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Geospatial Analysis and Geographic Information System (GIS) Mapping of a Greenhouse Gas at Minna, Nigeria

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Abstract

Carbon dioxide is generally considered the culprit greenhouse gas. This study will help prepare the framework for a carbon dioxide emission database for Minna. This study concerned household or static sources that were considered significant sources of carbon dioxide over any 24-hour cycle. Stations of interest were appropriately geo-referenced and marked in the conventional way. The stations were re-visited with the carbon dioxide level meter whence information about the outdoor levels of carbon dioxide was logged progressively from one point to the next. The field dataset indicate ambient carbon dioxide levels above the 350ppm threshold selected for this study. By use of the Geographic Information System (GIS), a carbon dioxide emission layer map for Minna was created. The resulting interactive GIS-enabled layer map is a good enough indicator of the major greenhouse gas emmision trend across Minna town.

Keywords: Greenhouse, emission, geo-referencing, GIS, mapping

1.0 Introduction

Large-scale emission of anthropogenic greenhouse gases resulting in the global warming trend is presently enjoying worldwide attention. The absence of a carbon dioxide emission database for Minna was a source of frustration for the provincial state government of Niger. Minna is the administrative capital of sate of Niger in Nigeria. The aim and objective of this study was the application of the knowledge of geospatial analysis and Geographic Information System mapping to contribute towards the preparation of a framework for a carbon dioxide emission database for Minna. Such a database could be "warehoused" until the Minna Geographic Information System (MG1S) project is complete, so it could be integrated as a layer of the MG1S. Above all, a carbon dioxide emission database for Minna would be central to the activation of a public awareness programme to educate the residents of Minna about the contribution of their town to the overall global warming episode. As a justification, this study was predicated on one of the founding charters of the Federal University of Technology, Minna, i.e. the deployment of academic resources to proffering solutions to questions plaguing the immediate communities. The study was designed to cover all of the developed areal extent of Minna town, more of a house-to-house coverage scheme. This study concerned household or static sources that were considered significant sources of carbon dioxide over any 24-hour cycle.

A review of the literature concerning the environmental consequences of increased levels of atmospheric carbon dioxide (CO2) by Robinson (2007) leads to the conclusion that increases during the 20^{th} and early 21^{st} centuries have produced no deleterious effects upon earth's weather and climate. Robinson and his co-workers feared that CO2 would result in "human-caused global warming" i.e. hypothetical severe increases in earth's temperatures, with disastrous environmental consequences. Increased carbon dioxide has, however, markedly increased plant growth.
Atmospheric CO2 fertilizes plants. Higher CO2 enables plants to grow faster and larger and to live in drier climates. Plants provide food for animals, which are thereby also enhanced. Predictions of harmful climatic effects due to future increases in hydrocarbon use and minor greenhouse gases like CO2 do not conform to current experimental knowledge.

In 2009 the United States NewsWeek Project Green reveals that Texas State produces more carbon emissions than most countries. Considering its role in the US economy, it is no surprise Texas ranks as it does. As the nation's leading producer of energy and with more cattle and oil refineries than any other state, it is essentially America's power plant, gas plant, gas pump and beef basket. While many environmentalists focus on the methane (another greenhouse gas) produced by cars, the raising of cattle also contribute to CO2 emissions (the burning of fuel to transport cattle and meat, etc.). A case study released by Japanese scientists showed that the production of just one kilogram of beef results in more CO2 emissions than going for a three-hour drive while leaving all the lights on at home. Texas also has the largest petrochemical industry in the country. By some estimates more than half of all Texans live in areas where the air is unsafe to breathe as defined by the EPA's clean air act (www.newsweekwebexclusive.com).

In an article published by Laurence in 2008 (www.suitel01.com), the author stated that carbon dioxide levels, largely man-made, are increasing the world average temperature and this increase will have a devastating effect on sea levels. He further stated that the Fourth Assessment Report (AR4) of the United Nations Intergovernmental Panel on Climate (IPCC) issued in November 2007 stated that most of the observed increase in globally averaged temperatures since the midtwentieth century is very likely due to the observed increase in anthropogenic (human-induced) greenhouse gas concentrations. He added that anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilised. Man-made carbon dioxide emission is having a profound impact on the environment through an increase in sea levels and a dangerous increase in world temperature. It is imperative that such increases in carbon dioxide emissions must not only be stabilised but reduced to avoid the worst effect of global warming. As measured by the Mauna Loa observatory in Hawaii the present-day concentration of CO2 in the atmosphere average out at 380 parts per million.

In 2009 Connor (www.independent.co.uk) stated that the world will overshoot its long-term target on greenhouse emissions within two decades. He said a study found out that the average global temperature will rise above threshold that could cause dangerous climate change during that time. He said scientists have calculated that the world has already produced about a third of the total amount of carbon dioxide (CO2) that could still be emitted between 2000 and 2050 and still keep within a 2°C rise in global average temperature. He further stated that substantial reductions in global emissions have to begin soon, really before 2020. If we wait longer the required phase-out of carbon emissions will involve tremendous economic costs and technological challenges. A 2°C global warming would take us far beyond the variations that earth has experienced since we humans have been around. The study concluded that the world must agree on a cut in carbon dioxide emissions of more than 50% per cent by 2050 if the probability of exceeding a 2°C rise in average temperature is to be limited to a risk of 1 in 4.

Lovejoy and fellow workers in 2008 (www.westcoastclimateequity.org) mentioned that in the course of the earth's history, life collectively has had a strong influence on atmosphere and climate. It has helped shaped both, and has been shaped by both. Today, atmospheric and climate changes are driven by a single species- ourselves and they are happening very rapidly. One of the principal elements in this is carbon, the most basic of the building blocks of living organisms. Greenhouse gas emissions are central in the climate agenda. But the key question has always been what is a '"safe" concentration of atmospheric greenhouse gases. The pre-industrial concentration was 280ppm. Today the concentration is 389ppm and emission rate have passed beyond the worst case scenario of the Intergovernmental Panel on Climate Change (IPCC). It's been suggested that

350ppm was the concentration beyond which it was unsafe to go. The rapid retreat as well as the thinning of the Arctic Ocean ice is consistent with the conclusion. So, too, earth's ecosystem and biodiversity are sending multiple signals that essentially confirm 350ppm as the limit. Unquestionably we are beyond where we should be.

Ndoke *et al.* (2006) pointed out that since the beginning of the industrial revolution, the atmospheric concentration of CO2 has increased considerably, as well as those of other greenhouse gases. This increase in concentration is likely to accelerate the rate of climate change i.e. an indirect implication of global warming. The main greenhouse gases are water vapour, carbon dioxide (CO2), ozone, methane, nitrous oxide, and the chlorofluorocarbons. Levels of these gases are rising as a direct result of human activity. Apart from global wanning, greenhouse gases are also responsible for the phenomenon known as ozone layer depletion. It is predicted that the global average temperature will rise by about 2°C (3.6°F) by the year 2100 if current emission trend continues. CO2 is being generated in ever increasing amount in part due to increase in the population of the earth, in part due to clearing of forests (and thus to less use of CO2 in photosynthesis) and in part to increased combustion of fossil fuels. If this increase becomes severe, it could enhance greenhouse effect, leading to global warming trend. This warming might be enough to melt part of the polar ice caps and raise the level of the oceans.

In 2001 Marland and Boden (www.cdiac.esd.ornl.gov) stated that there is broad consensus which the world community has achieved, that the atmospheric concentration of carbon dioxide (CO2) is increasing, and this increase is due largely to the combustion of fossil fuels. This increase is likely to lead to changes in the global climate. This consensus is sufficiently strong that virtually all countries are involved in trying to achieve a functioning agreement on how to confront and mitigate these changes in climate. Large and growing anthropogenic release of carbon to the atmosphere is a relatively recent phenomenon. Fossil fuel release occurs largely from energy consuming activities in the developed countries also as a result of changes in land use and the destruction of terrestrial vegetation.

2.0 The Study Area

Minna, the administrative capital of the state of Niger in Nigeria, is a semi-rural town some 150 km northeast of Abuja by road transport. Like most Nigerian towns and cities, Minna is plagued with the usual challenges of rapid and haphazard urbanization. Such urban centres usually face sanitation and air pollution crises. Minna has undergone marked transformation in the area of geo-spatial information characterization over a period of thirty-four years (it was formally designated a state capital in 1976) as shown by the archival map of Fig.l and the modem geo-referenced, digitized map of Fig.2.

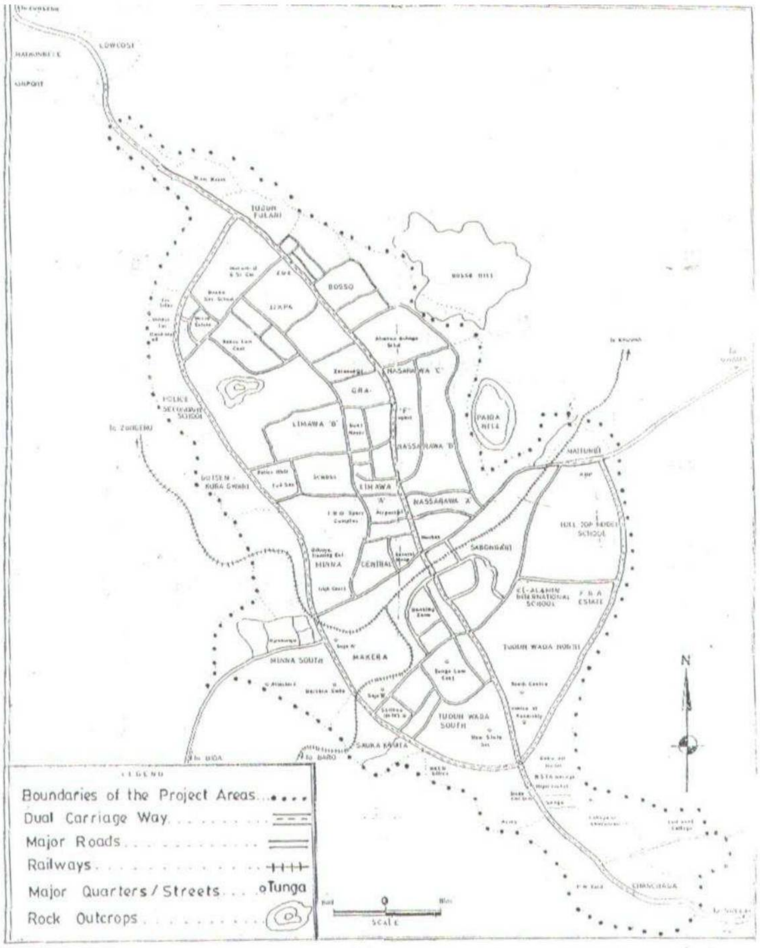


Fig MAP OF MINNA AND IT'S ENVIRON SHOWING THE PROJECT AREAS

Fig. 1. Archival map of Minna in analogue format

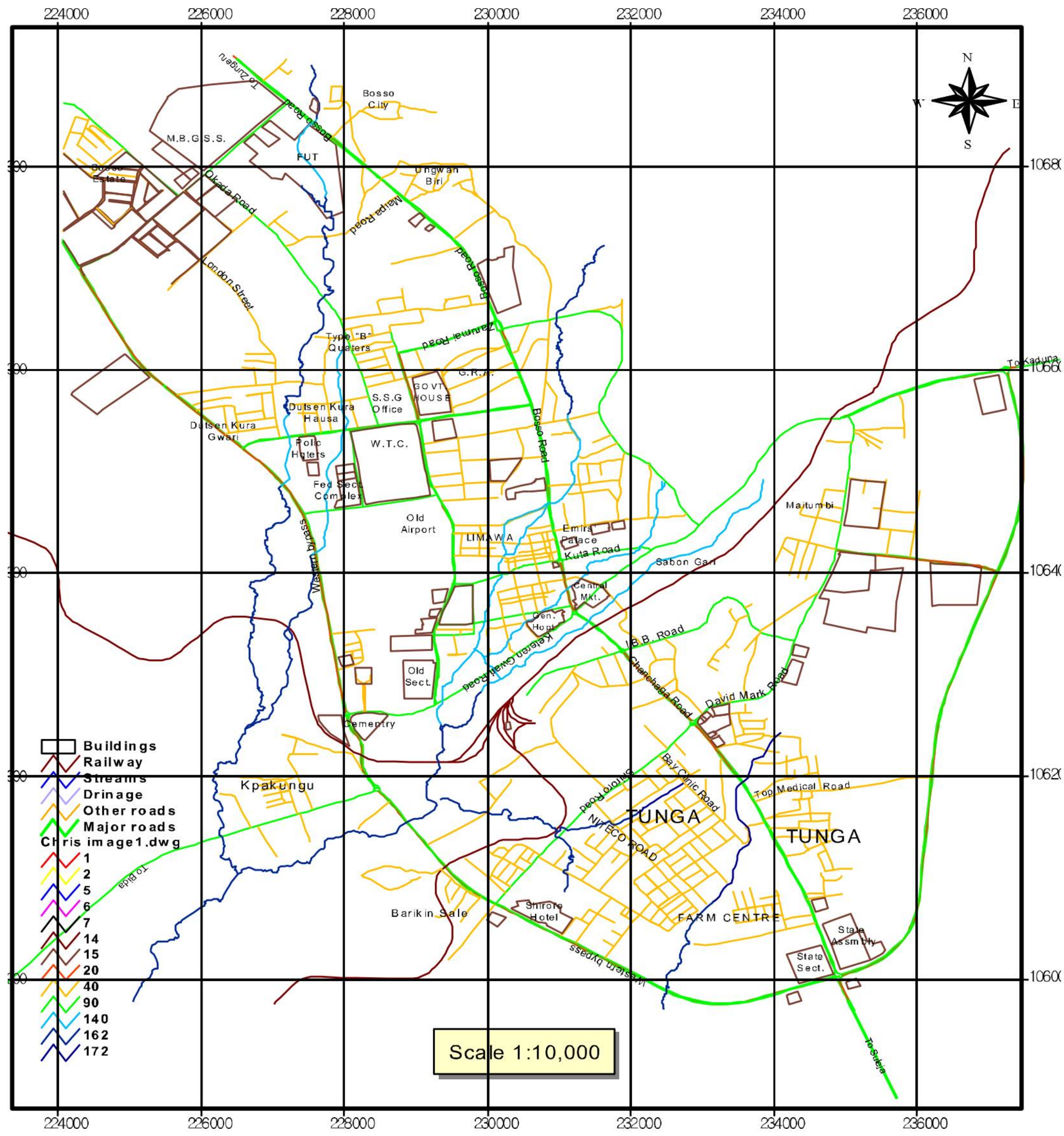


Fig.2. Digitised map of Minna in proper co-ordinates

3.0 Data Acquisition

Co-ordinate identification for this study was facilitated by the use of hand-held Global Positioning System (GPS) units. Stations of interest that were identified were appropriately geo-referenced and marked in the conventional way. The stations were re-visited with the carbon dioxide meter whence information about the sources of carbon dioxide and their corresponding values were logged progressively from one point to the next. About 9357 points of interest were identified for this study.

4.0 Presentation of Result

The dataset was 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, emission sources, rated output of sources, and the presence or absence of carbon dioxide above the threshold. An illustration of the dataset showing 100 stations (coinciding for the precinct called Maikunkele) is presented as Table 1.

Table 1: Illustration of the dataset showing 100 stations for the Maikunkele precinct

Shape	*ID*	*Northing*	*Easting*	*Location (precinct)*	*Emission sources*	*Rated output*	CO_2 *above 350 ppm*
Point	1	9.6515	6.5292	Maikunkele	* Generator	1.5kW	Present
Point	2	9.6514	6.5291	Maikunkele	Generator	1.5 kW	Present
Point	3	9.6513	6.5291	Maikunkele	Firewood hearth	**N/A	Present
Point	4	9.6512	6.5286	Maikunkele	Generator	2.0 kW	Present
Point	5	9.6509	6.5288	Maikunkele	Generator	2.0 kW	Present
Point	6	9.6505	6.5290	Maikunkele	Generator	2.0 kW	Present
Point	7	9.6504	6.5290	Maikunkele	Generator	2.0 kW	Present
Point	8	9.6502	6.5289	Maikunkele	Generator	2.0 kW	Present
Point	9	9.6498	6.5289	Maikunkele	Generator	2.0 kW	Present
Point	10	9.6497	6.5288	Maikunkele	Generator	2.0 kW	Present
Point	11	9.6496	6.5287	Maikunkele	Generator	2.0 kW	Present
Point	12	9.6496	6.5286	Maikunkele	Generator	2.0 kW	Present
Point	13	9.6495	6.5284	Maikunkele	Generator	2.0 kW	Present
Point	14	9.6493	6.5283	Maikunkele	Generator	2.0 kW	Present
Point	15	9.6491	6.5281	Maikunkele	Generator	2.0 kW	Present
Point	16	9.649	6.5280	Maikunkele	Generator	2.0 kW	Present
Point	17	9.6488	6.5279	Maikunkele	Generator	2.0 kW	Present
Point	18	9.6487	6.5277	Maikunkele	Generator	2.0 kW	Present

Point	19	9.6486	6.5277	Maikunkele	Generator	2.0 kW	Present
Point	20	9.6485	6.5276	Maikunkele	Firewood hearth	N/A	Present
Point	21	9.6483	6.5274	Maikunkele	Coal hearth	N/A	Present
Point	22	9.6482	6.5271	Maikunkele	Coal hearth	N/A	Present
Point	23	9.6482	6.5169	Maikunkele	Firewood hearth	N/A	Present
Point	24	9.6479	6.5166	Maikunkele	Generator	7.5 kW	Present
Point	25	9.6479	6.5166	Maikunkele	Generator	1.5kW	Present
Point	26	9.6475	6.5165	Maikunkele	Generator	11.5kW	Present
Point	27	9.6477	6.5164	Maikunkele	Generator	2.0 kW	Present
Point	28	9.6477	6.5163	Maikunkele	Generator	2.0 kW	Present
Point	29	9.6479	6.5162	Maikunkele	Firewood hearth	N/A	Present
Point	30	9.6479	6.5161	Maikunkele	Coal hearth	N/A	Present
Point	31	9.6481	6.5161	Maikunkele	Coal hearth	N/A	Present
Point	32	9.6482	6.5158	Maikunkele	Firewood hearth	N/A	Present
Point	33	9.6481	6.5158	Maikunkele	Generator	2.0 kW	Present
Point	34	9.6484	6.5155	Maikunkele	Generator	2.0 kW	Present
Point	35	9.6484	6.5154	Maikunkele	Generator	2.0 kW	Present
Point	36	9.6483	6.5151	Maikunkele	Coal hearth	N/A	Present
Point	37	9.6482	6.5149	Maikunkele	Coal hearth	N/A	Present

Point	38	9.6479	6.5149	Maikunkele	Generator	2.0 kW	Present
Point	39	9.6477	6.5153	Maikunkele	Generator	2.0 kW	Present
Point	40	9.6476	6.5154	Maikunkele	Charcoal hearth	N/A	Present
Point	41	9.6474	6.5155	Maikunkele	Firewood hearth	N/A	Present
Point	42	9.6474	6.5156	Maikunkele	Firewood hearth	N/A	Present
Point	43	9.6473	6.5157	Maikunkele	Generator	2.0 kW	Present
Point	44	9.6472	6.5158	Maikunkele	Generator	2.0 kW	Present
Point	45	9.6470	6.5158	Maikunkele	Firewood hearth	N/A	Present
Point	46	9.6470	6.5160	Maikunkele	Generator	7.5 kW	Present
Point	47	9.6469	6.5160	Maikunkele	Coal hearth	N/A	Present
Point	48	9.6468	6.5162	Maikunkele	Generator	2.0 kW	Present
Point	49	9.6467	6.5415	Maikunkele	Generator	2.0 kW	Present
Point	50	9.6466	6.5416	Maikunkele	Firewood hearth	N/A	Present
Point	51	9.6136	6.5418	Maikunkele	Generator	12 kW	Present
Point	52	9.6136	6.5421	Maikunkele	Generator	2.0 kW	Present
Point	53	9.6137	6.5422	Maikunkele	Generator	7.5 kW	Present
Point	54	9.6137	6.5420	Maikunkele	Generator	12 kW	Present
Point	55	9.6137	6.5423	Maikunkele	Generator	2.0 kW	Present

Point	56	9.6138	6.5424	Maikunkele	Coal hearth	N/A	Present
Point	57	9.6138	6.5422	Maikunkele	Firewood hearth	N/A	Present
Point	58	9.6138	6.5423	Maikunkele	Generator	12 kW	Present
Point	59	9.6137	6.5425	Maikunkele	Generator	2.0 kW	Present
Point	60	9.6137	6.5426	Maikunkele	Generator	2.0 kW	Present
Point	61	9.6139	6.5427	Maikunkele	Coal hearth	N/A	Present
Point	62	9.6139	6.5428	Maikunkele	Generator	11.5 kW	Present
Point	63	9.6139	6.5428	Maikunkele	Coal hearth	N/A	Present
Point	64	9.6139	6.5429	Maikunkele	Firewood hearth	N/A	Present
Point	65	9.6139	6.5429	Maikunkele	Generator	2.0 kW	Present
Point	66	9.6139	6.5430	Maikunkele	Generator	2.0 kW	Present
Point	67	9.6139	6.5430	Maikunkele	Generator	2.0 kW	Present
Point	68	9.6140	6.5431	Maikunkele	Generator	7.5 kW	Present
Point	69	9.6139	6.5431	Maikunkele	Coal Hearth	N/A	Present
Point	70	9.6139	6.5432	Maikunkele	Firewood hearth	N/A	Present
Point	71	9.6140	6.5433	Maikunkele	Coal hearth	N/A	Present
Point	72	9.6140	6.5434	Maikunkele	Coal hearth	N/A	Present
Point	73	9.6140	6.5433	Maikunkele	Generator	2.0 kW	Present
Point	74	9.6141	6.5435	Maikunkele	Generator	2.0 kW	Present
Point	75	9.6139	6.5436	Maikunkele	Generator	2.0 kW	Present

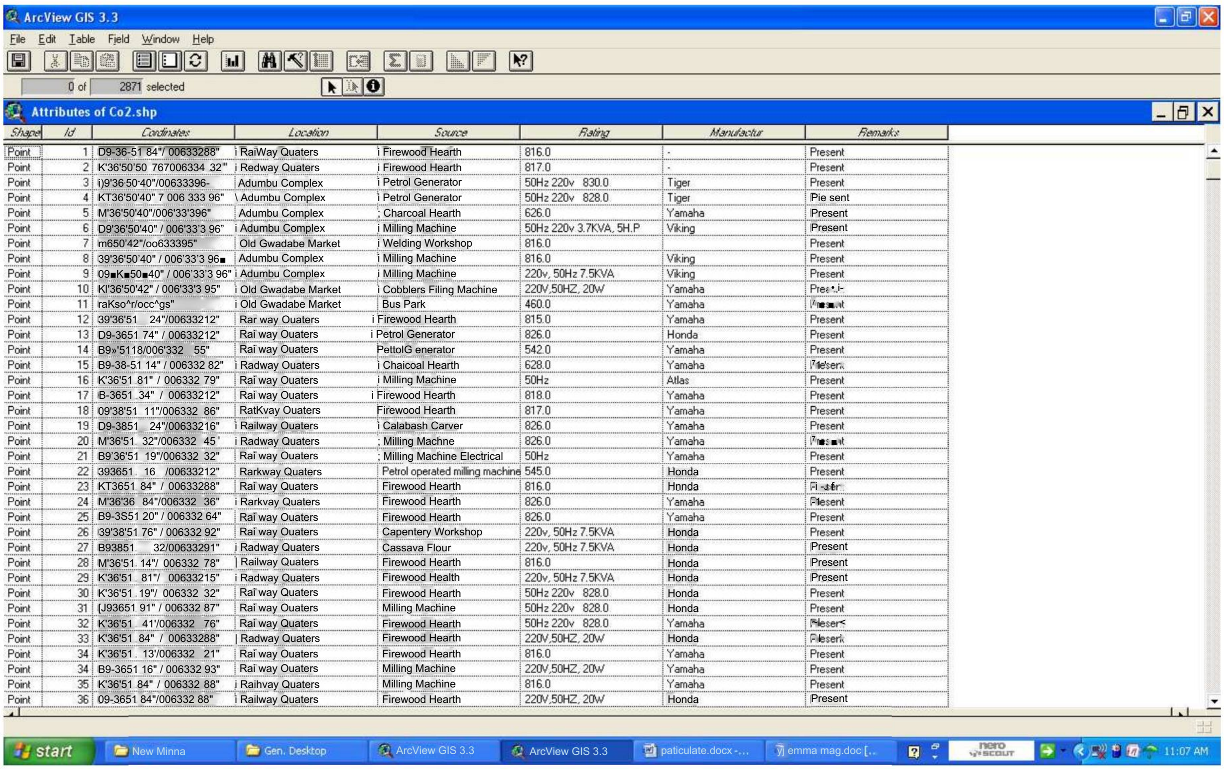
Point	76	9.6140	6.5436	Maikunkele	Generator	2.0 kW	Present
Point	77	9.6140	6.5437	Maikunkele	Generator	2.0 kW	Present
Point	78	9.6141	6.5438	Maikunkele	Coal hearth	N/A	Present
Point	79	9.6141	6.5439	Maikunkele	Generator	1.5 kW	Present
Point	80	9.6141	6.5439	Maikunkele	Coal hearth	N/A	Present
Point	81	9.6141	6.5440	Maikunkele	Generator	2.0 kW	Present
Point	82	9.6142	6.5441	Maikunkele	Firewood hearth	N/A	Present
Point	83	9.6142	6.5442	Maikunkele	Firewood hearth	N/A	Present
Point	84	9.6142	6.5443	Maikunkele	Coal hearth	N/A	Present
Point	85	9.6142	6.5443	Maikunkele	Generator	2.0 kW	Present
Point	86	9.6142	6.5451	Maikunkele	Generator	2.0 kW	Present
Point	87	9.6143	6.545	Maikunkele	Coal hearth	N/A	Present
Point	88	9.6145	6.5451	Maikunkele	Firewood hearth	N/A	Present
Point	89	9.6144	6.5452	Maikunkele	Coal hearth	N/A	Present
Point	90	9.6144	6.5453	Maikunkele	Generator	7.5 kW	Present
Point	91	9.6145	6.5454	Maikunkele	Generator	2.0 kW	Present
Point	92	9.6145	6.5455	Maikunkele	Firewood hearth	N/A	Present
Point	93	9.6145	6.5457	Maikunkele	Generator	11.5 kW	Present
Point	94	9.6145	6.5458	Maikunkele	Generator	2.0 kW	Present

Point	95	9.6146	6.5460	Maikunkele	Coal hearth	N/A	Present
Point	96	9.6146	6.5460	Maikunkele	Firewood hearth	N/A	Present
Point	97	9.6146	6.5461	Maikunkele	Generator	2.0 kW	Present
Point	98	9.6147	6.5462	Maikunkele	Generator	2.0 kW	Present
Point	99	9.6147	6.5464	Maikunkele	Generator	2.0 kW	Present
Point	100	9.6147	6.5466	Maikunkele	Coal hearth	N/A	Present

^Generator = Generic term for petrol- or diesel-powered electric generator; **N/A = Not applicable

4.1 Naming of Locations on Digitised Maps: From the theme and edit icons of the ArcView GIS 3.3 menu, the text mode was enabled in order that locations on the map could be named.

4.2 Creation of a Database and the CO2 Emission Layer Map on the ArcView3.3 Platform: The conventional database contains rows and columns, geographic coordinates of the locations of CO2 emissions, sources of emissions, rating of sources of emissions, and emission status. An illustration of a portion of the dataset of study corresponding to the Minna central district on the ArcView3.3 is shown in Fig.3.



Shape	Id	Cordinates	Location	Source	Rating	Manufactur	Remarks
Point	1	D9-36-51 84"/ 00633288"	RaiWay Quaters	Firewood Hearth	816.0	-	Present
Point	2	K'36'50'50 767006334 32"	Redway Quaters	Firewood Hearth	817.0	-	Present
Point	3	i)9'36 50-40"/00633396-	Adumbu Complex	Petrol Generator	50Hz 220v 830.0	Tiger	Present
Point	4	KT36'50'40" 7 006 333 96"	Adumbu Complex	Petrol Generator	50Hz 220v 828.0	Tiger	Pie sent
Point	5	M'36'50'40"/006'33'396"	Adumbu Complex	Charcoal Hearth	626.0	Yamaha	Present
Point	6	D9'36'50'40" / 006'33'3 96"	Adumbu Complex	Milling Machine	50Hz 220v 3.7KVA, 5H.P	Viking	Present
Point	7	m650'42"/oo633395"	Old Gwadabe Market	Welding Workshop	816.0		Present
Point	8	39'36'50'40" / 006'33'3 96	Adumbu Complex	Milling Machine	816.0	Viking	Present
Point	9	09K50 40" / 006'33'3 96"	Adumbu Complex	Milling Machine	220v, 50Hz 7.5KVA	Viking	Present
Point	10	KI'36'50'42" / 006'33'3 95"	Old Gwadabe Market	Cobblers Filing Machine	220V,50HZ, 20W	Yamaha	[illegible]
Point	11	raKso^r/occ^gs"	Old Gwadabe Market	Bus Park	460.0	Yamaha	[illegible]
Point	12	39'36'51 24"/00633212"	Rar way Quaters	Firewood Hearth	815.0	Yamaha	Present
Point	13	D9-3651 74" / 00633212"	Rai way Quaters	Petrol Generator	826.0	Honda	Present
Point	14	B9»'5118/006'332 55"	Rai way Quaters	PettolG enerator	542.0	Yamaha	Present
Point	15	B9-38-51 14" / 006332 82"	Radway Quaters	Chaicoal Hearth	628.0	Yamaha	[illegible]
Point	16	K'36'51 81" / 006332 79"	Rai way Quaters	Milling Machine	50Hz	Atlas	Present
Point	17	B-3651 34" / 00633212"	Rai way Quaters	Firewood Hearth	818.0	Yamaha	Present
Point	18	09'38'51 11"/006332 86"	RatKvay Quaters	Firewood Hearth	817.0	Yamaha	Present
Point	19	D9-3851 24"/00633216"	Railway Quaters	Calabash Carver	826.0	Yamaha	Present
Point	20	M'36'51 32"/006332 45'	Radway Quaters	Milling Machne	826.0	Yamaha	[illegible]
Point	21	B9'36'51 19"/006332 32"	Rai way Quaters	Milling Machine Electrical	50Hz	Yamaha	Present
Point	22	393651 16 /00633212"	Rarkway Quaters	Petrol operated milling machine	545.0	Honda	Present
Point	23	KT3651 84" / 00633288"	Rai way Quaters	Firewood Hearth	816.0	Hnnda	[illegible]
Point	24	M'36'36 84"/006332 36"	Rarkvay Quaters	Firewood Hearth	826.0	Yamaha	Piesent
Point	25	B9-3S51 20" / 006332 64"	Rai way Quaters	Firewood Hearth	826.0	Yamaha	Present
Point	26	39'38'51 76" / 006332 92"	Rai way Quaters	Capentery Workshop	220v, 50Hz 7.5KVA	Honda	Present
Point	27	B93851 32/00633291"	Radway Quaters	Cassava Flour	220v, 50Hz 7.5KVA	Honda	Present
Point	28	M'36'51 14"/ 006332 78"	Railway Quaters	Firewood Hearth	816.0	Honda	Present
Point	29	K'36'51 81"/ 00633215"	Radway Quaters	Firewood Health	220v, 50Hz 7.5KVA	Honda	Present
Point	30	K'36'51 19"/ 006332 32"	Rai way Quaters	Firewood Hearth	50Hz 220v 828.0	Honda	Present
Point	31	[J93651 91" / 006332 87"	Rai way Quaters	Milling Machine	50Hz 220v 828.0	Honda	Present
Point	32	K'36'51 41'/006332 76"	Rai way Quaters	Firewood Hearth	50Hz 220v 828.0	Yamaha	Pleser<
Point	33	K'36'51 84" / 00633288"	Radway Quaters	Firewood Hearth	220V,50HZ, 20W	Honda	Pleserk
Point	34	K'36'51 13'/006332 21"	Rai way Quaters	Firewood Hearth	816.0	Yamaha	Present
Point	34	B9-3651 16" / 006332 93"	Rai way Quaters	Milling Machine	220V,50HZ, 20W	Yamaha	Present
Point	35	K'36'51 84" / 006332 88"	Raihvay Quaters	Milling Machine	816.0	Yamaha	Present
Point	36	09-3651 84"/006332 88"	Railway Quaters	Firewood Hearth	220V,50HZ, 20W	Honda	Present

Fig.3. A portion of the dataset of study corresponding to the Minna central district on the ArcView GIS 3.3

The database was inputted and hot-linked to the geospatial data. Thus where CO_2 is present above the threshold of 350ppm, a dot is indicated on the map. The process of hot-linking the database and the digitised map on ArcView3.3 is shown in Fig.4. The CO_2 emission status map on ArcView3.3 is shown in Fig. 5.

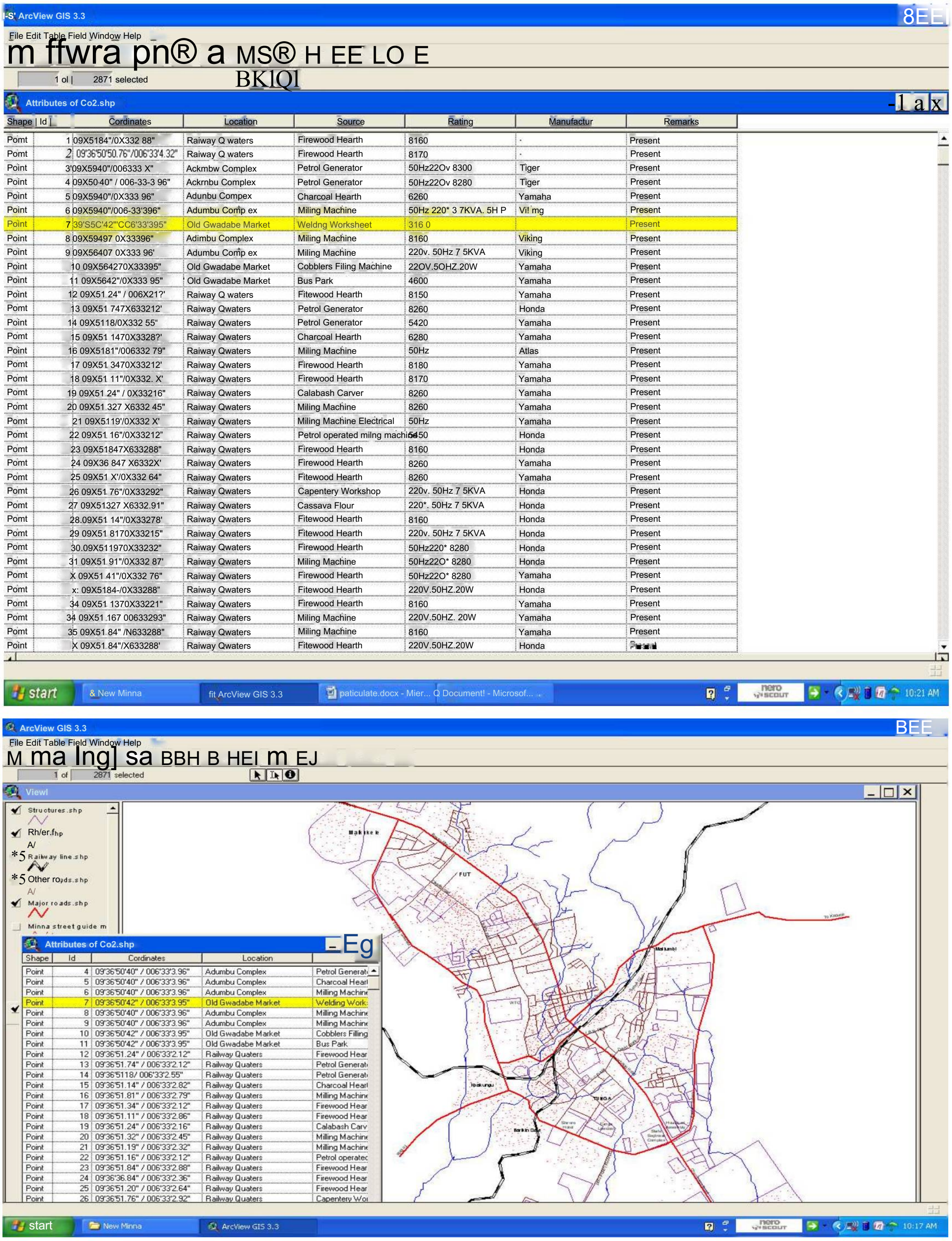


Fig.4. Hot-linking database and digitised map

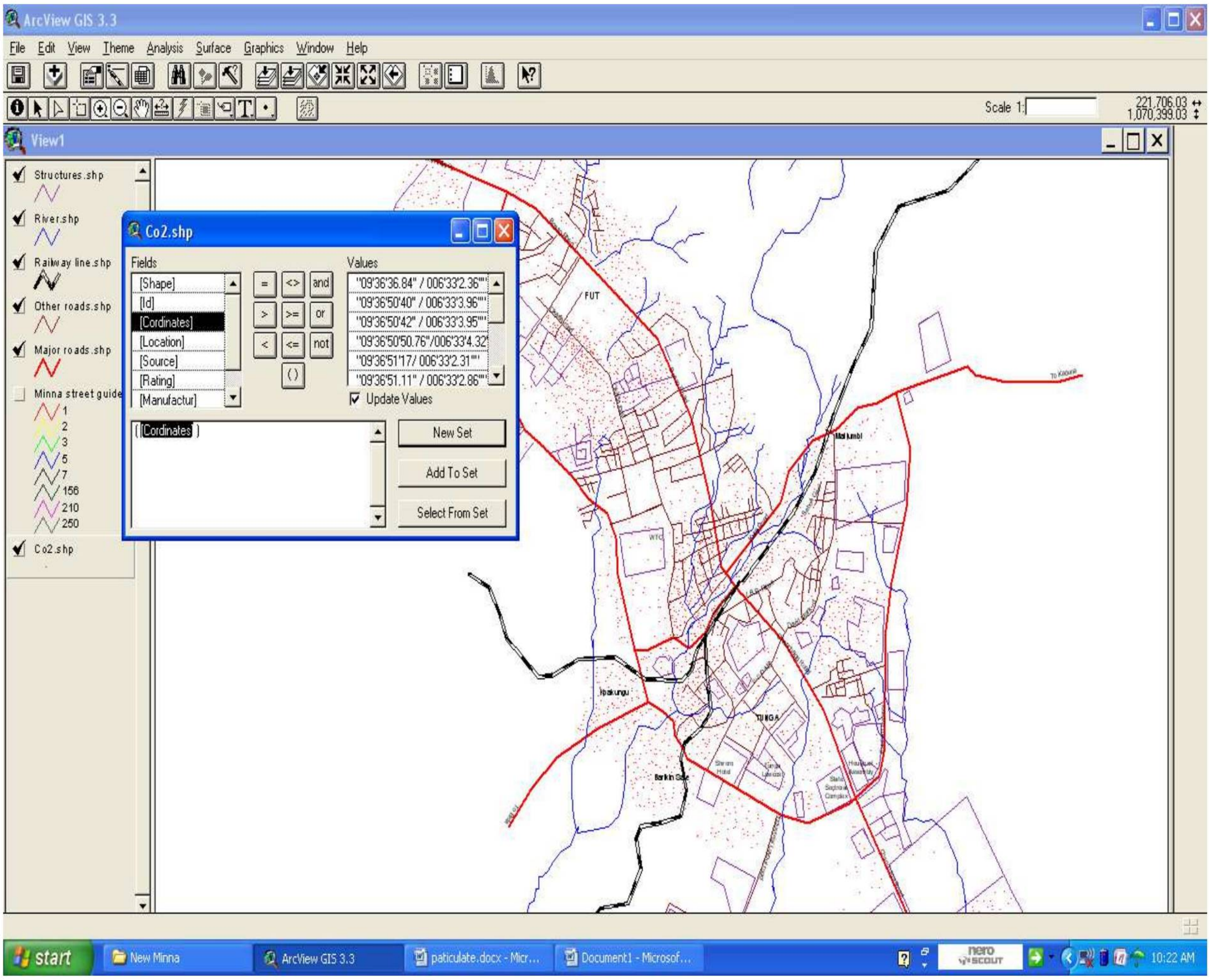


Fig.5. CO2 emission status map on ArcView3.3

5.0 Conclusion

The map of Fig.5 is the GIS CO2 emission layer map of Minna, PC-compatible, interactive, and can be readily interfaced with the Minna Geographic Information System (MGIS) at a point in the near future. The map of Fig.5 is a veritable planning tool and virtual audit mechanism in the hands of the local authorities charged with urban decongestion and public health education. This study is the kernel of a planned series of studies on air pollution and CO2 emission issues to be carried out across Nigeria.

References

Ndoke, P., N., Uduak, G.A., and Kato, M.E. 2009. Contributions of vehicular traffic to carbon dioxide emissions in Kaduna and Abuja, Northern Nigeria. *Leonardo Electronic Journal of Practices and Technologies,* **9,** 81-90.

Robinson, A. 2007. Environmental effects of increased atmospheric carbon dioxide, *Jounal of American Physicians and Surgeons,* **3,** 171-178.

www.cdiac.esd.ornl.gov

www.independent.co.uk

www.newsweekwebexclusive.com

www.suitel 01 .com

www.westcoastclimateequity.org