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Spatial Analysis and Geographic Information System (GIS) Mapping of Noise Pollution in Bosso Local Government Council, Niger State, Nigeria

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Abstract

This study was designed and executed such that a full noise pollution profile for Bosso Local Government Council of Niger State would be successfully presented. The core objective of this project is the preparation of a framework for a noise pollution database for the nearest developed environs of Minna. Data collection was facilitated by both the use of the hand-held GPS units and the sound level meter. Stations of interest that were identified were appropriately geo-referenced and marked in the conventional way. The stations were re-visited with the noise level equipment whence information about the sources of environmental noise, the corresponding values of noise, and the status of noise pollution were logged progressively from one point to the next. Further, by use of the Geographical Information System (GIS) platform, a noise pollution layer for Bosso Local Government Council has been created, a novelty in itself. It can be deduced from the pollution map produced for this project work that, overall, the noise level regime over Tudun Fulani, Maikunkele, Bosso, Maitumbi, and Chanchaga neighbourhoods are quite high because a significant number of households and business locations use alternative power sources when the central power supply is cut. This GIS pollution layer map could now serve as a veritable urban development tool that would assist public health officials and town planners recommend appropriate actions to be taken to safeguard the health of the citizenry.

Keywords: Environmental noise pollution, GIS, noise pollution map

Introduction

Environmental noise is a nuisance that we have to put up with from day to day and it has been recognised as a form of pollution. Over the last couple of decades, interest has been centred on environmental pollution and climate change issues all over the world. Thus it is fitting and proper that, in fulfillment of one of its founding charters, the Federal University of Technology, Minna, should be able to make its contribution to the field of environmental pollution, especially as it affects the local communities. To this end this study has been designed and executed such that, in addition to creating a unique database of environmental noise pollution, an appropriate town-gown synergy advocacy could be evolved.

Environmental Pollution Aspects of Noise

Introduction: The word noise is derived from the Latin term "nausea". It has been defined as an unwanted sound, a potential hazard to health and communication dumped into the environment (Miglani, 2003). It is a well-known fact that exposure to high levels of noise over a long period of time has negative resultant effects on human health; these may manifest in form of gradual hearing loss, irritation, high blood pressure, etc.

Environmental Noise: Noise pollution affects quality of life and has been linked to health problems. The Environmental Noise Directive (END) aims to manage noise and preserve quiet areas by engaging the public, local authorities and operators (Parliamentary Office of Science and Technology, 2009).

Background: Environmental noise is unwanted or unpleasant outdoor sound generated by transport and industry. The European Community's Green Paper on Future Noise Policy (1996) recognized that environmental noise is "one of the main local environmental problems in Europe" but that it has had a lower priority than other environmental problems, such as air or water pollution. It also recognized that, despite significant reductions in the noise produced by individual sources, total exposure to environmental noise has not changed significantly. For example, the introduction of quieter vehicles has been offset by an increase in traffic. Environmental noise in the UK is controlled by numerous laws, guidelines and standards covering planning, transport, the environment and compensation. To provide a common approach to noise management, the European Union introduced the Environmental Noise Directive (END) in 2002. This was transposed into Environmental Noise Regulations in England and the devolved administrations in 2006.

The Effect of Environmental Noise: Environmental noise rarely reaches the sound pressure levels associated with hearing impairment. However, noise can cause annoyance, is commonly blamed for sleep disturbance and has been linked by researchers to less obvious effects, such as cardiovascular and mental health problems and reduced performance at work or school. The ways in which noise affects health are not clear (Parliamentary Office of Science and Technology, 2009).

Annoyance: Annoyance can cause stress and longer term health problems such as hypertension (permanently raised blood pressure). It has been estimated that 55% of the UK population1 live in

dwellings where the outdoor environmental noise level exceeds a guideline value suggested by the WHO. On average, annoyance increases as the measured sound level increases but, individual attitudes to the same noise source can vary.

Sleep Disturbance: Evidence on the links between noise exposure and sleep quality is complex. The WHO recommends that sound levels should be kept below an average level of 30dB(A) in the bedroom, or a maximum of 45dB(A) for a single event. Higher sound levels have been related to reduced quality of sleep and awakenings. It appears that the majority of people will get used to common background noises at higher average sound levels and sleep will not be disturbed. However, the full restorative effects of sleep may be reduced even if people are not awakened.

Cardiovascular Problems: Unusually loud noises cause elevated heart rates and blood pressure, which quickly return to normal once the noise stops. The effects of longer term exposure are not well understood, but it has been linked to a slightly increased likelihood of hypertension, heart disease and heart attack. Separating the effect of noise from other confounding factors, such as air pollution, body mass index, age and smoking is difficult.

Performance and Educational Achievements: Noise has been shown to affect the performance of adults and children in cognitive tasks. The EC sponsored RANCH study investigated the link between children's health and noise in the UK, the Netherlands and Spain. It found that chronic exposure to aircraft noise can impair children's reading comprehension and memory to some extent. No link was found between road noise and performance. It was suggested that aircraft noise may be more disruptive than road noise due to its "variability and unpredictability". However, previous studies at higher noise exposure levels had found a link between road noises and perform.

Vulnerable Groups: Certain groups of people are more vulnerable to environmental noise. High background noise levels make conversation more difficult for the hearing impaired. Studies have linked a range of psychological symptoms to environmental noise, including anxiety, stress, irritability and mood change. There is no evidence that noise directly causes mental illness, but research suggests that people who are prone to certain psychiatric disorders may be more sensitive to environmental noise. The European Federation for Transport and Environment (T&E) believes that environmental noise unfairly affects poorer people. A study in Birmingham found that socially deprived populations experienced slightly higher exposure to night time noise. Poorer people may be less able to afford houses in quieter areas. However, some people will choose to pay more to

live in noisy areas for better access to amenities (Parliamentary Office of Science and Technology, 2009).

Area of Study

The area selected for this project is Bosso Local Government Council (L.G.C.) of Niger State. Bosso Local Government Council is located on latitude $9^0 40'$N and longitude $6^0 28'$E with an effective area of 6,606.14 m^2. The area is bounded to the North and northeast by Shiroro Local Government Council, to the northwest by Wushishi Local Government Council, to the southeast by Paikoro Local Government Council, to the south by Katcha Local Government Council and southwest by Gbako Local Government Council. The map of the study area is shown in Fig.1.

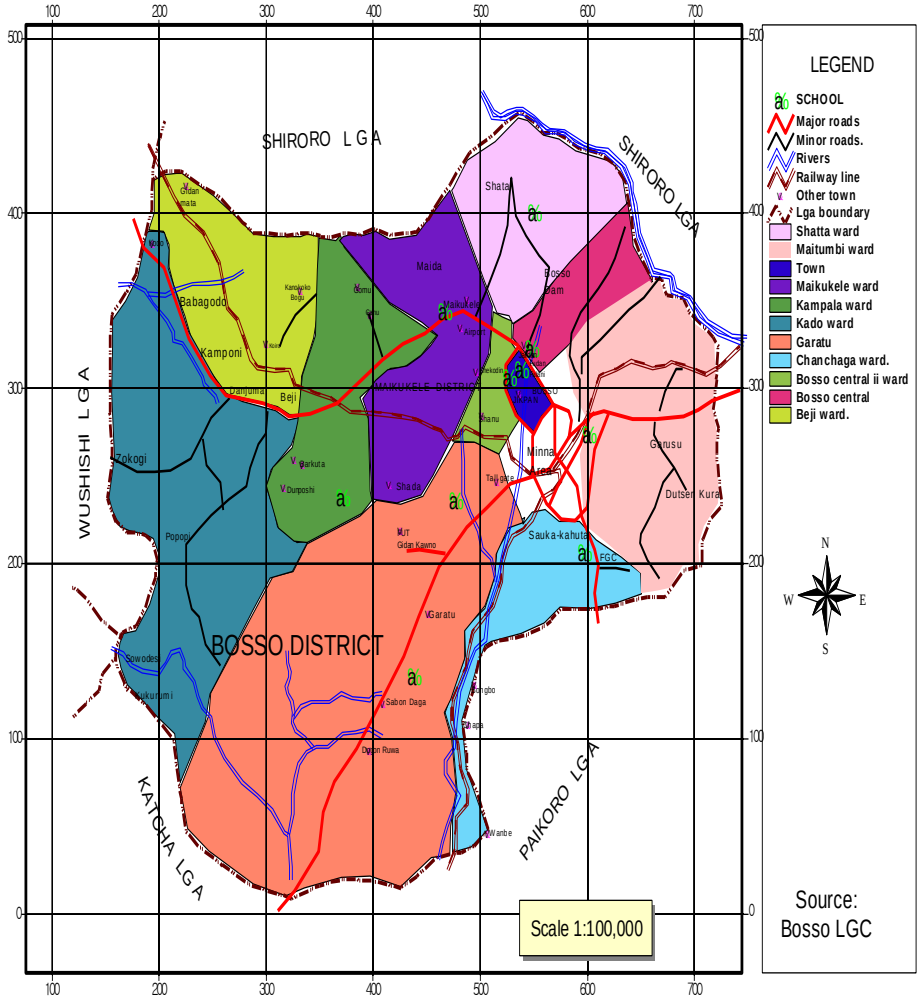


Fig.1. Map of study area

Problem Statement and Objectives of Study

The Problem: The absence of noise pollution database for Greater Minna (i.e. Minna towns and its outlying neighbourhoods) was a source of embarrassment for the Niger State Government when an international development agency requested to be granted access to that type of dataset. Representatives from the Niger State Ministry of Environment duly contacted the Federal University of Technology, Minna, in order to help solve what was obviously a pressing problem. For this exercise Bosso Local Government Council is considered a province of Minna.

Project Objectives: The principal objectives of this project work are as follows:

i. To help prepare the framework for a noise pollution database for Minna; this project will be the substratum upon which subsequent studies would be laid.
ii. To help build the nucleus for an environmental awareness advocacy programme to be funded and executed by the Niger State Government.

Justification of Project Work: This study is predicated on one of the founding charters of the Federal University of Technology, Minna, i.e. the deployment of academic resources to solve pressing community needs (the town-gown synergy concept).

Scope and Limitation of Study: The study was designed to cover all of the developed areal extent of Bosso Local Government Council, more of a house-to-house coverage scheme.

Barma *et al.* (2009) said that no one on earth can escape the sounds of noise. They defined noise as a disturbance to the human environment that is escalating at such a high rate that would become a major threat to the quality of human lives. They also pointed out that in the past thirty years, noise in all areas, especially in urban areas, has increased rapidly.

According to Kenneth and Canon the effect of noise on intrapersonal behavior has long been of interest to general experimental and physiological psychologists, and the publication of a number of volumes on this topic (e.g., Broadbent, 1971; Kryter, 1970; Welch & Weleb, 1970) attests to the significance that these issues are accorded. Public concern over "noise pollution" congressional legislation dealing with permissible noise exposure levels in industrial settings, and work such as

that of Cameron *et al.* (1972), suggesting that noise may be associated with the incidence acute illness, provide further impetus for research of this sort. Investigations of the interpersonal impact of ambient noise, however, are much less in evidence though Glass and Singer (1972) have provided a nice bridge between these two complementary focuses, and there has been work on the relationship between noise and conformity (Dustin, 1968), aggression (Geen & O'Neal, 1969; Geen & Powers, 1971), and verbal disinhibition (Holmes & Holzman, 1966).

Shi (1971) in a literature survey on noise pollution suggests that physically, noise is a complex sound that has little or no periodicity. However, the essential characteristic of noise is its undesirability. Thus, noise can be defined as any annoying or unwanted sound. In recent years, the rapid increase of noise level in our environment has become a national public health hazard. Noise affects man's state of mental, physical, and social well-being. The problem forms a special type of air pollution. Noise study is a rather new subject among other branches of science. The transition from art to near-science started before World War II. The work is an attempt to arrive at an understanding of the general situation on the problem of noise. The survey consists of four major parts: the present status of noise pollution, its sources, its effects, and the control. Finally, lists of terminology and a bibliography relating to noise pollution problems are included.

Butterfield (2006) reported that more stringent noise at work regulations developed by Health and Safety Executive after public consultation, came into force for general industry on 6 April 2006. Also music industry was granted a two-year period to develop sector specific guidance on compliance, but should meanwhile comply with existing noise regulations. Local Authorities also have issues concerning monitoring and compliance. Following a period of debate, it was agreed that Capita Symonds Ltd (CS) would complete a noise study to assess the current noise exposure of groups of people within the industry and would then report back on the impact of the proposed legislation on 'live' music concerts. This report contains details of the personal exposures of a cross section of staff working at twelve events throughout the year. It explores the adequacy of any control measures in place and makes recommendations for improvements. The calculated daily personal exposures LEP,d ranged from 80dB(A) to 104 dB(A) and the measured LC, peak values ranged from 122 dB to 146 dB. They also found that generally the use of hearing protection and noise control was inadequate. Because of the high noise levels, it is recommended that all areas front of house and at the side of the stage should be designated as hearing protection zones and

marked accordingly and all non-essential staff excluded. All persons working within the hearing protection zone should wear suitable hearing protection at all times.

Mahandiyan (2006) wrote that it was perhaps the first time that humans are dying of environmental pollution in hunt of overnight development and technological advancements. Though, the pollution of any kind is a slow poison, but 'environmental noise' is such a pollution, which was dire enemy of human brain and does not spare even animals and properties too. The noise pollution is in no way lesser hazardous than the air and water pollution. But, comprehensive legislation like water and air pollution is yet to be passed on noise. Although, the sweat music and soneral voice brings joy, cordiality, relaxations, mental peace and makes life worth living but undesired noise brings disturbances to peace mental disorders and hence makes the life miserable. It is heartening that original text of Indian constitution is free from the word environment. In a long series of labour laws in India, the noise pollution is left unattended. To control noise pollution is a great cause before the whole humanity for its survival. This cause became the subject matter to this treatise. The book contains evil effects, causes and available legislation on noise pollution. A true effort has been attempted to comment upon legal provisions or case law on noise pollution. A need of sustainable development has been emphasized through this paper. Role of NGOs and duties of citizens has been discussed in a lucid manner. The book is a practical approach to make the people understand their fundamental right to peaceful environment because rule of law must defend the rule of life and life will survive only when the biosphere is safe. Sustainable development is not a new idea, but growing concern of its problems and challenges on the globe is an additional feather of this book. The golden thread is the control of noise pollution, legal or extra-legal.

According to the investigations of Cohen and colleagues (Cohen *et al.*, 1973) reading and math's scores of third grade students in noise abated classrooms were higher than those in classrooms with higher noise levels. Some time ago, Green and co-workers (Green *et al.*, 1982) of New York University's Institute of Environmental Medicine found that for all elementary schools in boroughs of Brooklyn and Queens "an additional 3.6% of the student in the noisiest schools read at least one year below grade level". They went on to remark that "the dose response relationship indicated that the percent reading below grade level increased as noise level increased." Other researchers have found the same kind of relationship. For example, Cohen and colleagues (Cohen *et al.*, 1973) determined that elementary school students living for at least 4 years in the lower floors of an

apartment complex near heavy traffic show greater impairment of reading ability than children living on higher floors away from the traffic. In the studies, indoors sound levels varied from 66-dB on the lower floors of an apartment to 55-dB on the higher floors. In a U.S. EPA classification, "noisy residential areas" averaged 58-dB and were rated low socio-economic, while "quiet residential" averaged 38-dB and were rated affluent neighborhoods. These, of course, were outdoors sound levels. With indoor levels of 55-66-dB, concentration, the ability to pay attention, may well be difficult to nonexistent. If that is true, it may be pertinent to ask why far more children are not reading impaired.

An update from *Info Note HS-14-Noise Pollution & Your Environment*, ***200****4/2005*, (www.sjshire.wa.gov.au) describes noise as unwanted sound. It can originate from numerous sources, such as commercial and industrial activities, machinery, swimming pools and other recreational influences such as amplified music. It was also reported that the impact of noise can vary depending on the location of your house and source of the noise. The following measures were recommended to owners/occupiers on how the impact of noise on neighbourhood can be reduced:

- Give prior warning in writing to neighbours about parties and/or social gatherings, which may have an effect of level of noise. This gives neighbours time to accommodate your needs.
- Only operate outside power tools, including lawn mowers and edger's for a maximum of 2 hours per day and only as often as is reasonable, between the hours of :*7am to 7pm Monday to Saturdays 9am to 7pm Sundays and Public Holidays*
- Musical instruments should not be played in practice for more than one hour in any day and only between the hours of : *7am to 7pm Monday to Saturdays 9am to 7pm Sundays and Public Holidays*

  Ensure your car, truck, motorcycle and lawn mowers have effective mufflers fitted.
- Shut windows and doors when playing music inside.
- Avoid operating bores outside the hours of:*7am to 7pm Monday to Saturdays 9am to 7pm Sundays and Public Holidays.*

- Ensure that when purchasing an air conditioning or generator unit that its location will not cause annoyance to neighbors. Air conditioner noise must comply with the Environmental protection (Noise) Regulations 1997. Ask the installer for confirmation of this.

Peterson and co-workers (Peterson and Northwood, 1981) of the University of the Miami School of Medicine appeared to demonstrate in rhesus monkeys that moderate levels of realistic noise can produce sustained elevations in blood pressure without significant alterations in the auditory mechanism. The unique aspect of this investigation was the finding that changes in auditory sensitivity did not necessarily follow changes in such physiological parameters as blood pressure.

Given the concern over noise, one wonders just how desirable a quiet town would be. Darlington, near Newcastle, England, was almost such a place. Between 1976-1978, Darlington was designated a "quiet town experiment". Noise abatement zones and better traffic management was instituted, as were vehicle noise testing and stricter enforcement of noise regulations (Gloag, 1980).

Sudden and unexpected noise has been observed to produce marked changes in the body, such as increased blood pressure, increased heart rate, and muscular contractions. Moreover, digestion, stomach contractions, and the flow of saliva and gastric juices all stop. Because the changes are so marked, repeated exposure to unexpected noise should obviously be kept to a minimum. These changes fortunately wear off as a person becomes accustomed to the noise (Broadbent, 1957). However, even when a person is accustomed to an environment where the noise level is high, physiological changes occur. The fact that noise has psychological effects is undoubted. The question is how these effects can be assessed and whether they lead to damage. No clear case has been made thus far for psychological damage caused by moderately high levels of noise, the levels that would cause hearing damage to only a small fraction of the people exposed. Indeed, fears have been expressed that ". . . over emphasis on damage may backfire when people come to realize that the truth of the matter seems to be simply that people can express violently their dislike about being disturbed by noises.

Dolman and Scott (2006) categorised the undersea noise as a source of pollution and as a potential threat to marine biodiversity. They began their studies in the early 1990s in response to a

coincidence of three 'focusing events': the shock testing of vessels by the US Navy; the transmission of up to 205 decibels of sound off Heard Island as part of the Acoustic Thermometry of Ocean Climate (ATOC) experiment; and the testing of low- and mid- frequency active sonar by US, Australian and NATO naval vessels. Somewhat less controversial, but arguably no less serious, is undersea noise resulting from seismic surveys, dredging and construction activities, shipping, offshore wind farms, sonar use associated with fishing and ocean science experiments. Recent scientific research indicates that sources of undersea noise such as military sonar can cause cetaceans and other marine mammals' physiological damage. Moreover, recent instances of atypical mass strandings have been linked to the use of tactical mid-frequency active sonar. The presence of undersea noise may also result in the exclusion of cetaceans from important habitats or impede reproductive and feeding patterns. Finally, it should be noted that comparatively little research has been undertaken in connection with the impact of undersea noise on species other than cetaceans, such as fish and deep sea squid, and no such research has been carried out in respect of diving birds such as penguins and cormorants. The issue of noise pollution and in particular, its impact on cetaceans, has reached the attention and the agenda of a number of international organizations concerned with the protection of the marine environment and the protection of biodiversity. These organizations include the International Whaling Commission (IWC) and the 1979 Convention on Migratory Species.

Data Acquisition

Co-ordinate Identification: Co-ordinate identification for this project exercise was facilitated by the use of hand-held Global Positioning System (GPS) units. A GPS unit measures the geographical location (and elevation) of a place in terms of its longitude and latitude in units of degrees, minutes and seconds as well as the Universal Traverse Mercator (UTM) protocol. A typical GPS device is shown in Fig. 2.

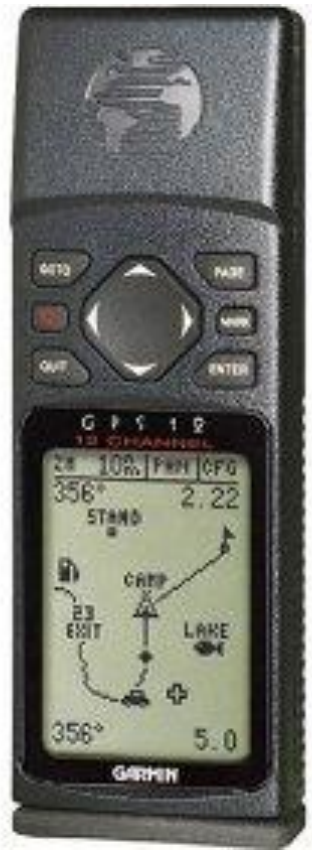


Fig. 2. Typical GPS device

Field Equipment: Sound level meters are instruments used to measures *sound pressure level* and are commonly used in noise pollution studies for the quantification of almost any noise, but especially for industrial, environmental and aircraft noise. However, the reading given by a sound level meter does not correlate well to human-perceived loudness; for this a loudness meter is needed. The current international standard for sound level meter performance is IEC 61672:2003 and this mandates the inclusion of an *A*-frequency-weighting filter and also describes other frequency weightings of *C* and *Z* (zero) frequency weightings. The older *B* and *D* frequency-weightings are now obsolete and are no longer described in the standard. A typical sound level meter device is shown in Fig.3.

Fig. 3. Typical sound level meter

The equipment that was used for this study is the standard Xtech A-weighted noise level meter.

Data Collection Procedure: At the outset of this project work, team members were provided with cadastral maps of the study area. The cadastral maps show the wards and the geo-referenced co-ordinates of the whole of Bosso Local Government Council. Before striking out, the maps were carefully studied and interpreted, and data collection was facilitated by both the use of the hand-held GPS units and the sound level meter.

Dataset of Study: About 2500 households strations were occupied for this study. These stations were the points of interest that suffer from high noise levels. The dataset collected from the field are usually presented in conformance with the Geographic Information System (GIS) protocol in terms of single static source representing a point shape, their numerical IDs, latitude, longitude, conventional locations on the ground noise emission sources, rated output of sources, and the presence or absence of noise (determined from a comparison of the measured value with the threshold value). An abridged form of the dataset is presented as Table 1.

Table 1: Abridged form of dataset of study

Shap	**ID**	**Coordinates**		**Locatio n**	**Pollution Sources/Type**	**Rated Output**	**Noise Level (dB)**	**Pollution Status**
		North	**East**					
Point	1	9.6491	6.5263	Bosso	Studio recorder	Nil	87	PRESENT
Point	2	9.6489	6.5263	Bosso	Barbing saloon stereo player	Nil	99.1	PRESENT
Point	3	9.6484	6.5264	Bosso	Electric miller grian	3700w/220v/50Hz	87.3	PRESENT
Point	4	9.6486	6.5265	Bosso	Vulcaniser/Viking	1.5kw/220v/50Hz	77	PRESENT
Point	5	9.6486	6.5267	Bosso	Tiger-EP2500A	2500W	73.5	PRESENT
Point	6	9.6485	6.5269	Bosso	Small generator/Yamaha	ET950W	92.4	PRESENT
Point	7	9.6488	6.527	Bosso	Heman Generator	EF6600W	91.3	PRESENT
Point	8	9.6488	6.5272	Bosso	Electric miller grian	Nil	85.9	PRESENT
Point	9	9.6489	6.5273	Bosso	Motor cycle/Jinchen	Nil	70	PRESENT
Point	10	9.6518	6.5298	Bosso	Wood mach. Router/Siemens	1200w/220v/50Hz	73.9	PRESENT
Point	11	9.6517	6.5296	Bosso	Studio recorder	Nil	72.5	PRESENT
Point	12	9.6515	6.5295	Bosso	Home stereo player	Nil	90.2	PRESENT

Point	13	9.6515	6.5264	Bosso	Electric miller vegetable	Nil	81.6	PRESENT
Point	14	9.6514	6.5292	Bosso	Motor cycle/Suzuki	Nil	87.9	PRESENT
Point	15	9.6513	6.5292	Bosso	Vulcaniser/Viking	1.5kw/220v/50Hz	70.3	PRESENT
Point	16	9.6512	6.5291	Bosso	Petrol generator/Tiger-EP1500A	5000W	74	PRESENT
Point	17	9.6509	6.5291	Bosso	Small generator/Yamaha	Nil	80	PRESENT
Point	18	9.6505	6.5286	Bosso	Diesel generator/ Imex	4500W	78.9	PRESENT
Point	19	9.6504	6.5288	Bosso	Studio recorder	7.5kw/220v/50Hz	91.4	PRESENT
Point	20	9.6502	6.529	Bosso	stereo player	1.5kw/220v/50Hz	83.5	PRESENT
Point	21	9.6498	6.529	Bosso	Electric miller grian	Nil	73	PRESENT
Point	22	9.6497	6.5289	Bosso	Vulcaniser/Viking	1.5kw/220v/50Hz	79.8	PRESENT
Point	23	9.6496	6.5289	Bosso	Generator/stereo player	Nil	77	PRESENT
Point	24	9.6496	6.5288	Bosso	Electric miller vegetable	Nil	76.3	PRESENT
Point	25	9.6495	6.5287	Bosso	stereo player	Nil	70.1	PRESENT
Point	26	9.6493	6.5286	Bosso	Home stereo player	Nil	90.5	PRESENT
Point	27	9.6491	6.5284	Bosso	Motor Cycle/ Suzuki	Nil	95	PRESENT
Point	28	9.649	6.5283	Bosso	Wood mach. Router/Siemens	1200w/220v/50Hz	83.6	PRESENT
Point	29	9.6488	6.5281	Bosso	Studio recorder	Nil	87.2	PRESENT
Point	30	9.6487	6.528	Bosso	Home stereo player	Nil	88.8	PRESENT
Point	31	9.6486	6.5279	Bosso	Welding filling mach./Bolts	1200w/220v/50Hz	91.4	PRESENT
Point	32	9.6485	6.5277	Bosso	FG Wilson Diesel	80KVA	99.3	PRESENT
Point	33	9.6483	6.5277	Bosso	Vulcaniser/Viking	1.5kw/220v/50Hz	88	PRESENT
Point	34	9.6482	6.5276	Bosso	Home stereo player	Nil	87.1	PRESENT
Point	35	9.6482	6.5274	Bosso	Electric miller vegetable	Nil	97.3	PRESENT

Point	36	9.6479	6.5271	Bosso	Motor cycle/Suzuki	Nil	72	PRESENT
Point	37	9.6479	6.5169	Bosso	Vulcaniser/Viking	1.5kw/220v/50Hz	71.5	PRESENT
Point	38	9.6475	6.5166	Bosso	Tiger-EC3500A	3.5kw/220v/50Hz	78.6	PRESENT
Point	39	9.6477	6.5166	Bosso	Motor cycle/Jincheng	Nil	79.1	PRESENT
Point	40	9.6477	6.5165	Bosso	Barbing saloon stereo player	3500W	82.4	PRESENT
Point	41	9.6479	6.5164	Bosso	Generator/Heman	1.2kw	83	PRESENT
Point	42	9.6479	6.5163	Bosso	Electric miller grian	Nil	99	PRESENT
Point	43	9.6481	6.5162	Bosso	Small generator/Yamaha	650W	91.2	PRESENT
Point	44	9.6482	6.5161	Bosso	Diesel generator/ Imex	7.5kw/220v/50Hz	96.8	PRESENT
Point	45	9.6481	6.5161	Bosso	Motor cycle/Jinchen	Nil	87.4	PRESENT
Point	46	9.6484	6.5158	Bosso	Generator repair/Heman	7.5kw/220v/50Hz	96.3	PRESENT
Point	47	9.6484	6.5158	Bosso	Yamaha Gen-EF6600E	6600W,27.5amps,240 v	77	PRESENT
Point	48	9.6483	6.5155	Bosso	Vulcaniser/Viking	1.5kw/220v/50Hz	71	PRESENT
Point	49	9.6482	6.5154	Bosso	Petrol generator/Tiger	5000W	73.5	PRESENT
Point	50	9.6479	6.5151	Ungwan Biri	Motor cycle/Jincheng	Nil	76.8	PRESENT
Point	51	9.6477	6.5149	Ungwan Biri	Wood mach. Router/Siemens	1200w/220v/50Hz	78.3	PRESENT
Point	52	9.6476	6.5149	Ungwan Biri	Generator/Heman	1.2kw	79	PRESENT
Point	53	9.6474	6.5153	Ungwan Biri	Electric miller grian	Nil	84	PRESENT
Point	54	9.6474	6.5154	Ungwan Biri	Motor cycle/Jinchen	Nil	86.2	PRESENT

Point	55	9.6473	6.5155	Ungwan Biri	Home stereo player	Nil	78.1	PRESENT
Point	56	9.6472	6.5156	Ungwan Biri	Electric miller vegetable	Nil	95	PRESENT
Point	57	9.647	6.5157	Ungwan Biri	Motor cycle/Suzuki	Nil	96.3	PRESENT
Point	58	9.647	6.5158	Ungwan Biri	Vulcaniser/Viking	1.5kw/220v/50Hz	94.2	PRESENT
Point	59	9.6469	6.5158	Ungwan Biri	Tiger-EC3500A	3.5kw/220v/50Hz	85.9	PRESENT
Point	60	9.6468	6.516	Ungwan Biri	Welding filling mach./Bolts	1200w/220v/50Hz	98.7	PRESENT
Point	61	9.6467	6.516	Ungwan Biri	Studio recorder	Nil	87	PRESENT
Point	62	9.6466	6.5162	Ungwan Biri	Welding driiller/Power plus	Nil	83	PRESENT
Point	63	9.6136	6.5415	Ungwan Biri	Vulcaniser /Viking	1.5kw/220v/50Hz	91	PRESENT
Point	64	9.6136	6.5416	Ungwan Biri	Small generator/Yamaha	650W	94	PRESENT
Point	65	9.6137	6.5418	Ungwan Biri	Diesel generator/ Imex	7.5kw/220v/50Hz	73	PRESENT
Point	66	9.6137	6.5421	Ungwan Biri	stereo player	Nil	84	PRESENT
Point	67	9.6137	6.5422	Ungwan Biri	Electric miller vegetable	Nil	96	PRESENT
Point	68	9.6138	6.542	Ungwan Biri	Yamaha Gen-EF6600E	6600W,27.5amps,240 v	73	PRESENT
Point	69	9.6138	6.5423	Ungwan Biri	Motor cycle/Suzuki	Nil	88	PRESENT

Point	70	9.6138	6.5424	Ungwan Biri	Electric miller vegetable	Nil	98.2	PRESENT
Point	71	9.6137	6.5422	Ungwan Biri	YAMAHA/ET2600	2000W	98.1	PRESENT
Point	72	9.6137	6.5423	Ungwan Biri	Diesel generator/ Imex	7.5kw/220v/50Hz	75	PRESENT
Point	73	9.6139	6.5425	Ungwan Biri	Electric miller vegetable	Nil	87	PRESENT
Point	74	9.6139	6.5426	Ungwan Biri	Generator/Heman	1.2kw	71	PRESENT
Point	75	9.6139	6.5427	Ungwan Biri	Barbing saloon stereo player	Nil	77	PRESENT
Point	76	9.6139	6.5428	Ungwan Biri	Petrol generator/Elepaq	7.5kw/220v/50Hz	98	PRESENT
Point	77	9.6139	6.5428	Ungwan Biri	Generator repair/Heman	7.5kw/220v/50Hz	93	PRESENT
Point	78	9.6139	6.5429	Ungwan Biri	Welding driiller/Power plus	Nil	82	PRESENT
Point	79	9.6139	6.5429	Ungwan Biri	Petrol generator/Tiger-EP1500A	5000W	84	PRESENT
Point	80	9.614	6.543	Ungwan Biri	Small generator/Yamaha	Nil	87	PRESENT
Point	81	9.6139	6.543	Ungwan Biri	Studio Loudspeaker/Aiwa	Nil	74	PRESENT
Point	82	9.6139	6.5431	Ungwan Biri	Honda/EU1000iA	1000W	76	PRESENT
Point	83	9.614	6.5431	Ungwan Biri	petrol generator/ Tiger	2500W	96	PRESENT
Point	84	9.614	6.5432	Ungwan Biri	Home stereo player	Nil	95	PRESENT

Point	85	9.614	6.5433	Ungwan Biri	Vulcaniser /Viking	1.5kw/220v/50Hz	91.2	PRESENT
Point	86	9.6141	6.5434	Ungwan Biri	Generator repair/ Suzuki	7.5kw/220v/50Hz	74.3	PRESENT
Point	87	9.6139	6.5433	Ungwan Biri	FG Wilson Diesel	80KVA	78.2	PRESENT
Point	88	9.614	6.5435	Ungwan Biri	Electric miller vegetable	Nil	87.4	PRESENT
Point	89	9.614	6.5436	Ungwan Biri	Diesel generator/Imex	7.5kw/220v/50Hz	86.1	PRESENT
Point	90	9.6141	6.5436	Ungwan Biri	Electric miller grian	3700w/220v/50Hz	71.2	PRESENT
Point	91	9.6141	6.5437	Ungwan Biri	Welding filling mach./Bolts	1.2kw/220v/50Hz	93.6	PRESENT
Point	92	9.6141	6.5438	Ungwan Biri	Studio recorder	Nil	86.8	PRESENT
Point	93	9.6141	6.5439	Ungwan Biri	Motor cycle/Hunda	Nil	77.7	PRESENT
Point	94	9.6142	6.5439	Ungwan Biri	Tiger-EC3500A	3.5kw/220v/50Hz	91	PRESENT
Point	95	9.6142	6.544	Ungwan Biri	Motor cycle/ Honda	Nil	90.8	PRESENT
Point	96	9.6142	6.5441	Ungwan Biri	Electric miller grian	Nil	84.1	PRESENT
Point	97	9.6142	6.5442	Ungwan Biri	Small generator/Yamaha	ET950W	71	PRESENT
Point	98	9.6142	6.5443	Ungwan Biri	Heman Generator	EF6600W	81.6	PRESENT
Point	99	9.6143	6.5443	Ungwan Biri	Vulcaniser/Viking	1.5kw/220v/50Hz	98.3	PRESENT

Point	100	9.6145	6.5451	Ungwan Biri	Home stereo player	Nil	97.1	PRESENT

Creation of a Unique GIS Layer of Noise Pollution Level Map for Minna

Concept of Geographical Information System (GIS): The Geographical Information System (GIS) is a computer system for capturing, storing, checking, integrating, manipulating, analysing and displaying data related to positions on the earth's surface. Typically, a Geographical Information System is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature. Each feature is linked to a position on the graphical image on a map and a record in an attribute table. GIS can relate otherwise disparate data on the basis of common geography, revealing hidden patterns, relationships, and trends that are not readily apparent in spreadsheets or statistical packages, often creating new information from existing data resources. Basically a GIS is like any other database, but with an important difference: *all information in GIS must be linked to a geographic (spatial) reference* (latitude/longitude, or other spatial coordinates).

Conversion of Analogue to Digital Map

Digitisation: This is the transformation of information from analogue format such as a paper (scan) map to digital format. The distinction from other Information Systems is that for a GIS the data inputs are of two types:

(i) Spatial data (latitude/longitude for geo-referencing, the features on a map, e.g. soil units, administrative districts), and

(ii) Non-Spatial (Attribute data): these are the descriptive data about the features, e.g. soil properties, population of districts, etc.).

A scanned map of the kind shown in Fig.1 cannot be accepted in a GIS database except when digitised.

Tools for Digitization: This is generally used for capturing data from analogue maps. It is based on the observation that any map consists of three basic kinds of features, viz: point features, line features, and polygon or area features. Points do not have length, width, or area. They are described completely by their coordinates and are used to represent discrete location information on the map to identify locations of features such as, cities, towns, well locations, rain gauge stations, soil sampling points, etc. A line consists of a set of ordered points. It has length, but no width or area. Therefore, it is used to represent features such as roads, streams or canals which have too narrow a width to be displayed on the map at its specified scale. A polygon or area is formed when a set of ordered lines form closed figure whose boundary is represented by the lines. Polygons are used to represent area features such as land parcels, lakes, districts, agro ecological zones, etc. A polygon usually encloses an area that may be considered homogeneous with respect to some attribute. For example, in a soil map, each polygon will represent an area with a homogeneous soil type.

From the analogue map of the study area (see Fig.1), all non-spatial data were converted to points, lines, and polygons by transferring the scanned analogue map onto the ArcView3.3 platform. Then the “Themes” icon was invoked whence points were selected, the boundary line dialogue was opened, and the appropriate settings applied. The digitised map for the study area is shown in Fig.4.

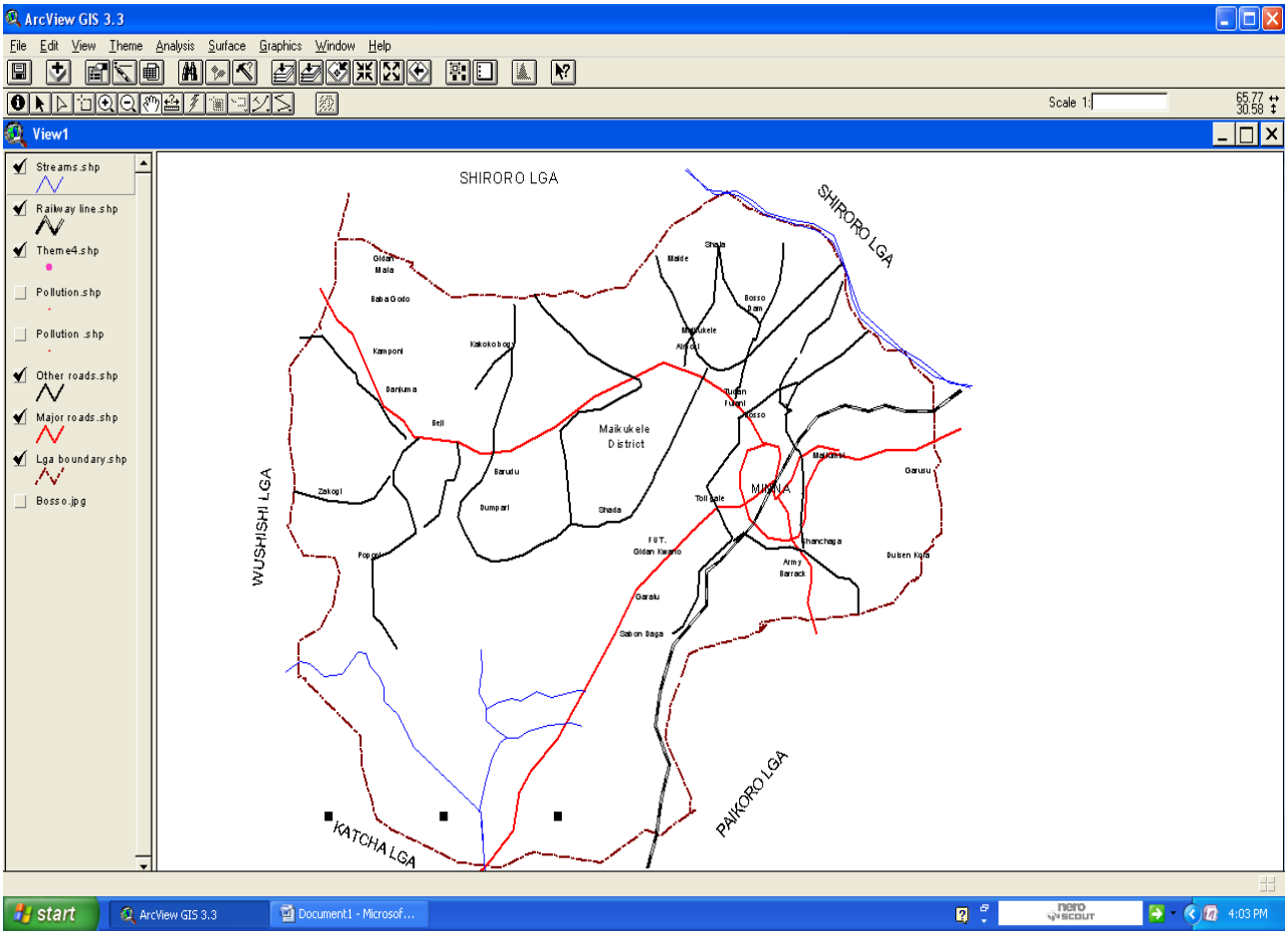
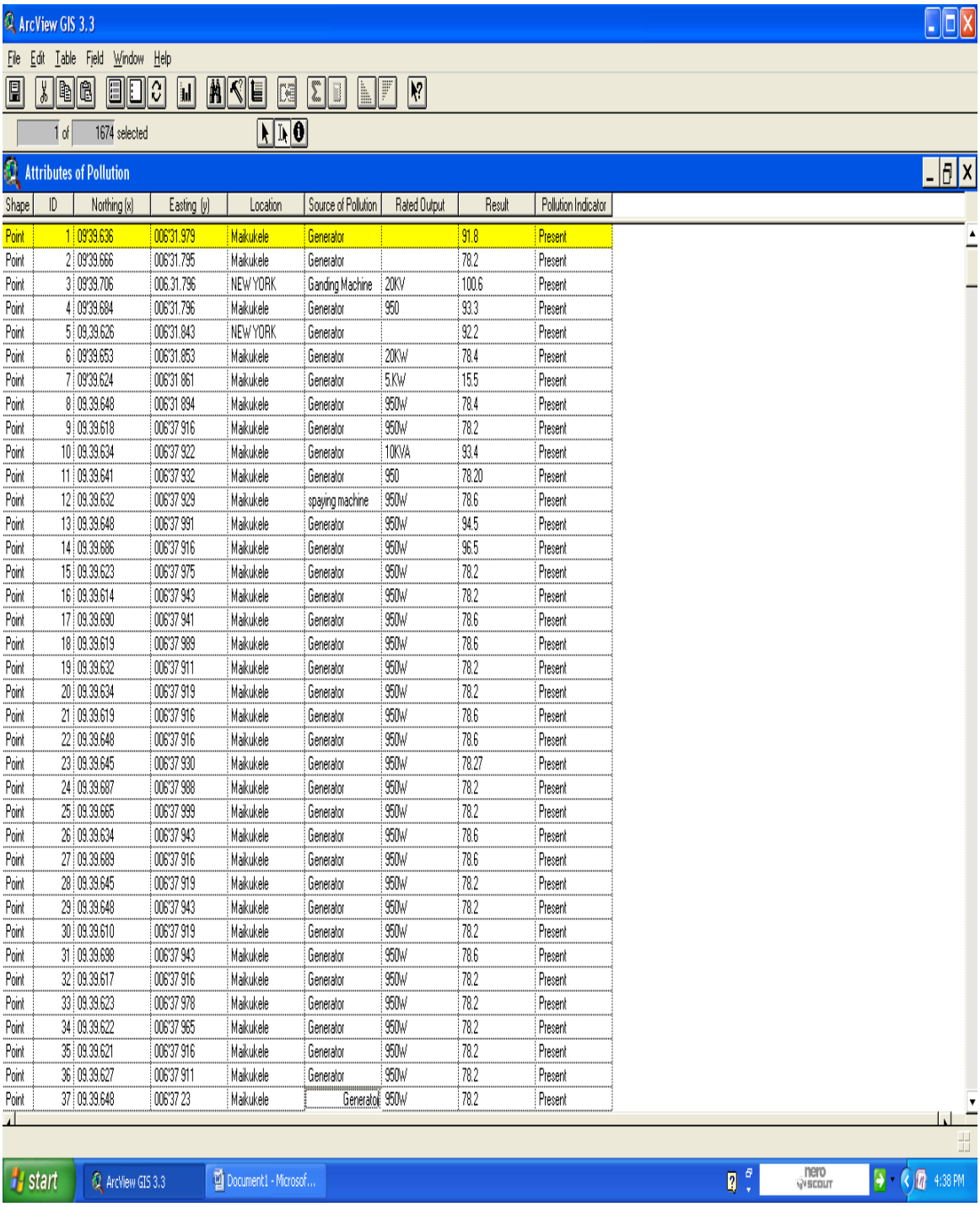


Fig.4. Digitised map of study area

Inputation of Co-ordinates/Database Development

From the non-spatial (attribute) data which shows the conventional location, sources of pollution, physical characteristics of sources, values of pollution, and pollution status, a link was created with the spatial dataset in order to develop a database for the study area, see Fig.5.



Attributes of Pollution

Shape	ID	Northing (x)	Easting (y)	Location	Source of Pollution	Rated Output	Result	Pollution Indicator
Point	1	09'39.636	006'31.979	Makukele	Generator		91.8	Present
Point	2	09'39.666	006'31.795	Makukele	Generator		78.2	Present
Point	3	09'39.706	006.31.796	NEW YORK	Ganding Machine	20KV	100.6	Present
Point	4	09'39.684	006'31.796	Makukele	Generator	950	93.3	Present
Point	5	09,39.626	006'31.843	NEW YORK	Generator		92.2	Present
Point	6	09'39.653	006'31.853	Makukele	Generator	20KW	78.4	Present
Point	7	09'39.624	006'31 861	Makukele	Generator	5.KW	15.5	Present
Point	8	09.39.648	006'31 894	Makukele	Generator	950w	78.4	Present
Point	9	09.39.618	006'37 916	Makukele	Generator	950w	78.2	Present
Point	10	09.39.634	006'37 922	Makukele	Generator	10KVA	93.4	Present
Point	11	09.39.641	006'37 932	Makukele	Generator	950	78.20	Present
Point	12	09.39.632	006'37 929	Makukele	spaying machine	950w	78.6	Present
Point	13	09.39.648	006'37 991	Makukele	Generator	950w	94.5	Present
Point	14	09.39.686	006'37 916	Makukele	Generator	950w	96.5	Present
Point	15	09.39.623	006'37 975	Makukele	Generator	950w	78.2	Present
Point	16	09.39.614	006'37 943	Makukele	Generator	950w	78.2	Present
Point	17	09.39.690	006'37 941	Makukele	Generator	950w	78.6	Present
Point	18	09.39.619	006'37 989	Makukele	Generator	950w	78.6	Present
Point	19	09.39.632	006'37 911	Makukele	Generator	950w	78.2	Present
Point	20	09.39.634	006'37 919	Makukele	Generator	950w	78.2	Present
Point	21	09.39.619	006'37 916	Makukele	Generator	950w	78.6	Present
Point	22	09.39.648	006'37 916	Makukele	Generator	950w	78.6	Present
Point	23	09.39.645	006'37 930	Makukele	Generator	950w	78.27	Present
Point	24	09.39.687	006'37 988	Makukele	Generator	950w	78.2	Present
Point	25	09.39.665	006'37 999	Makukele	Generator	950w	78.2	Present
Point	26	09.39.634	006'37 943	Makukele	Generator	950w	78.6	Present
Point	27	09.39.689	006'37 916	Makukele	Generator	950w	78.6	Present
Point	28	09.39.645	006'37 919	Makukele	Generator	950w	78.2	Present
Point	29	09.39.648	006'37 943	Makukele	Generator	950w	78.2	Present
Point	30	09.39.610	006'37 919	Makukele	Generator	950w	78.2	Present
Point	31	09.39.698	006'37 943	Makukele	Generator	950w	78.6	Present
Point	32	09.39.617	006'37 916	Makukele	Generator	950w	78.2	Present
Point	33	09.39.623	006'37 978	Makukele	Generator	950w	78.2	Present
Point	34	09.39.622	006'37 965	Makukele	Generator	950w	78.2	Present
Point	35	09.39.621	006'37 916	Makukele	Generator	950w	78.2	Present
Point	36	09.39.627	006'37 911	Makukele	Generator	950w	78.2	Present
Point	37	09.39.648	006'37 23	Makukele	Generator	950w	78.2	Present

Fig.5. Merged database on the ArcView3.3 platform

Production of Noise Pollution Map

Each of the point identified in Fig.5 was now linked (hot-linking) to the spatial map for the production of the noise pollution map. Prior to this a colour (red) was selected on the Arcview platform to represent our point source, see Fig.6.

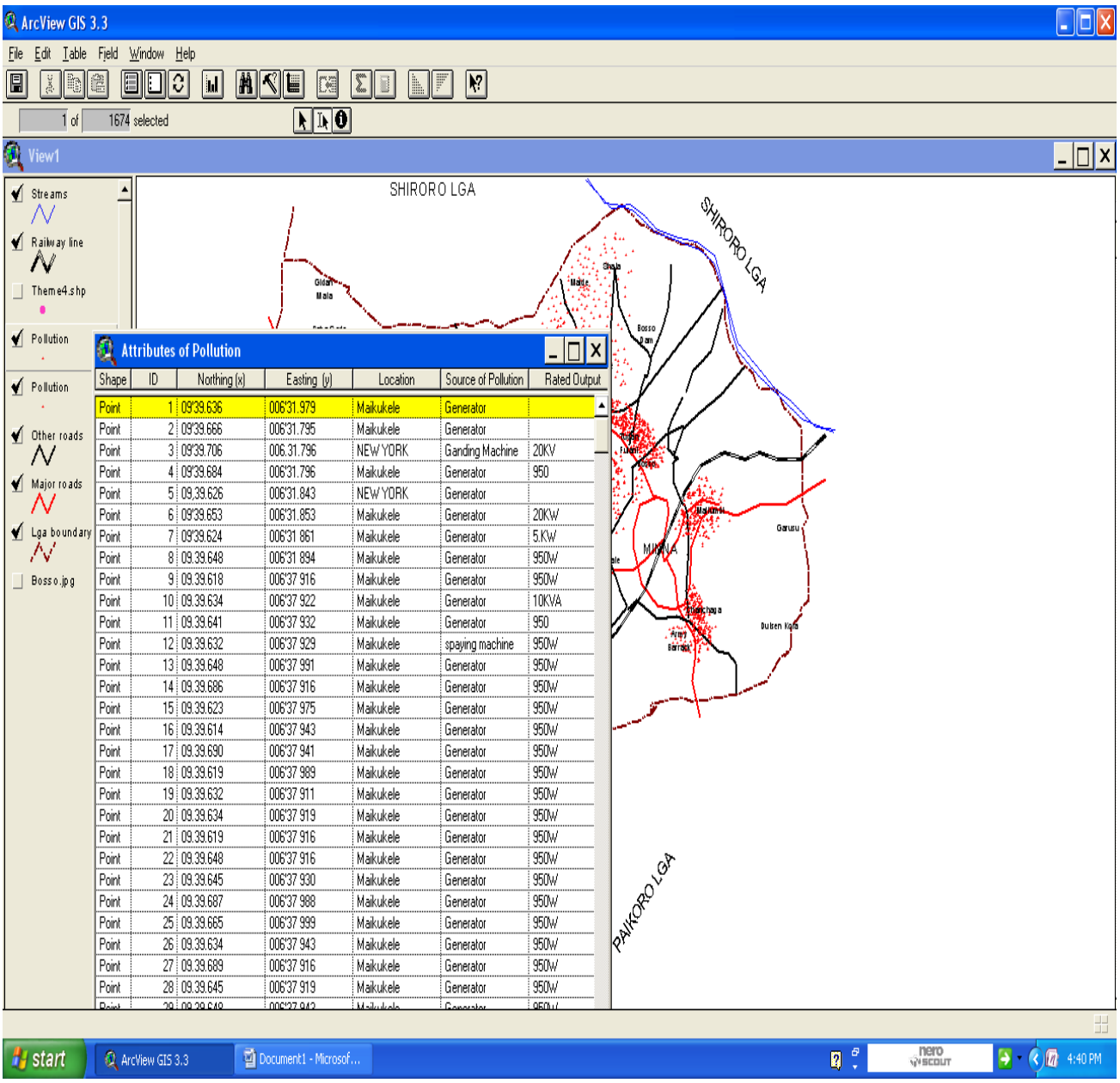


Fig.6. Hot-linking merged database with spatial map on the ArcView3.3 platform

The resultant noise pollution map is shown in Fig.7.

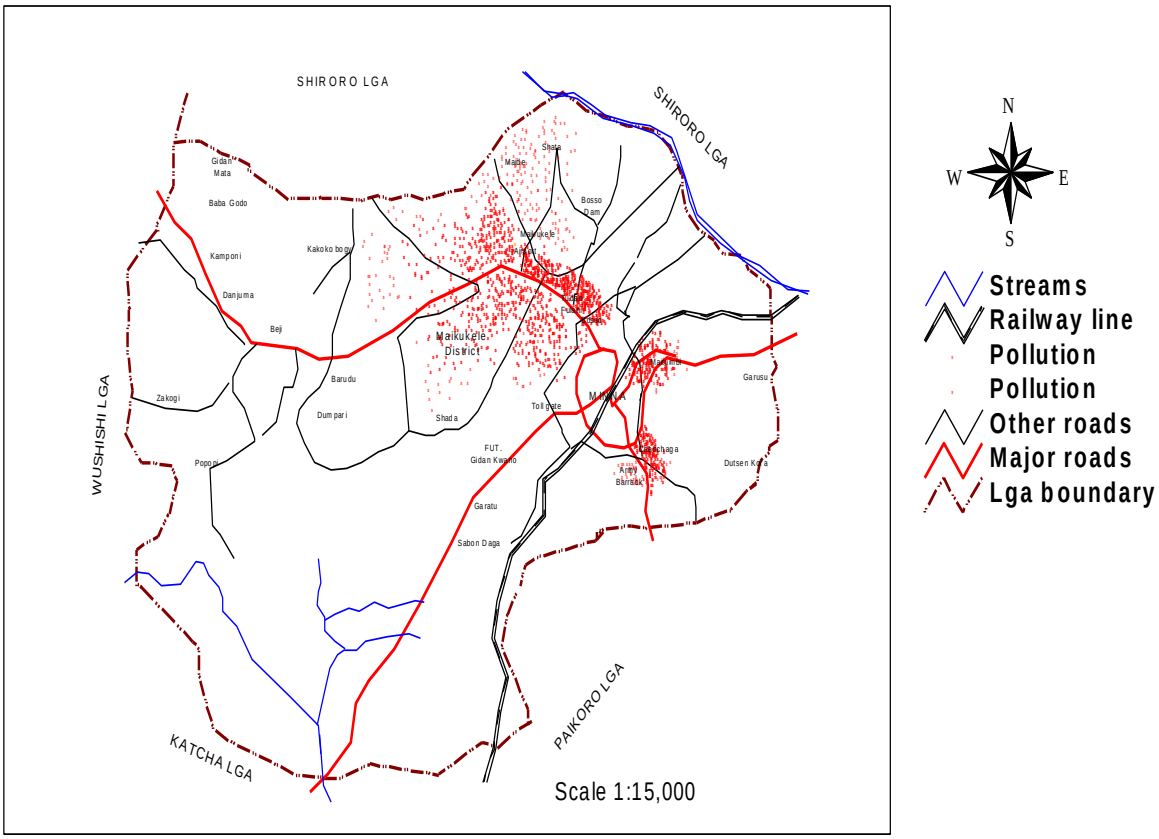


Fig.7. Noise pollution map of study area

The red-doted points on the map show sources of noise pollution with values greater than 70dB.

Query Procedure and Presentation of Pollution Layer

The query was performed on ArcView3.3 by ensuring that the entire menu themes were active. The Query Builder allows for easy selection of features based on their attributes. Inside the dialog box, under Fields, the first step involved double-clicking on “Point”. The points that comprised of geo-reference points, locations, sources, rating, and noise levels as well as pollution status

appeared in the box at the bottom of the dialog. To find specific attributes, the = sign was chosen by clicking on it once. An attribute name from the point list was selected by double-clicking to add it to the expression, and then "New Set" was selected. By default, ArcView highlighted the queried selection in red. The attributes that were queried were highlighted in red on the map. Fig.8 shows location query for the study area.

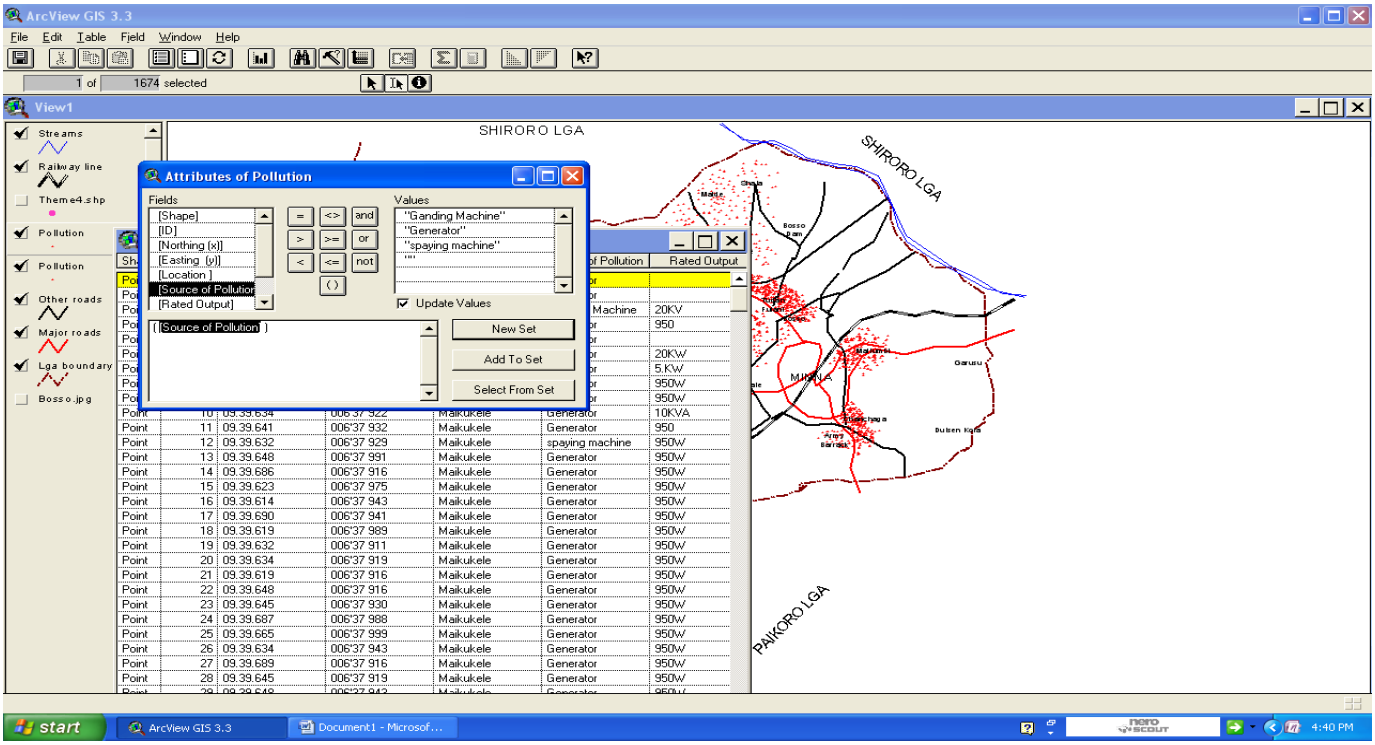


Fig.8. Location query of study area

Results and Conclusion

All the stations occupied for this survey (about 2500 households) indicate noise levels greater than the internationally-recommended safe threshold of 70dB. Station occupation was biased in favour of households that have high noise sources. The predominant sources of noise are common household generators. Others are grain milling machines, metal milling machines, and music store loudspeakers. The GIS tool has been employed in the analysis of the full body of the dataset acquired for this project work with the core objective of producing a noise pollution layer for Bosso Local Government Council of Niger State. This unique GIS layer is the first of its kind anywhere in Nigeria. Thus at the click of a mouse, information about the noise pollution signature for Bosso

Local Government Council of Niger State can readily be assessed. From the noise pollution map of Fig.4.5 it is observed that the Tudun Fulani, Maikunkele, Bosso, Maitumbi, and Chanchaga neighbourhoods have high red dot densities, whilst the dot densities for Shata, and Maide neighbourhoods are sparsely distributed.

It can be deduced from the pollution map produced for this project work that, overall, the noise level regime over Tudun Fulani, Maikunkele, Bosso, Maitumbi, and Chanchaga neighbourhoods are quite high because a significant number of households and business locations use alternative power sources when the central power supply is cut. Because of the homestead densities of these neighbourhoods, without appreciable lots or spaces between homes, milling machines easily constitute nuisances. The more developed a neighbourhood is, the greater the noise dot density.

This GIS pollution layer map could now serve as a veritable urban development tool that would assist public health officials and town planners recommend appropriate action to be taken to safeguard the health of the citizenry.

Recommendation

From the result of this study it is recommended that there should adequate and safe clearance between power generating units and homesteads when these units are in use. Householders should switch to the purchase of low-noise generator brands from reputable manufacturers. Further, efforts should be made by householders to explore the possibility of alternative power generating sources like solar units since their initial cost of installation are not prohibitively expensive anymore.

The result of this study is actually futuristic in its outlook, thus it is strongly recommended that a GIS host platform for Minna be created so that the interactive nature of the noise pollution map of Fig.7 can be fully exploited.

It is also recommended that novelty studies of this kind be replicated in the major towns and cities of Nigeria.

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