the jurisdiction of the Chennai Corporation area was expanded from174 sq.km to 426 sq.km. Chennai city is governed by the Chennai Corporation which is headed by an Indian Administrative Service officer. The Mayor and the Councillors of the Chennai Corporation are elected through a popular vote by the residents.Urbanization has resulted in land degradation and increased disaster rate such as Air and Noise Pollution (Du Rompaey et al 2015).

3.1.1 Chennai metropolitan area

The Chennai Metropolitan Area (CMA) is the urban agglomeration, which comprises the city and its suburbs. It is home to approximately 8.9 million, making it the fourth most populous metropolitan area in the country and 31stlargest urban area in the world. The extent of CMA is 1189 Sq.km. It comprises the city of Chennai, 16 Municipalities, 20 Town Panchayats and 214 Village Panchayats in 10 Panchayat Unions. The Chennai Metropolitan Development Authority (CMDA) is the nodal agency responsible for planning and development of Chennai Metropolitan Area.Noise generally has given mankind a serious problem which has not been given any attention until recently (Eze et al 2014).

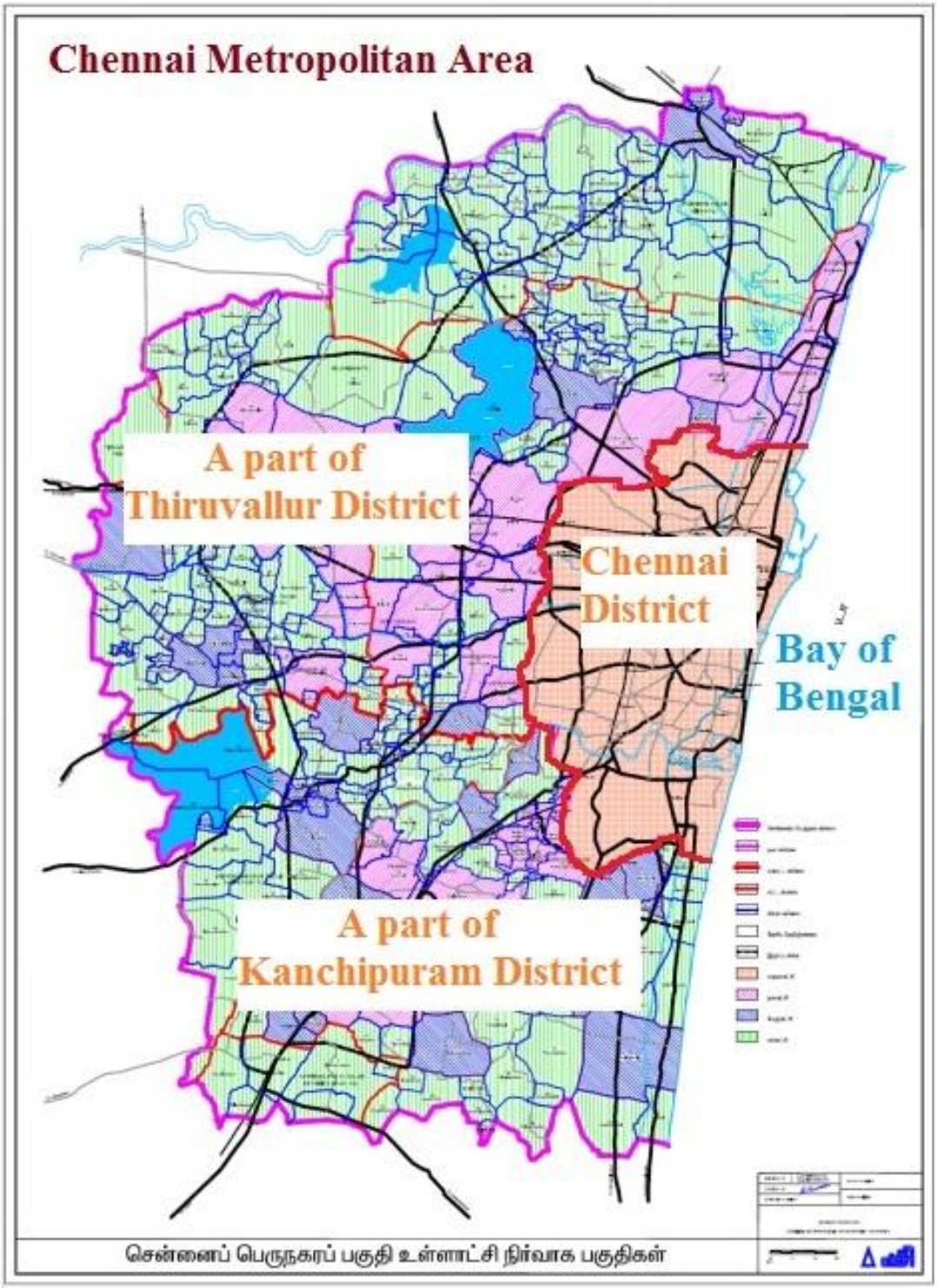
CMA spreads over three Districts viz. Chennai District (Chennai Municipal Corporation area) 176 sq.km, part of Thiruvallur District 637 sq.km (out of 3427 sq.km) and part of the Kancheepuram District 376 sq.km (out of 4433 sq.km) totalling 1189 sq.km. Its residential, commercial and industrial activities are expanding quickly along the Old Mahabalipuram Road in the east

and the Grand Southern Trunk Road (GST Road) in the south and towardsAmbattur,Koyambedu and Sriperumpudur inthewest.Healthprofessionals will have to lead the way to make the people at all levels to recognize the dangers of noise pollution. (Goines L et al 2007).CMA covering Chennai District, a part of Tiruvallur District and a part of Kanchipuram District is shown in Figure 3.2.

3.1.2 Geography of Chennai

Chennai Metropolis (with latitude between 12º50”49” and 13º17”24” and longitude between 79º59”53” and 80º20”12”) is located in the north–eastern part of Tamil Nadu on a flat coastal plain known as the Eastern Coastal Plains. Two rivers viz. Cooum and Adyar pass through CMA and these rivers are placid and meander on their way to the sea. Buckingham Canal, a man made canal, is another large waterway, 4 km (2.5 miles) inland, runs north-south parallel to thecoast, linking the two rivers through the Metropolis. A third river, the Kosasthalaiyar, flows through the northern fringes of the city before draining into the Bay of Bengal, at Ennore. The Otteri Nullah, an east–west stream, runs through north Chennai and meets the Buckingham Canal at Basin Bridge (**Chennai District - District Profile - Location and Area**).The recognition of road traffic noise as the main source of pollution has led to design models to predict noise level. (Golmohammadi R. et al 2009).

Sholavaram Lake, Red Hills Lake and Chembarambakkam Lake are the three large lakes in the area.Some areas of the city have the problem of excess iron content in groundwater.Chennai”s soil is mostly clay, shale and sandstone. Chennai is classified under SeismicZoneIII, indicating a moderate risk of damage from earthquakes (**Chennai District – District Profile - Geographical and Physical features**). Despite widespread prevalence of exposure, noise has been treated differently than air pollution. (Hammer M.S. et al 2014).



(Source:http://www.cmdachennai.gov.in/pdfs/smp/1_CMA_AdministrativeUnits_Tamil1.pdf)

Figure 3.2 Chennai Metropolitan Area depicting the Chennai District and parts of Tiruvallur and Kanchipuram Districts.

3.1.3 Climate of Chennai

Chennai lies on the thermal equator and it is hot and humid for most of the year. The hottest part of the year is late May to early June with maximum temperature around 40°C. The coolest part of the year is January, with minimum temperature around 20°C.The lowest recorded temperature was 13.8°C on 11 December 1895 and January 29, 1905. The highest recorded temperature was 45°C on 30 May 2003. Exposure to high occupational noise which results in health risks is commonly encountered in wheat processing industry also. (Ibrahim et al 2014).

The city gets most of its seasonal rainfall from the north–east monsoon winds, from mid–October to mid–December. The average annual rainfall is about 140 cm. The highest annual rainfall recorded is 257 cm in 2005. Cyclones in the Bay of Bengal sometimes hit the city. Prevailing winds in Chennai are usually south-westerly between April and October and north-easterly during the rest of the year.The impact of reaction to noise may range from a minor disturbance to loss of life quality to profound debilitation. (Job 1999).

3.1.4 Economy of Chennai

Chennai has a diversified economic base anchored by automobile, software, hardware manufacture, health care, financial services and industries. As of 2012, the city is India"s second largest exporter of information technology (IT) and business process outsourcing (BPO) services. Many software companies and software services companies have development centres in Chennai, which contributed 14 percent of India"s total software exports of ₹ 14,42,140 million during 2006–07, making it the second largest Indian city software exporter following Bangalore.

The city has 30 percent of India”s automobile industry and 40 percent of the auto components industry. Since the major part of India”s automobile industry is based in and around the Chennai, it has earned the nickname "Detroit of India". A large number of automotive companies including Hyundai, Renault, Robert Bosch, Nissan Motors, Ashok Leyland, Daimler AG, Caterpillar Inc., Komatsu Limited, Ford, BMW and Mitsubishi have manufacturing units in Chennai (**The Economic Times 2011**).

Prominent financial institutions, including the World Bank, Standard CharteredBank, ABNAMRO, Bankof America, The Royal Bank of Scotland, GoldmanSachs, Barclays, HSBC, INGGroup, Allianz, SumitomoMitsu i Banking Corporation,The Bank of Tokyo-Mitsubishi UFJ,Abu Dhabi Commercial Bank, Asian Development Bank, Credit Suisse, BNP Paribas Fortis, Irevna, Deutsche Bank and Citibank have back office and development centre operations in the city.Chennai is home to national level commercial banks, many state level co–operative banks and finance and insurance companies. Telecom and Electronics manufacturers based in and around Chennai include Nokia, Nokia Siemens, Motorola, Dell, Force10, Wipro, Zebronics, Foxconn and Siemens among others. Chennai is currently the largest electronics hardware exporter in India, accounting for 45% of the total exports in 2010–11.

The city also serves as the location of Madras Stock Exchange and the secondary financial hub in India following Mumbai.As a growing metropolitan city in a developing country, Chennai confronts substantial urban pollution, traffic congestion, poverty, overpopulation, and other logistic and socioeconomic problems.Chennai is also known as the Cultural Capital of South India and is the most visited city in India by international tourists (**Euromonitor International**).

3.1.5 Transportation

The different sources of noise pollution in Chennai City are Transport, Industries, Residential and Others.The major modes of transport such as Air, Sea, Road and Rail are in significant use in Chennai City. However, the road networkwhich passes through the entire city primarily influences the local noise problem. The total length of roads including interior roads in Chennai is about 7300 km. Most of the roads are made of asphalt (bituminous) roads, while about 1300 km are made of cement concrete roads. The total bus route length is of about 358 km including concrete roads (**www.chennaicorporation.gov.in**).

The buses and autos (3 wheelers) are the common public transportation modes other than MRTS trains which largely contribute to noise pollution. Large number of privately owned 2 wheelers and four wheelers are also used as modes of transportation. Lorries or trucks are used for transporting goods within the city as well as to the other parts of the country which also contributes a lot of noise pollution in the city.

In railways, most of the express trains and the Metro Rail Transport System (MRTS) trains within the city for public transport have electric engines and hence do not contribute much to the noise pollution in the city. Railways are also used for transportation of goods to and from the other parts of the country. Airport and Chennai harbour are used for transportation of goods within the country and to import and export from other countries. As airport is within the heart of the city, landing and take off aeroplanes cause lot of noise pollution. There are more than 100 flights daily take off and land at the international and domestic airports.