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Development and Analysis of Noise Map of Pune Region Using Arc-GIS

Rohan Raut, Sajal Sinha, Swaraj Meshram, Chaitanya Ingale, Pro. Shree Kambale
Department of Civil Engineering,
Dr. D. Y. Patil Institute of Engineering Management and Research,
Akurdi, Pune.

***Abstract*-We present our analysis report on Noise Pollution Level in different areas of Pune region and ways to minimize the problem as much we can. In this paper, we have analyzed the data which we collected from various online websites related to Noise Pollution survey in different regions of Pune and used that data to identify possible trends and factors. We used normal distribution or Gaussian distribution to get the values and those values were used to plot the maps and graphs. Furthermore, various techniques in order to minimize noise pollution have been discussed.**

***Keywords*- Noise, Pune, Normal distribution, Gaussian distribution, Arc-GIS.**

I.INTRODUCTION

1. Noise Pollution:

Environment is polluted in numerous ways, which are all somehow interconnected with one another. But the pollutants are just a tool, we humans alone play the main role in polluting the environment. Human beings – we are a unique selfish creature who created these tools for our comfortness without even care about its impact to the surrounding and for us too. Transport was invented to save time. But now conveyance is creating the major threat. In addition to it, the road network become very complex which increase the volume of traffic. It makes the present situation even adverse by collapsing the quality of the environment as a result of an abnormal change in sound characteristics. The sound which is unpleasant and unwanted in the surrounding and it is most commonly in higher decibels is known as Noise.

Now-a-days one of the most critical environmental problem is noise pollution which affects human's lifestyle, activities and health. Sound is produced by vibrations, oscillation of air or when it strikes some object. Humans have the ability of hearing sound with frequency ranges from 20Hz to 20000Hz. raffic noise is the one which increases steadily due to growth of transportation and people movement. It affects all over the human body, causing permanent, temporary and stable functional changes that lead to diseases of the nervous exhaustion, endocrine, mental depression, cardiovascular, autonomic neurosis and immune system.

Considering noise exposure, many works show that it can be associated to many adverse health outcomes, such as hearing impairments and tinnitus, cardiovascular and metabolic repercussions, learning impairment, sleep disorders, and annoyance. As a dramatic consequence, the World Health Organization (WHO) estimates that noise effects on health may be responsible for up to 1.6 million Disability-Adjusted Life-Years (DALYs), i.e., the potential years of life lost due to premature death, in Western Europe. Among the noise sources, those related to transportation, i.e., aircraft, railway and road (in this order), make a major contribution to both the perception of noise disturbance and health impact, due to several factors, such as long-term exposure, noise intermittency or low frequency noise.

2. Effects of Noise Pollution:

Noise pollution can cause annoyance, aggression, hypertension, increase in blood pressure, high-stress levels, hearing loss, sleep disturbance, depression and panic attacks. If decibel levels are in the range of 80 decibels (dB) and 90dB, over a period of time, people can develop damage to nerves or hearing loss, said doctors. High noise levels and its impact will be documented and mitigation measures for sources will be identified.

Noise pollution also impacts wildlife. A wide range of animals, including insects, frogs, birds, and bats, rely on sound for a variety of reasons. Noise pollution can interfere with an animal's ability to attract a mate, communicate, navigate, find food, or avoid predators and thus can even be an existential threat to vulnerable organisms.

he problem of noise pollution is especially serious for marine animals, particularly those that rely on echolocation, such as certain whales and dolphins, and much of the world's oceans are polluted with chaotic sounds from ships, seismic tests, and oil drills. Some of the loudest and most detrimental sounds in the sea are from naval sonar devices, whose noise can travel hundreds of miles through the water and is associated with mass strandings of whales and dolphins. However, it should be noted that, to a lesser extent, noise annoyance and some noise effects may come from other sound sources, such as

community noise, industrial noise or recreational and leisure noise.

3. Why Noise Maps?

Noise maps are obtained using numerical simulations, with software specifically developed for environmental noise mapping, based on acoustic emission models of transportation and industrial noise sources as well as propagation models. hese emission and propagation models are derived from national standards, such as DIN 18005-1 (Germany), NMPB-08 (France) or NORD 2000 (Denmark).

At the European level, harmonised standards were also proposed, such as Harmonoise, or more recently the CNOSSOS-EU model ("Common Noise Assessment Methods in Europe") , which should become the reference model in Europe from 31 December 2018. Other approaches, based on measurement (using fixed sensor networks or participatory measurements with smartphones) or social data, are beginning to emerge, but will still require coupling with numerical models to be able to test action plans, as required by the European directive.the usual numerical methods will remain the reference approach for a very long time, until the approaches evolve and the standards change.

Presently, improving calculation methods and noise map representation are therefore still very important issues. Noise mapping based on numerical simulations requires beforehand a huge amount of information concerning the investigated area, based on third-party data or models. Firstly, the generation of the noise emission requires the knowledge of the road network including the speed limits, the signage and the traffic flow on each road section.

Secondly, the sound propagation model requires data about the type of buildings, in addition to both the topography and soil landscape. hirdly, statistical data are needed in terms of population distribution and location of offices and business activities. Because noise prediction models rely on geometric calculations, a fine description and accurate quality of the geometric data (i.e., roads, buildings) are required, otherwise it would be impossible to evaluate noise levels.

herefore, the manipulation of all these data through Geographic Information System (GIS) seems obvious to facilitate the production of noise maps. In addition, the evolution of GIS technologies makes it possible to share the results with citizens and decision-makers thanks to the standards and geographical services distributed over the Internet, through Spatial Data Infrastructure (SDI) platforms. As Abramic et al. pointed out, applying SDI techniques for noise mapping strategies permits also encoding data in a similar manner, thus achieving semantic interoperability between models. In addition, SDI offers a natural way to expose and share data on the web. his clearly shows the potential interest of integrating the production of noise maps directly within a GIS, and not in parallel, as is currently the case by coupling the inputs and outputs of noise mapping software with GIS platform. Such implementation could considerably facilitate the evaluation and implementation of action plans to reduce noise.

Lastly, as underlined by King and Rice, the philosophy behind the European directive 2002/49/EC, and more generally the context of the European directive INSPIRE, also motivate the use of open-source GIS , instead of black box implementations of comparable commercial software packages. Thus, the present paper proposes an implementation of a simplified noise mapping approach within a GIS, allowing to produce noise maps at a city or urban agglomeration scale with limited calculation times, in order to consider several planning scenarios within reasonable duration.

II. LITERATURE REVIEW

Oyedepoaetal. (2019) In this paper a detailed method used for assessing and mapping noise pollution levels in Ota metropolis, Nigeria using ArcGIS 10.5 Software is presented in this paper. Noise readings were measured at a time interval of 30 min for each site considered using a precision grade sound level meter. The noise map developed was based on the computed values of average equivalent noise (LAeq) for the selected locations.

Results of this study show that the A-weighted sound level (LAeq), the background noise level, and the peak noise level vary with location and period of the day due to traffic characteristics especially traffic volume, vehicle horns, vehicle-mounted speakers, and unmuffled vehicles at road Junctions, major roads, motor parks, and commercial centers.

Vasilyev et al. (2017) In this paper, the peculiarities and negative features of existing methods of monitoring acoustic pollution have been considered. New methods of monitoring, using automated systems are suggested, allowing the undertaking of continuous measurements of noise, and the other parameters in the environment. A new approach to noise mapping is suggested in this paper.

New approaches to monitoring acoustic pollution are approbated in conditions of the urban territory of the Samara region of Russia. By using the results of noise measurements and developing a program provision, noise maps of the urban territory of the Samara region have been developed. In this research, the method of dynamic mapping of acoustic pollution was used for collecting data and making the noise map of the city which will help in forecasting upcoming situations without physically collecting data from time to time.

Picautaetal (2019) In this paper, an alternative method is proposed for the assessment of the noise environment, based on a crowdsourcing approach. For this purpose, a smartphone application and a spatial data infrastructure have been specificallydeveloped to collect physical data (noise indicators, GPS positions, etc.) And perceptual data (pleasantness), without territorial limits, of the sound environment. In this paper, all the methodological and technical issues are detailed, and a first analysis of the collected data is proposed. In this paper, the data collected from smartphones for the study purpose and then further used to develop a new application.

Zhang1etal. Through this research, we acknowledged that the advent of crowdsensing technology has provided a promising possibility for monitoring noise pollution in large-scale areas. Constructing noise maps by using mobile smartphones in a cost-effective manner is being widely used in the city and industrial plants. In this short paper, the typical crowdsensing-based applications for the noise map applied in smart cities are briefly presented and summarized. Furthermore, the general implementation and systems of crowdsensing-based noise map applications are summarized. Finally, open research challenges are discussed to further investigate the feasibility and effectiveness of noise maps in smart cities.

F. Farcaş and A. Sivertun (2012) Traffic noise pollution is a growing problem that highly affects the health of people. To cope with this problem, one has to regulate traffic or construct noise barriers. To implement effective measures against traffic noise the information about its distribution noise maps is imperative. This paper presents researchers' work in creating a noise calculator software package implementation that can create noise maps. The noise calculator is based on the noise model described in the Nordic prediction method for road traffic noise. As a case study, the noise calculator was used to build both large noise maps for the Skane region in the south of Sweden and detailed noise maps for smaller areas in the city of Lund.

Patil et al.,(2018) In this paper the detailed case study on noise pollution of Nashik city and noise map of the same data presented. The objective of the work was to measure the noise pollution range at different locations in Nasik urban area and analyze the impact of noise pollution and compare the noise levels with permissible limits specified by CPCB. The authors used different tools for noise mapping. For creating a noise map, they used software called Q-GIS. The maps showing the road network and different institutional buildings were collected from Google Maps. They also studied traffic volume on road at different time duration.

S Vanitha et al., (2020) This paper describes a study that aimed at measuring the noise levels at selected points in the Trichy district to generate a noise map over the study area. They observed that the highest noise pollution in urban areas is caused by traffic noises. Separate models were built by them for all the locations in the stretch in the study area due to noise levels were different in different areas. Finally, a GIS model for noise prediction was developed for a busy corridor in Trichy city by authors. The noise pollution level in the study area of Trichy city has been plotted in a spatial analysis map using Arc-GIS software.

Lin-Huaet al., (2013) In this paper, the comprehensive evaluation of traffic noise pollution in Guangzhou Higher Education Mega Centre based on population exposure is presented. According to the traffic flow data of 10 roads of Guangzhou Higher Education Mega Centre, the traffic noise map is drawn by the noise analyzing software (Zhong Da Sheng Tu). The authors calculated results with the measured noise, it is found that the Zhong da Sheng Tu software can simulate the traffic noise accurately. Further, based on the population exposure and acoustic function region, they put forward a new method to comprehensively evaluate the pollution of Guangzhou Higher Education Mega Centre, which has proved to be feasible.

III. METHODOLOGY

For construction of noise maps, we used ArcGIS softwareArc-GIS is a geographic data system (GIS) for working with maps and geographic information maintained by the Environmental Systems Research Institute (Esri). It's used for creating and using maps, compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information during a range of applications, and managing geographic information during a database.The system provides an infrastructure for creating maps and geographic information available throughout a corporation, across a community, and openly on the online.

ArcGIS consists of the subsequent Windows desktop software: ArcReader, which allows one to look at and query maps created with the opposite ArcGIS products; ArcGIS Desktop (often mentioned as "ArcMap" to differentiate it from ArcGIS Pro), made from four fundamental applications:

- ArcMap, for viewing and editing spatial data in two dimensions and creating two-dimensional maps;
- ArcScene, for viewing and editing three-dimensional spatial data during a local projected view;
- ArcGlobe, for displaying large, global 3D datasets;
- ArcCatalog, for GIS data management and manipulation tasks.

ArcGIS Pro, a new, integrated GIS application, planned to eventually supersede ArcMap and its companion

programs. ArcGIS Pro works in 2D and 3D for cartography and visualization, and includes AI (AI).

Our foremost and most important step was collection of data. Noise Intensity is recorded everyone once a year, so this possessed a threat for us. As map prepared by us can be used throughout - anytime of the year, it was necessary to use proper intensity. For this we used normal distribution or say 95% rule. In applied mathematics, a normall (or Gaussian or Gauss or Laplace–Gauss) distribution may be a sort of continuous probability distribution for a real-valued variate.

Normal distributions are important in statistics and are often utilized in the natural and social sciences to represent real-valued random variables whose distributions aren't known. heir importance is partly thanks to the central limit theorem. It states that, under some conditions, the typical of the many samples (observations) of a variate with finite mean and variance is itself a random variable—whose distribution converges to a traditional distribution because the number of samples increases. Therefore, physical quantities that are expected to be the sum of the many independent processes, like measurement errors, often have distributions that are nearly normal.

Moreover, Gaussian distributions have some unique properties that are valuable in analytic studies. as an example, any linear combination of a hard and fast collection of normal deviates may be a normal deviate. Many results and methods, like propagation of uncertainty and method of least squares parameter fitting, are often derived analytically in explicit form when the relevant variables are normally distributed. A normal distribution is usually informally called a bell curve. Therefore, we used normal distribution and calculated those value which coverers 95% of total values and then the map is prepared using those values.

IV. DISCUSSION

The following table shows the values which we calculated by using Gaussian Distribution.

	PuneUniversity		NucleasMall		kakadeAngan		Aundh		Karweroad	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
200	66.1	59.5	70.5	60.7	62.3	48.4	67.3	58	69.9	63.2

200	74.7	71.9	73.5	72.9	71.5	67.8	72.3	69.4	71.5	70.1
2010	60.6	54.75	65.75	60.2	54.9	52.75	60.2	55.7	63.4	50.9
2011	55.8	48.2	62.35	54.8	55.05	47	54	48.1	61.9	54.8
2012	74.7	72.6	74.4	71.7	71.5	65.1	71.2	63.8	70.5	60.7
2013	68.45	54.3	62.8	51.05	53.2	49.55	68.2	54.1	62.3	54.9
2014	68.45	54.3	62.8	51.05	58	49.65	66.73	52.9	62.3	54.9
2015	67.9	51.8	63.4	50.9	59.3	48.8	58.9	48.2	63	51.2
2016	67.9	51.8	63.4	50.9	59.3	49.7	66.7	52.5	63.4	52.4
2017	78.76	73.2	73.5	69	71.8	68.7	81.75	69.4	80.05	74.6
2019	74.18	69.12	73.9	68.6	72.2	68.1	73.9	69.8	72.2	71
2018	72.5	68.8	71.2	66.4	70.6	65.9	71.04	69.8	77.62	71.9
2020	76	66.4	73	68.9	74	69.9	76.6	71	78	71.9

The following line plots shows trends which were followed by noise intensity value over a period of 11 years.

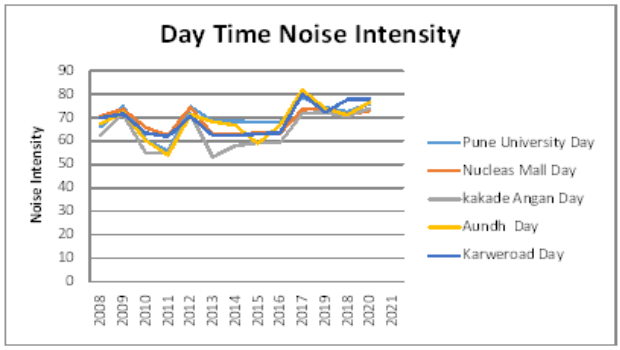

Fig 1. Day Time Noise Intensity.

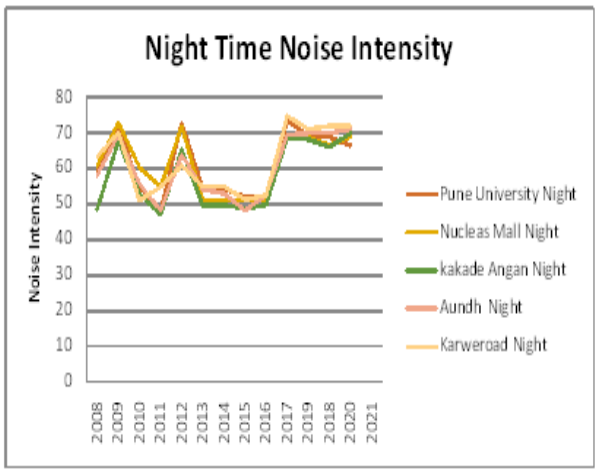

Fig 2. Night Time Noise Intensity.

As you'll see, residential areas like Aundh, Kakade Anganwadi have relatively low Noise Intensity compared to others thanks to the very fact that not any major roads undergo them, alongside there aren't any attractions to draw in people.

The Noise Intensity due nighttime of residential areas are often said on be lowest of all kinds of areas, since most of the household were through with their work. We will also observe that the worth of intensity has simultaneously increased over period of your time, in residential areas too and most predicted factor are increase and development of region.

Sound pollution is residential areas is usually mentioned as COMMUNITY sound pollution which supports our incontrovertible fact that if community will increase noise pollution too will increase.

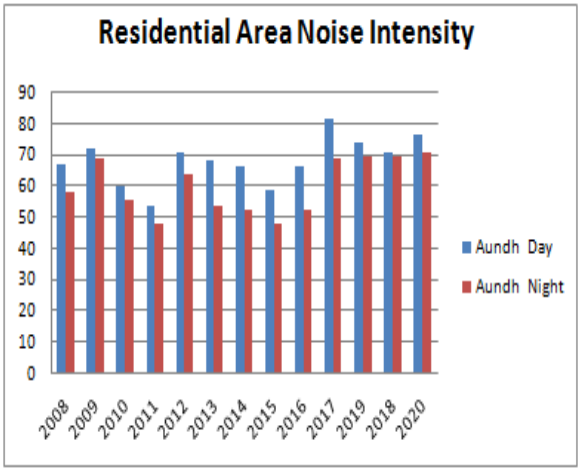

Fig 3. Residential Area Noise Intensity.

In lifestyle people are simultaneously exposed to many sound sources, which emerge from background sound-scapes of considerable variability thanks to building layouts, residential pattern, topography, meteorology, and lifestyle.

In contrast, noise regulation, planning, and control treat the sound environment by separating it into pieces and describe it by a one-number indicator. His practice ignores the likelihood of any effect modification (by inhibition, partial or full additivity, or synergism). This effect modification can happen not only between sound sources (multisource issue) but also with simultaneously occurring environmental factors (vibration and air pollution) from an equivalent source or through other contextual factors (multistressor issue).

What people realize sound perception of combined sound exposure mainly rests on experimental work using short-term loudness judgments in repeated designs in controlled settings. Recent psychoacoustic experiments didn't find full support for the foremost prevalent models in practice (e.g., simple energy summation), when the context of the assessment is more carefully distinguished (sound heard within combined sound or alone).

The findings are difficult to match with field studies where long-term judgments of annoyance happen within the immediate context of the subject's living environment.

The combined noise paradox is such a finding. It describes the phenomenon that total annoyance is usually judged equal or maybe less than the dominant source alone. Some call it compromises judgments suggesting them to result from ambiguous questions or misinterpretations of the frame of reference when total annoyance should be assessed. In experiments, compromise judgments were observed mainly with unequally loud and time-separated sounds.

But also increases in total annoyance are observed within the field studies. Although masking partly explains lower annoyance, higher annoyance thanks to equally loud sources is a smaller amount well understood. Further effect modifications are observed with simultaneously occurring vibrations, low-frequency annoyance, and tonal and impulsive components of heterogeneous sound sources like those from industry. He larger annoyance effects observed can vary in terms of decibel equivalents between −3 and +15 dB. The very best values are related to impulsive noise and low ground noise context.

Eventually, pollution and other contextual factors can further contribute to total annoyance. Incomplete accountancy of effect modifications in environmental risk assessments will cause errors in planning and fewer than optimal noise control.The assessment of economic noise is kind of different thereto of transportation noise. Whereas transportation noise can generally be predicted given a gaggle of input datasets, no such predictive techniques exist for industrial noise. The only because of determine

the emission of an industrial source is through measurement.

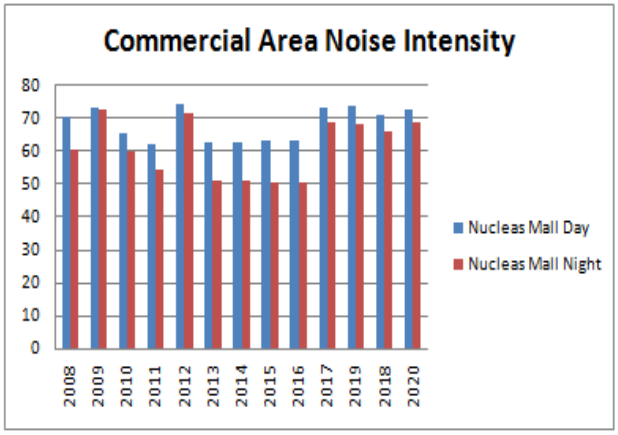

Fig 4. Commercial Area Noise Intensity.

In some cases, this is often often impossible and international databases or previous similar experience could even be utilised to make an informed estimate. If best practice is to be followed, this poses two significant problems for any authority who wishes to assess all existing sites of economic noise across a city region.

First, all sites must participate in some quite measurement campaign which needs a fantastic amount of resources.

Second, all measurements must be conducted during a typical uniform fashion. Given the variation within the type of noise, the times of operation and thus the situation of noise sources across each industrial site, it isn't always possible to undertake to to the present . Inevitably, default values or some simplifications are getting to be introduced to the assessment procedure.

Similar to transportation sources, industrial noise could even be perceived during a totally different manner across different industries. Industrial noise often contains more intrusive acoustic characteristics like impulsive or tonal elements and intrinsically industrial noise often attracts more stringent noise criteria than the transport sector. These intrusive characteristics tend to increase noise annoyance and can be included in any noise assessment going to assess the acoustic impact of a site.

V. RESULTS

Fortunately, hearing loss due to community noise pollution is largely preventable. Preventive and control measures have been recommended, viz., stringent implementation of legislation, efficient engineering products, proper planning of roadways, considering their proximity to human settlements. In industry setting, personal protective equipment such as ear muffs and ear plugs are required.Good practices to prevent noise-induced ailments in children should be adopted. Noise attenuation by placing vegetations around buildings have also been recommended.

Recommendations of the Delhi Pollution Control Committee include ban on pressure horns, phasing out of three wheeler autos, extensive plantation of trees on the roadsides, encouraging use of noise-absorbent materials, adequate noise barriers around silence zones, monitoring of loudspeaker, and generator sets to ensure compliance with prescribed rules. Above all, awareness of the public and stakeholders is the key component in the prevention and control of community noise pollution. Basic and essential information should be extensively disseminated, such as noise levels created by common sources of noise pollution, adverse health effects on both the person creating noise, and the public preventive measures and conditions punishable under law.

Graphic displays in public places are a good medium to spread the message. School campaigns, health education programs, and publicizing through print and electronic media can actively address this issue. Involvement of non-governmental organizations in generating public interest and co-operation, and providing audio-logical facilities will immensely help the cause.

Further exploratory studies are urgently required in India. Socio-demographic factors and determinants of noise-induced health effects, co-morbidities, population-specific thresholds for normal or impaired hearing should be studied

Following Noise Maps were developed using the data in table1.1

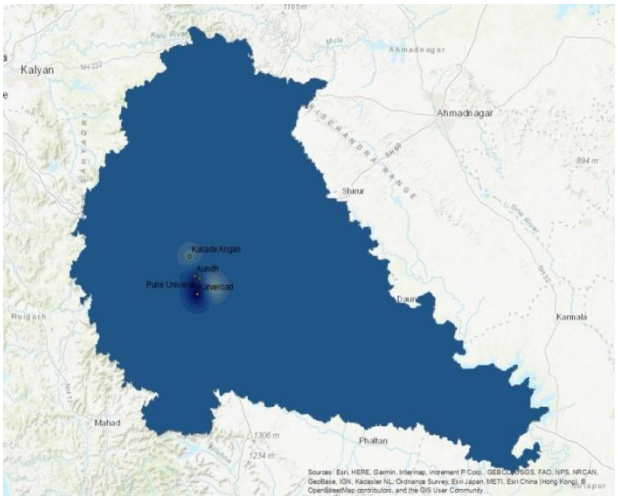

Fig 6.Night-time Noise Intensity Map Pune region

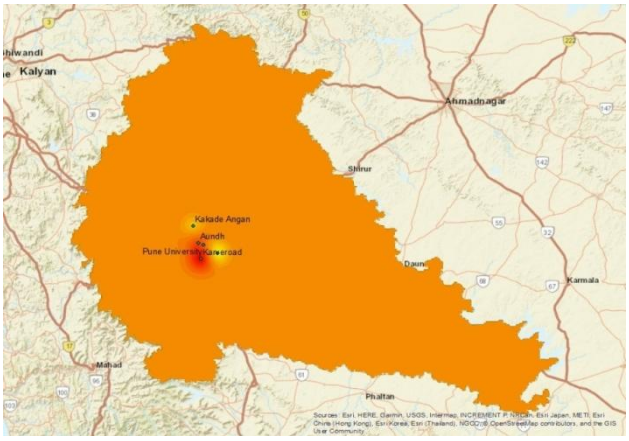

Fig 7.Daytime Noise Intensity Map Pune region

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