SPATIOTEMPORAL DYNAMICS OF LANDUSE/ LANDCOVER OF OWERRI AND ENVIRONS, SOUTHEASTERN NIGERIA; IMPLICATIONS FOR SOLID WASTE MANAGEMENT

BY

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CERTIFICATION

This is to certify that this study entitled, "Spatiotemporal Dynamics of Landuse/ Landcover of Owerri And Environs, South-Eastern Nigeria; Implications For Solid Waste Management" was done by Meribe, Promise Noel with the registration number 20174082468 in partial fulfilment of the requirements for the award of the degree of Master of Science (M.Sc.) in Environmental Geology, Department of Geosciences in the School of Science, Federal University of Technology Owerri.

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DEDICATION

This work is dedicated to the loving memory of my late sister, Dr. Mrs. Ezinne Obute, my beloved parents Mr. and Mrs. D.D. Meribe, and My Mummy (Lady J.C Agwatu).

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First and foremost, I am grateful to God Almighty for keeping me alive today. The burden of this project was lightened by the kind gesture, assistance, guidance, and useful suggestions by experienced and Prof. A.I. Opara and Dr. A.A. Onunkwo (My Project Supervisors). I am also grateful to my parents Mr. and Mrs. D.D Meribe, My Daddy in the Lord (Prof. C.C.Z.Akaolisa), My Mummy Dr. Mrs. C.A. Meribe, Lady J.C Agwatu, Paddymon, Uncle Franklyn Obute, Late Dr. Mrs. Ezinne Obute, Sis. Udy Onwuama, Sigidy, Femi, Kelechi, Nne, Chizzy male, Sochi, Chizzy female, Oga-Emma, Nkasi, Chika Brother, Young master, Chi-Chia, Tysolo, Big & Small madam, My VP, Ik Oty, Bit, 2Baba, Uchi, Seaman, Uju, Sir Prince, Evidence, Uju, Prof O.C Okeke, Prof .S .O. Onyekwuru, and, Mr. Essein who contributed greatly to accomplishing this work.

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ABSTRACT

Multi-criteria geospatial modelling using Geographic Information System and remote sensing data were carried out with the objective of identifying suitable waste disposal sites that are both economically feasible and environmentally sustainable in Owerri Metropolis and environs, Imo State, Nigeria. Several data sets including climatic data, soil, groundwater, drainage, landuse/land cover and slope data were extracted from satellite data were used to generate several thematic maps which will aid the siting of eco-friendly landfills in the study area. Two vintages of Landsat -8 data for years 2000 and 2020 were used to investigate the spatio-temporal dynamics of the landuse characteristics of the study area. Data collected were geo-coded and geo-referenced using the handheld GPS instrument. The GPS coordinates of individual waste containers/dump locations were also obtained. The acquired data sets were further processed using a set of software which include ESRI ArcGIS 10.8, ENVI 5.2, and Geomatica. Various investigations were carried out using the ArcGIS 10.8 software to evaluate the potentials of GIS in the robust management of solid waste in the study area. The study produced several thematic maps which include topographical map, watershed/drainage map, lineament/lineament density map, colour composite maps for, normalized difference vegetation index (NDVI), normalized difference built-up index (NDBI), normalized difference water index (NDWI), and Land use/Land cover Maps for 2000 and 2020 respectively. Weights and factor parameters were determined using the analytical hierarchy process pair-wise comparison model. In addition, map overlay analyses were used to create the land fill suitability map of the study area which was classified into low, medium and high suitability based on the multi-criteria data used. The GIS examination of the trademark elements of the site area yielded field (5) appropriate points. They identified landfill locations are believed to be robust to limit ecological and human risks of the dumpsites. Field inspection and ground truthing of the selected five points further confirmed the suitability of the selected locations. This strategy has therefore been shown to be effective for waste management and landfill site selection.

Keywords: Geographic Information System (GIS), Land use/Land cover (LULC), Waste management, Watershed/Drainage Map, Remote Sensing, Topographic map, and Landfill.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Due to environmental concerns associated with environmental waste disposal and other anthropogenic elements, the need to build up information on land use and land cover changes within Owerri and environs, southeastern Nigeria has become critical. Irrational land-use strategies, planning, and practices have exacerbated environmental challenges within the study area. Burley (1961) defined land cover as "the vegetation and man-made structures that cover the land. Because of the linkage between land surface cycles and environmental waste, global concerns over shore use and land cover planning have grown. Along these lines, land use practices and environmental waste recycling are major drivers of the global water and energy cycle (Mahnood et al., 2010).

Similarly, deforestation has a negative impact on water and energy transitions, as well as other elements of the near-surface ecosystem (Pielke et al, 2002). Many land cover/land use studies have been carried out since the advent of the first remote sensing satellite (Landsat 1) in 1972. These studies were conducted in a variety of locations, including metropolitan areas, horticultural areas, and mining areas. Singh et al. (1997), for example, used Remote Sensing data and GIS to conduct a detailed research on the influence of coal mining and the thermal power industry on land use patterns in and around the Singrauli coalfields. Using PAMAP GIS programming, a land use data set was created using multispectral and multi-fleeting data from Landsat - MSS and Landsat-TM for the years 1975, 1986, and 1991.There are essentially two approaches to using remote sensing for biological system monitoring and other biodiversity assessments. These are immediate perceptions of organic entities and networks, as well as atypical perceptions of natural biodiversity intermediaries (Turner et al., 2003). As a result, Geographic Data Framework (GIS) prepared satellite symbolisms have progressed over time as a massive backhanded distant detecting instrument for demonstrating spatial and transient qualities of biodiversity structures/types using ecological boundaries. Natural environments or biological systems such as forests, fields, and seabed grasses can be effectively planned using this strategy. As a result, the concept of land cover/land use planning around the world is shaped accordingly. A wide range of environmental factors have been evaluated for various topical purposes around the world using Geographic Data Framework/satellite distant detecting innovation (Herr et al.,1993; Aspinall et al.,1993; Mc Satiate 1995; Hepinstall et al., 1997; Lillesand et al.,2004).

In the northwestern part of China, Hu et al (2004) used NDVI and Adorned Cap Change to find a negative and positive difference in land corruption over time. They discovered that between 1987 and 1996, the amount of vegetation cover and soil moisture increased in this area. Within the Nyando Basin, however, Olang et al. (2011) investigated Spatio-temporal shifts in land cover changes and their environmental effects. Six Landsat pictures from 1973, 1986, and 2000 were used by the researchers. According to the data, forest cover in the watershed has decreased by nearly 20%, while agricultural fields have increased by approximately 16 percent. This has something to do with dangerous land use activities (Olang et al., 2011). Eludoyin et al. (2011) conducted a GIS Assessment of Land Use and Land Cover Changes in Obio Akpor Local Government Area, Rivers State, Nigeria, in the same vein. Farmland, mangrove, primary forest, and sparse vegetation decreased by 45.34, 37.06, 43.06, and 8.09 percent over time, respectively, while secondary forest, built-up area, and water rose by 5.88, 74.55, and 3.43 percent, according to the study. One of the recommendations was that regulations and legislation be enacted to prevent the illegal extension of construction in any form, and that residents in the study region be educated and informed about the impacts of deforestation on the environment.

Similarly, the use of GIS-assisted satellite imagery for territorial planning of land cover/land use dynamics has long been recognized as an important tool for local biological systems planning, with discrete habitats or ecosystems such as woodland, grassland, or seabed grasses being successfully mapped. As a result, land cover/land use mapping is based on this information all over the world. A wide variety of habitat factors have been analyzed for various thematic goals around the world using Geographic Information System/satellite remote sensing technologies (Herr et al.,1993; Aspinall et al.,1993; Mc Cloy 1995; Hepinstall et al., 1997; Lillesand et al.,2004). Similarly, the use of GIS-processed satellite imagery for regional mapping of land cover/land use characterization has long been demonstrated as an important tool for mapping regional ecosystems. This is due to its simplicity of use, speed, accuracy, low cost, and wide range of coverage. With improved spectral and spatial resolution, satellite imagery has become more accessible, allowing for more detailed land use mapping. It was predicted that high-resolution satellite imagery would soon supplant more than half of the aerial photography market. Simultaneously, rapid advancements in computer science and other data innovation (IT) fields have provided even more critical assets for satellite image handling and analysis. Imagine how efficient and cost-effective it is to prepare delicate and hard products. The ability to store and process larger and more detailed images and attribute data sets using GIS technology has been aided by access to faster and more capable computer platforms. With improved spectral and spatial resolution, satellite imagery has become more accessible, allowing for more detailed land use mapping. It was predicted that high-resolution satellite imagery would soon supplant more than half of the aerial photography market. Simultaneously, rapid advancements in computer science and other data innovation (IT) fields have provided even more critical assets for satellite image handling and analysis. Imagine how efficient and cost-effective it is to prepare delicate and hard products. The ability to store and process larger and more detailed images and attribute data sets using GIS technology has been aided by access to faster and more capable computer platforms.

Given the growing global concern about land use and land cover mapping as a result of the link between land surface processes and land practices as significant drivers for environmental sustainability and the delicate environmental equilibrium, several studies have been carried out to investigate land use changes worldwide. Several studies on the application of geospatial data in the siting of landfills/ dumpsites have been carried out worldwide (Petrescu.,2013; De Feo & De Gisi., 2014; Dutta & Goel 2017; Krishna et al.,2017; Singh, A.,2019; Iacoboaea & Karabulut et al.,2021; Debalke & Admas ., 2022). In the study area and environs, studies using GIS-interpreted remote sensing data have also been carried out for siting dumpsites and landfills (Echebima et al.,2019; Onwe et al., 2020). Several of the studies on the application of geospatial data in waste management used remote sensing and GIS data with multi-spatial and multi-temporal characteristics to perform statistical analysis with weighted overlay technique by considering various criteria for locating the solid waste disposal sites (Petrescu.,2013; De Feo & De Gisi., 2014; Dutta & Goel 2017; Krishna et al.,2017; Singh, A.,2019; Iacoboaea & Karabulut et al.,2021; Debalke & Admas ., 2022).

Because of the rapid changes of the landscape of the study area resulting from anthropogenic factors, there is a great need to critically assess the land use and land cover changes both in time and space within Owerri, Southeastern Nigeria and its implication for waste disposal and management. This study was therefore carried out using an integration of GIS technology and remote sensing to provide a basis for effective land use planning for solid waste disposal. The objective of this study therefore is to assess the Spatio-temporal dynamics of land use and landcover in Owerri and its environs in southeastern Nigeria, as well as the consequences for solid waste management. This research intends to set the pace for mapping and characterization of various land use and land cover factors within the area as a basis for long-term regional land use planning efforts. This will help various administrations at all levels to identify high-priority development and conservation zones, areas of solid waste disposal, and specific areas necessary for land-use optimization.

1.2 Statement Of The Problem

Cases of environmental contamination (of the soil, water and air) from the open waste dumpsite generally used in Owerri and environs have been reported by several authors. There is therefore an urgent need to carry out a study of the land cover/ land use changes within Owerri and environs over the past 20 years to critically evaluate the implications of the adopted land use policies and options over the years on waste disposal and management. Results of the spatio-temporal analysis of the geospatial data will be used to aid the siting of sustainable and robust engineered landfills in the study area to reduce environmental pollution.

1.3 Aim And Objectives Of Study

This research work aims to evaluate the spatio-temporal dynamics of land use and landcover of Owerri and environs, southeastern Nigeria and to assess the implications of the changes on waste disposal and management.

The objectives of the study include the following:

i. To identify physical factors that could influence land use of the study area.
ii. To create a various thematic maps necessary for a robust land use/ land cover classification scheme.
iii. To generate statistical data on land consumption by human activities and reduction of vegetation, bare land, wet/marshland, and water body
iv. To estimate land use/land cover changes in Owerri and environs within the period from 2000 and 2020.
v. To propose a robust and sustainable land use strategy for the Owerri and environs.
vi. To propose sites for suitable engineered landfills within Owerri and environs

1.4. Justification Of The Study

Land cover and land use change detection are best studied using different vintages of multi-spectral amd multi-criteria geospatial data. Also, the application of GIS and satellite data in siting of robust engineered landfill is well known and accepted worldwide. The use GIS and landsat data of Owerri and environs covering a period of twenty (20) years between 2000 -2020 is therefore very strategic and key for sustainable waste disposal and management in the study area. This study will further enrich the environmental planning and policy trust of institutions in the study area.

1.5. Scope Of Study

The present work was carried out in Owerri and environs and typically covers the areas presently under Owerri Municipal, Owerri North Local Government Area and Owerri West Local Government Area. The work is limited to the interpretation of a set of multi-criteria (meteorological, geological. Hydrological, etc) data using GIS assisted remote sensing technique for land cover/ land use change detection in the study area. Ground truthing of the geospatial data was also carried out to confirm the results of the geospatial studies.

1.6. Limitations Of The Study

The major limitation of this study was the issue of paucity of data and information on the land use from appropriate governmental agencies and institutions like Owerri Capital Development Authority. This key information will have aided comparative a robust comparative analysis of the geospatial data with data from environmental planning agency.

1.7. The Study Area

1.7.1. Location of the study area

The investigation zone is Owerri inside Owerri City, Imo State. Owerri via landmass covers over 55% of Owerri city territory. It is situated on the southwest piece of Imo State in the dug deltaic arrangement of the Niger Delta bowl, southeastern Nigeria. The territory is limited by longitudes 6^{o}54”30'E and 7^{o}11'0"E and scopes 5^{o}31'0"N and 5^{o}20'0"N. In addition, the area comprises three local Government Owerri North, Owerri West, and Owerri Municipal at the intersection of roads from Aba, Onitsha, Port Harcourt, and Mbaise Umuahia Road. Although there is as yet little industrial development, some factories produce galvanized sheet iron. The town is home to the Federal University of Technology Owerri, Imo State University, Alvan Ikoku Federal College of

Education, and several secondary schools. It is also served by a general hospital, a federal medical centre (FMC) and so many private hospitals. The town is located in one of the most densely populated areas of Nigeria and is inhabited by the predominantly Igbo people with an estimated population of 540,000 according to the 2006 estimates.

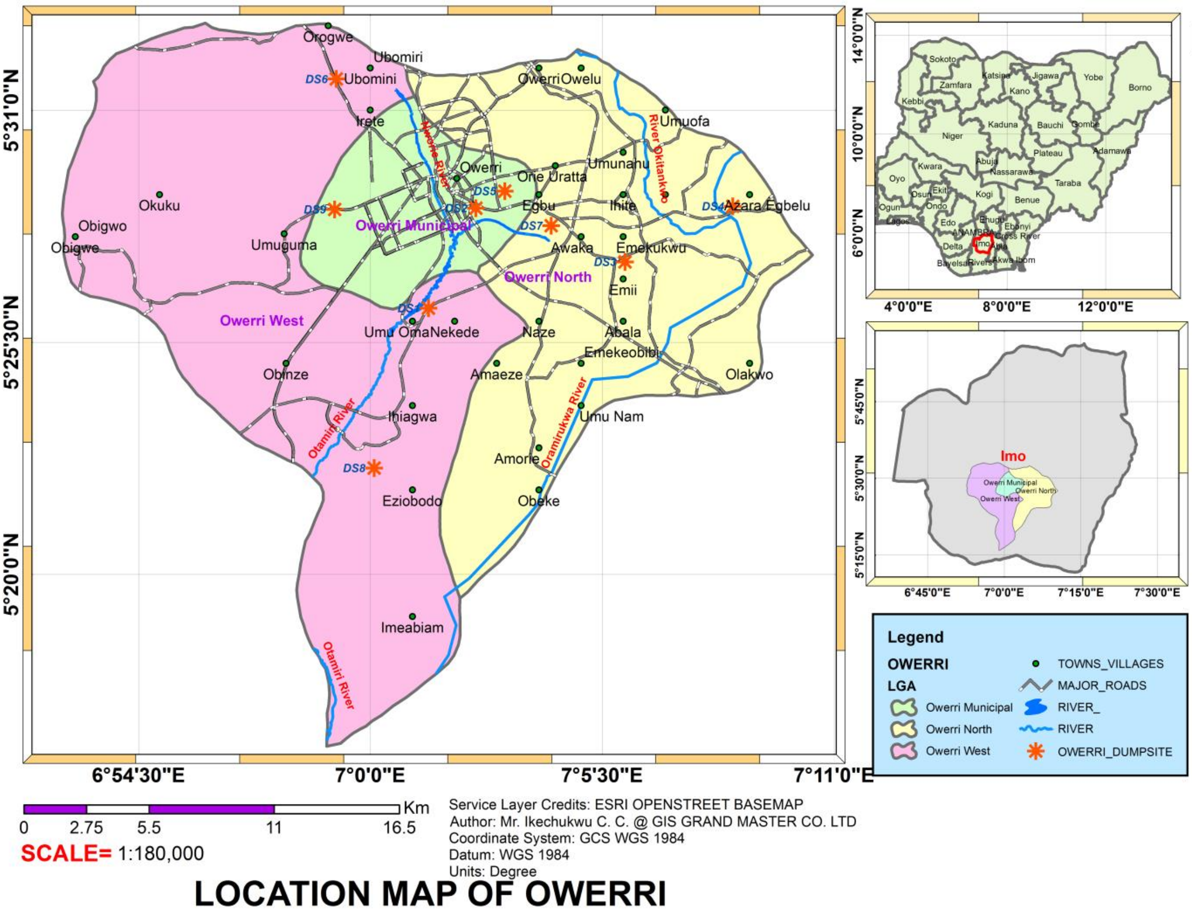

Figure 1: Location Map of the Study Area

CHAPTER TWO

LITERATURE REVIEW

2.1 Brief review of previous related studies

Since the arrival of the first remote sensing satellite (Landsat 1) in 1972, many land cover/land use studies have been embraced. These investigations were directed in different regions including metropolitan regions, horticultural regions, and mining regions. For instance, Singh et al (1997) carried out a detailed study on the impact of coal mining and thermal power industry on land use patterns in and around Singrauli coalfields using Remote Sensing data and GIS. Data set for land use was ready from multispectral and multi-fleeting information of years 1975, 1986, 1991 of Landsat - MSS, and Landsat-TM utilizing PAMAP GIS programming. The investigation uncovered that mining and constructed - upland regions expanded from 1975 to 1991. There was likewise considerable misfortune in rural and timberland land which was because of the fast industrialization of the space.

There are various instances of conventional and expert-based image classification systems for detection, monitoring, and mapping of land-use change and land degradation using remote sensing data. Tasseled Cap Transformation (TCT) and Normalized Difference Vegetation Index (NDVI) are very useful techniques to identify and delineate land degradation from vegetation coverage. Hu et al (2004) utilized NDVI and Adorned Cap Change for a negative and positive difference in land corruption over the long haul in the north-western piece of China. They tracked down that the space of vegetation cover and soil wetness expanded in this part from 1987 to 1996.

However, Olang *et al*. (2011) studied Spatio-temporal changes in land cover changes and their environmental implications within Nyando Basin. The researchers used six Landsat images of 1973, 1986, and 2000. From the findings, it was revealed that forests in the basin had declined significantly, by approximately 20 percent while agricultural fields expanded by approximately 16%. This was related to hazardous land use activities (Olang *et al*., 2012).

Furthermore, Breunig et al (2008) have utilized reflectance and emissivity data from ASTER satellite symbolism to recognize uncovered soils just as produce dirt surface picture in a rural space of focal Brazil. They utilized band mix composite guides by consolidating groups 5and 6 and groups 10 and14 to segregate dim red earth soils and splendid sandy soils, separately. The proportion of the groups were related to the research facility's estimated absolute sand division. Structure this investigation, the most noteworthy sandy surface at the lower rise and mud surface at higher height were noticed. The most elevated sandy surfaces were incidental with land debasement measures nearby.

On the same vain, Eludoyin *et al*. (2011) did a GIS Assessment of Land Use and Land Cover Changes in Obio Akpor Local Government Area, Rivers State, Nigeria. The study reveals that farmland, mangrove, primary forest, and sparse vegetation reduced over time by 45.34, 37.06, 43.06, and 8.09%, respectively while secondary forest, built-up area, and water increased by 5.88, 74.55, and 3.43%, respectively. One of the recommendations was the need to promulgate laws and legislations to prevent the unlawful expansion of construction of any form and that the people in the communities in the study area should be enlightened and educated on the effects of deforestation on the environment.

Land degradation study of the Nakuru area, Kenya was carried out utilizing multi-sensor satellite picture combination and post order system given by Torrion (2002). He utilized Landsat - TM, ASTER, emergency rooms 2, SAR, and DEM for the investigation. Extreme soil debased regions were found in the southwestern piece of the Nakuru area, Kenya. Vegetation cover, precipitation, surface run-off, and soil disintegration were found to have vital commitments in the forecast of land debasement. Symeonakis and Drake (2004) have likewise utilized these variables over Sub-Saharan Africa. They assessed vegetation cover from computerized satellite symbolism utilizing standardized contrast vegetation record (NDVI), surface run-off from Meteosat information, and soil disintegration information from soil protection administration. Therefore, these variables were joined for featuring serious defenselessness of land debasement. Essentially, to look at land corruption study utilizing various sensors, the spatial and ghostly goals of Landsat ETM+ and ASTER that were similarly dissected by Gao and Liu (2007) in Tongyu Area, Western Jilin Region of Upper east China. In this investigation corrupted soils were found to cover about 462.95 km2 of the space in the ASTER picture while 400.06 km2 were shrouded in the ETM+ picture. The general precision of the examination was 72.2% and 79.2% for the ASTER and ETM+ information separately.

In a comparable manner, Rahman and Rahman (2011) advise alternatives for higher solid waste control for Mohammadpur Thama via way of means of acquiring facts the usage of Global

Positioning System (GPS) to find the prevailing waste packing containers and unlawful disposal sites. They hired GPS facts and excessive decision photographs to generate spatial facts and used ArcGIS nine.2 to endorse green waste control alternatives. In the identical vein, Markovic, Janosevic, Jovanovic and Nikolic (2010) practice GIS, Analytic Hierarchy Process (AHP) and Clark Wright Savings set of rules in optimizing strong waste control within the Republic of Serbia.

However, this underscores Oyelola, Babatunde and Abiodun (2011) announcement that strong waste era spans all ranges of human activities. While recognizing the price of waste era, Idowu, Adagunodo, Esimai and Olopade (2012) view wastes to be an always developing problem at global and local levels and require the eye of stakeholders.

On this platform, Singh, Chauhan and Katiyar (2012) examine that growth in growth rate in all fields or spheres of man’s endeavour have brought about a steady rise in waste accumulation. According to them, high populace, speedy monetary boom and upward push in network general were mentioned as keys to excessive price of Municipal Solid Waste 24 era with in the global towns.

This similarly reinforces O’Neill (1998) view that the quantity of waste being generated hold to growth global without a concomitant upward push in disposal facility. In different words, because the populace of Lokoja has been developing, it follows that MSW era grows as nicely and poses critical mission of series and disposal via way of means of the control authority.

Chronologically, Yahaya, Ilori, Whanda and Edicha (2010) accept as true with that waste era changed into now no longer a trouble in the pre-industrial time as populace changed into smaller, thereby producing little wastes which had been especially natural wastes. These wastes had been constantly buried within the floor for composting and in turn enhance soil fertility even as aiming to preserve meals manufacturing for the populace then.

Additionally, Njoroge, Maina, and Nda'Nganga (2011) in their research entitled "Change in landscape cover types and pattern within Nairobi city and its environs' used Landsat satellite data for 3 decades spanning from the year 1976 to 2000. Image data were geo-referenced, classified, and analyzed along watershed zones delineated from a digital elevation model (DEM) of Nairobi city and peripheral region on a geographical information system (GIS) platform. Land cover categories of riverine vegetation and forest land showed the most marked decrease in real coverage by about 67 and 60%, respectively, while barren surfaces and urban areas increased by more than 100 and 98%, respectively, between 1976 and 2000.

However, Mundia and Aniya (2005) adopted three Landsat images and socio-economic data in a post-classification analysis to map the spatial dynamics of land use and cover changes as well as identifying the urbanization process in Nairobi city. The study revealed that urban expansion has been accompanied by loss of land cover and urban sprawl. Through the use of demographic and socio-economic data together with land use and cover change, Mundia and Aniya revealed that economic growth and proximity to transportation routes have been the major factors promoting urban expansion. Topography, geology, and soils were also analyzed as possible factors influencing expansion. The integration of remote sensing and Geographical Information systems (GIS) was found to be effective in monitoring land use and land cover changes and providing valuable information necessary for planning and research.

Interestingly, Graetz (1987) utilized a mix of otherworldly demonstrating and the normal files of soil and vegetation from Landsat and NOAA to complete customary observing, planning, and the board of land debasement in Australian rangeland. In this examination, the parched and semi-bone-dry grounds were found to have stretched out from the focal space of Australia toward the western and southern coasts. He recommended that future investigations of Australian rangeland should utilize high recurrence/low goal spatial information (NOAA AVHRR) with low recurrence/high goal spatial information (SPOT, MSS/TM/ETM) for ideal outcomes.

Explicitly, Geographical Information System (GIS) has been adjudged an awesome selection guide device for waste control making plans while implemented for outlining the feasible alternative for optimizing strong waste control via integration of diverse discipline parameters like avenue accessibility, land use cowl with populace, residential place and different applicable facts or different related facts that could assist in the choice of webweb sites to be able to lessen time wastage and decorate accuracy (Tamilenthi, Chandra, Vijaya and Rose, 2011). Remote sensing is one of the top notch equipment for stock and evaluation of surroundings and its sources, thanks to its precise ability of imparting the synoptic view of a massive region of the earth’s surfaces and its capability of repetitive insurance. Its multispectral functionality gives suitable comparison among diverse herbal functions wherein as its repetitive insurance gives facts at the dynamic adjustments taking vicinity over the earth floor and the herbal surroundings

(Navalgund et al; 1983 in Oyinloye, 2013). Further, the position of GIS in strong waste control could be very massive as many elements of its making plans and operations are extraordinarily depending on spatial facts. In trendy, GIS performs a key position in 27 retaining account facts to facilitate series operations.

In this way, elements inclusive of patron provider; reading most excellent places for switch stations; making plans routes for cars transporting waste from residential, business and commercial regions to switch stations and from switch stations to landfills; finding new landfills and tracking the landfill, are vital. GIS is a device that doesn't simplest reduces time and fee of web website online choice, however additionally gives a virtual facts financial institution for destiny tracking programme of the web website online (Tomlison,1990 in Oyinloye, 2013).

In another similarly study that was carried out by Alphan (2003) entitle "land-use and land-cover (LULC) changes in Adana city, Turkey". He employed the use of satellite data of 1984 and 2000. The study of the expansion of the city over adjacent agricultural fields and semi-natural areas was the major focus. Among the major findings was that Urban and built-up areas changed by a factor of 70% during the 16 years; about 30 percent on agricultural land and 70 percent on previously semi-natural land. Alphan (2003) argues that permanent immigration and urban development strategies were the main driving forces for the observed changes.

Additionally, Zurayk et al (2001) surveyed land corruption in Aarsal, Lebanon utilizing the topical guides of seepage thickness, waste surface, touching, slant, and land use. They utilized the spatial overlay method to make a factorial soil corruption hazard map in their investigation region. From the subsequent guide, they discovered that more than 90% of the spaces are in low and exceptionally low soil corruption classes. Also, elevated photographs were utilized to group land use/land cover while Landsat-TM was utilized for vegetation planning (NDVI). In this examination, the most significant level of land corruption was found inside the edited regions while the least was seen in the woods and lush spaces.

However, a more recent study is that of Ongoma, Muthama, and Gitau (2013) who investigated urbanization and its environmental implications and found that urbanization was evidenced by the reducing urban land surface reflectivity and the increasing population. They also found that wind magnitude exhibited a reduction with time which they believe is harmful to human and animal comfort and the environment at large. The study recommends proper planning of the cities to minimize further modification as a result of urbanization. The choice of residential and industrial places is also emphasized concerning these findings. The findings of this work are thus important for multi-sectoral use in the urban centers however, it did not comprehensively discuss the environmental implications of urbanization especially concerning land use and land cover changes.

In an associated way, Akure environs was examined, the usage of ArcView GIS 3.2 and Remote Sensing to broaden a person interface for choosing a waste disposal web website online even as developing buffer zones for different factors that decide an appropriate place of waste disposal facility. They take into consideration at unique, environmentally secure predetermined distances farfar from capacity landfill sites to be 500m, 250m, 2km and 500m for rivers, fractures, agreement and most important avenue community respectively. From the prevailing studies works reviewed above, it's far mentioned that maximum of the works had been primarily performed in different international locations.

Additionally, Mulatu (2006) utilized Ghastly Point Mapper (SAM) to group land use utilizing hyper otherworldly and Landsat information over the Netherlands. Ghostly Point Mapper (SAM) classifier decides a point between target range and reference range. The consequence of this investigation proposes that vegetation was precisely planned to utilize hyper – ghastly informational collections. Likewise, a mix of symbolism and auxiliary information like height viewpoint and incline were utilized to build the precision of nitty-gritty land cover planning in the investigation region. Likewise, Shafri et al (2007) utilized Ghostly Point Mapper (SAM) with the greatest probability, fake neural organization, and choice tree classifier for hyper - ghastly picture examination over a tropical woods region in Malaysia. Utilizing ground truth data and field examination, the most elevated generally exactness was 83.61% for the fake neural organization (ANN) while it was 50.63% and 48.83% for the choice tree and the unearthly point mapper order individually. Executive et al (2005) utilized Phantom Point Mapper (SAM) classifier to distinguish dynamic hill vegetation along the Belgian coast from hyper-unearthly symbolism. The general vegetation arrangement precision was 53% and 64% in Standard Phantom Point Mapper and Upgraded Otherworldly Point Mapper respectively in the timberland and lush spaces

Similarly, Hellden and Harsh (1980) completed an examination ashore debasement utilizing Landsat symbolism and social markers in Southern Tunisia. They executed two strategies in their examination which incorporate: (I) computerized picture order utilizing geological virtual products and (ii) ground truth testing of social and actual boundaries, e.g., incline, ravine disintegration, vegetation cover, populace thickness, ridges, collapse fixes, etc. At last, they consolidated all boundaries in a weighted overlay table and recognized debased regions. In this exploration, populace thickness and ravine disintegration were recognized as the key variables answerable for land debasement. They noticed an undeniable degree of land debasement in the settlement and horticultural regions

In the same way, Howard and Remson (1978) completed an examination on ecological land-use arranging at Half-moon Straight, California, 2km south of San Francisco. They thought of the outcome that a slant of under 25% is appropriate for private arranging while a slant of half or more delivers the region unacceptable. Likewise, for mechanical land-use choice, an incline of under half would be a great condition while that of half will be inadmissible. The further proposed that the region ought to be without unsatisfactory soil and the surface geography should comprise of materials equipped for conveying weighty burden and there ought to be no joint or flaw area.

Explicitly, Ololade et al (2008) completed an investigation ashore use/cover planning and change recognition in the Rustenburg Mining District utilizing Landsat pictures. The information utilized comprises Landsat MSS, 1973 (4 groups), Landsat-TM 1989, 1997 and 1998 (6 groups), Landsat-ETM 2002 (6 groups), and geological guides of 1969 and 2005 which were utilized as reference base guides of the area. Standard picture upgrades and enlistment was performed on the satellite pictures with managed characterization performed by utilizing the greatest probability technique. Land use classes produced incorporate forest, meadow, developed land, exposed soil, waterways, dams, water lakes, developed regions, following dams, and open cast mines which were distinguished from satellite information and field studies. Results showed that over the most recent thirty years open cast mines, following dams, mine dumps, and return water lakes have expanded broadly in the Rustenburg district. Essentially, vegetation has gone through an overall decline while forest and lush spaces have been changed to developed land. Edward et al (2009) in their investigation of open-pit gold mining and land-use changes in the Bogosu-Prestea region, southwest Ghana saw that land-use changes because of mining utilized over a long term period (1986 – 2006) was the significant reason for land use/land cover changes in the examination region. The examination uncovered that mining in the space expanded by 12.1 %

inland inclusion from 1986 to 2006 with a decline in farming area use from 97.8% in 1986 to 82.7% in 2006. Settlements likewise expanded from 0.45 % in 1986 to 4.95 % in 2006 due to a rustic–metropolitan relocation.

Furthermore, Samant and Subramanyam (1998) used Landsat TM symbolisms to contemplate the land-use change in Bombay (Mumbai), India which is the most noteworthy populated city of India. They found an amazing expansion in developed land by 300% and a decrease in woodlands by 55%, because of the expanding pressing factor of metropolitan extension to adapt up to the populace rise. This investigation was completed utilizing land use maps for 1925 and 1967 and was contrasted with Landsat symbolism of 1994 with measure land-use changes traversing from 1925 to 1994.

Simialrly, Zubair (2006) used distant detecting and GIS advancements to recognize land use and land cover changes in Ilorin, Nigeria from 1972 to 2001 utilizing Landsat TM pictures of 1972, 1986, and 2001. The Greatest Probability Calculation of administered order strategy was utilized to portray five land use and land cover classes for the investigation region in particular: farmland, no man's land, woodland, developed, and water-bodies. The outcomes deciphered uncovered that from 1972 through to 1986, farmland declined by 7% while the developed grounds expanded by 8%. The decrease in farmland was perceived as the progress from cultivating to metropolitan exercises because of the formation of Kwara State and with Ilorin being the capital city. The increase in the developed land was credited to the fast urbanization and improvement projects because of state creation.

However, an outline of land debasement utilizing multi-sensor picture combination and post order methodology was embraced by Torrion (2002). He utilized Landsat TM, ASTER, emergency rooms 2, SAR, and DEM for the investigation. Extreme soil debased regions were found in the southwestern piece of the Nakuru region, Kenya. Vegetation cover, precipitation, surface run-off, and soil disintegration were uncovered to play played vital parts in the expectation of land debasement. Additionally, Symeonakis and Drake (2004) utilized these equivalent components over Sub-Saharan Africa. They assessed vegetation cover from advanced satellite symbolism 6 utilizing NDVI, surface run-off from Meteosat, and soil disintegration information from soil preservation administration. Therefore, these components were joined to feature the serious vulnerability of the study region to land corruption. They proposed this procedure for close to continuous observing of land corruption too.

In addition, Hellden and Harsh (1980) chipped away at land debasement utilizing Landsat symbolism and social markers in Southern Tunisia. They carried out two techniques during their investigation: (I) computerized picture grouping (ii) ground truth inspecting of social and actual boundaries, e.g., incline, chasm disintegration, vegetation cover, populace thickness, ridges, flattening patches, etc. At long last, they joined all boundaries in a weighted overlay table and distinguished corrupted regions. Additionally, Baban and Yusof (2001), used Landsat TM groups TM3, TM4, and TM5 fused with auxiliary geological information as a contribution to the greatest probability classifier to create a land cover guide of the sloping region in Langkawi Island. The general exactness of the yield picture was 90% and individual class correctnesses went from 74% to 100%. Their outcomes feature the significance of consolidating geological information and showed that geography is the fundamental control on the spatial appropriation of land use/land cover types in the investigation region

Moreover, Prakasam (2010) examined the land use and land cover changes in the Kodaikanal locale of the Western Ghats in the Tamilnadu Territory of India. The goal was to notice changes during a period of a long time from 1969 to 2008 utilizing managed grouping of Landsat information. He saw that 70% of the area was shrouded with backwoods in 1969 however has diminished to about 33% in 2008, The developed terrains have additionally expanded from 3% to 21% appearance that the district is influenced by fast urbanization which lead to unfriendly ecological impacts for the distinguished bio-variety rich locale of Kodaikanal in the same way Joined utilizations of point estimations of actual properties, soil phantom reflectance with Landsat TM and ETM+ information was utilized to distinguish actual corruption of soil by Omuto et al (2007) in the upper Athi stream bowl in eastern Kenya. Furthermore, NDVI and land surface temperature (LST) were utilized to perceive long-haul vegetation just as warm conditions in the examination region. They saw that their outcomes have an 80% order exactness as for ground information.

In a likely manner, Muzein (2006), in their examination inside the scenes of the Focal Ethiopian Fracture study, uncovered that the utilization of minimal expense far off detecting and GIS strategies gave abundant data that empowers analysts to infer that low efficiency and family food weakness are the fundamental main thrusts behind land cover changes that are contrarily influencing the normal and semi-regular biological systems in the focal and southern Crack

Valley of Ethiopia. He suggested that the reclamation of regular biological systems or protection of biodiversity can be accomplished just if those main thrusts are handled economically.

2.1.2 Geology Of The Study Area

Geographically, the examination territory is underlain by a grouping of sedimentary rocks. The lithological and geologic setting of the investigation region controls the event and stream of the groundwater. Besides, the zone is underlain by the beachfront plain sands of the Benin Formation (Simpson, 1955), extending from Miocene to recent in age (Reyment, 1965). The Benin Formation is comprised of thick friable sands with minor intercalations of dirt beds and focal points. The sand units are medium to coarse-grained, pebbly, inadequately arranged, and locally contain focal points of fine-grained sandstone and sandy mud (Short and Stauble, 1967; Onyeagocha, 1980).

The grains of the Formation is sub-precise to balance. The shade of the sands and the sandstones are white or yellowish darker because of Alumonite coatings. Lignite happens in the streaks or finely scattered sections; haematite grains and feldspars are normal. The mud is grayish dark-colored, sandy or sleek, and contains some plant remains and scattered lignite. The sands and the sandstones units of the Formation are stores of upper mainland deltaic plain condition (Short and Stauble, 1967)

Petrographic investigation of the stones shows that the quartz makes up around 95 to 98% of the considerable number of grains (Onyeagocha, 1980). Benin Formation has a variable thickness and it has been demonstrated that the normal thickness of the Formation at the zone is about 800m (Avbovbo, 1978). Be that as it may, in certain spots encased by the investigation territory, the Formation is overlain by an extensive thickness of red earth made out of iron recolored regolith framed by enduring and consequent ferruginization of the endured materials. The Benin Formation is comparably underlain by the Ogwashi - Asaba arrangement. The Ogwashi - AsabaFormation comprises a lignite arrangement and is dominatingly made up of sands with minor shale units. Its normal thickness is 200m. The age is somewhat Oligocene (Kogbe, 1974).

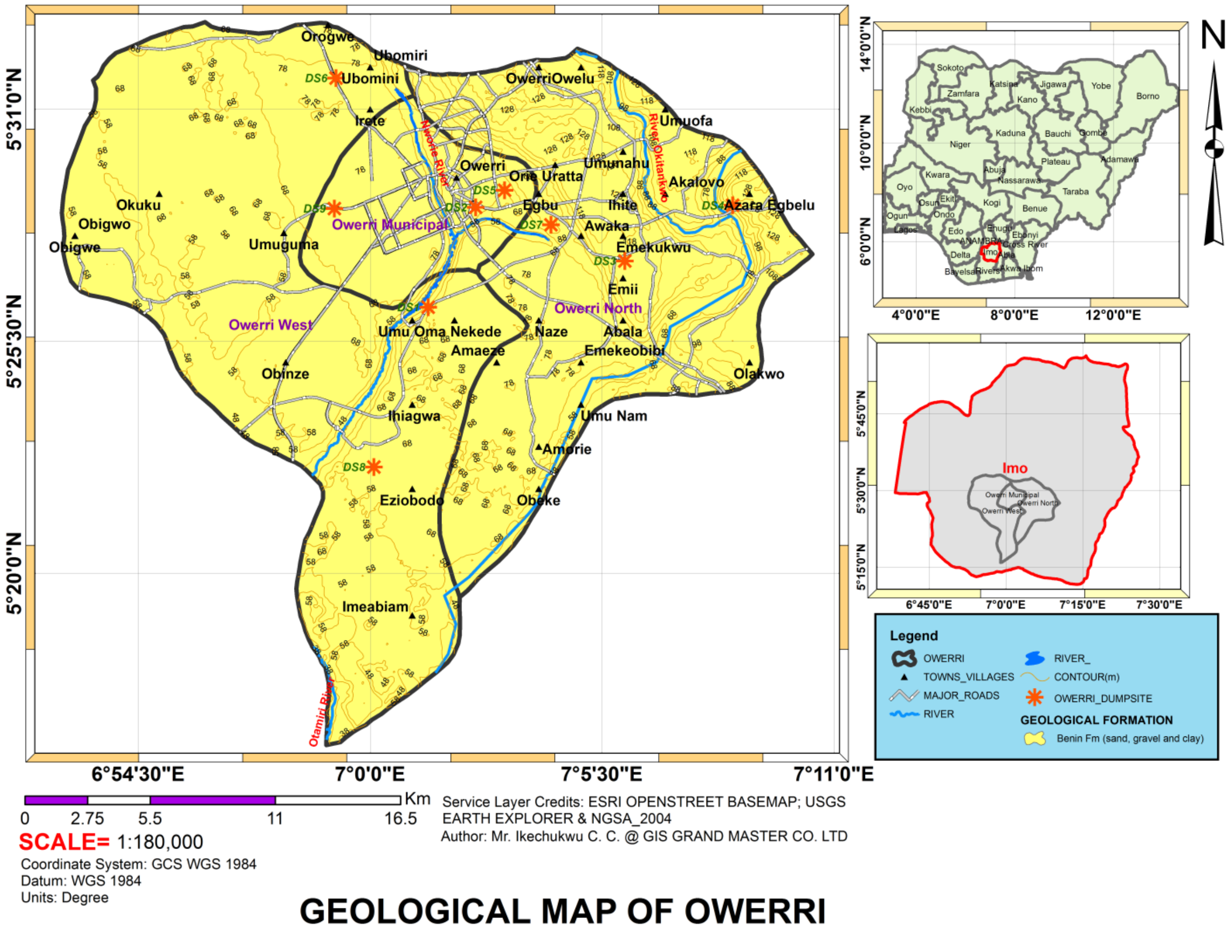

Figure 2: Geology Map of the Study Area

2.1.3 Physiographic Setting And Hydrology

The geography of the region somewhat controls the event and sorts of the spring found in the region. The examination region is outcropped by the Oligocene Benin Formation which is known as the beachfront plain sand (Fig 2). It comprises primarily of sands, sandstone, and rock with dirt happening in focal points. The sands and sandstones range from fine to coarse-grained and are generally unconfined, with thickness running from 2.0 m to 2100.0 m (Avbovbo, 1978). The nature of the situation is somewhat lagoonal and halfway fluvio-lacustrine/deltaic (Reyment, 1965). The development which plunges south westbound beginnings as a slight edge layer at its contact with the Ogwashi – Asaba Formation in the northern piece of the territory, and thickens southwards to about 1000.0 m in the Owerri region. The Benin Formation is made for the most part out of high safe crisp water-bearing mainland sands and rock with minor earth intercalations (Onyeagocha, 1980). The dregs speak to upper deltaic plain stores. The Formation is by and large water-bearing and subsequently it is the fundamental wellspring of compact groundwater in the region. The springs are energized predominantly by surface precipitation and close by wastes dregs affidavit and groundwater stream are for the most part in the NW – SE pattern, following the provincial pattern of the bowl. The sandy unit which comprises about 95% of the stone in the territory is made out of over 96% of quartz (Onyeagocha, 1980).

2.1.4 Stratigraphy Of The Study Area

Uma and Egboka (1985) conducted a detailed stratigraphy of southeastern Nigeria. Their Stratigraphic progression of rocks can be seen in Table 1.1 which comprises of Imo-Shale Formation, being the oldest followed by Ameki Formation, while Ogwashi-Asaba and Benin Formation being the most recent (Uma and Egboka, 1985). The waterfront plain sand having a place with the Benin Formation stretches out to an impressive profundity in the territory and with great pressure-driven properties for groundwater improvement. The Formation comprises prevalently of thick waterfront sand, sandstone, dirt, and sandy muds that happen in focal points. The Benin Formation is to some extent cross-stratified with the forset beds shifting back and forth among coarse and fine-grained sands. Petrographic study on a few dainty segments (Onyeagocha, 1980). Groundwater happens liberally in the beachfront plain sands (Benin Formation) and the static water level (SWL) ranges from 8.0 – 65.0 meters relying upon the area and the time. The Benin Formation is a decent spring with a normal yearly renewal of about 2.8 billion cubic meters for each year (Onyegocha, 1980). In many regions across the study area, over 90% of the Benin Formation has extremely high penetrability, transmissivity, and storage coefficient.

Table 4: Stratigraphic Units of the Niger Delta Basin (After Short and Stauble, 1967)

Outcropping Units	**Subsurface Units**	**Present-day Equivalents**
Benin Formation	Benin Formation	Continental (fluviatile) deposits mainly sandstones
Ogwashi–Asaba Formation	Agbada Formation	Mixed continental brackish water
Ameki Formation		Marine deposits, sandstones, and clays
Imo Shales	Akata Formation	Marine deposits, mainly clays

Table 5: Generalized Stratigraphy of the Study Area, Imo State (After Uma and Egboka, 1985).

Age	**Formation**	**Maximum approximated Thickness (m)**	**Lithology**
Miocene – Recent	*BeninFormation	2000	Unconsolidated, yellow and white sandstones occasionally pebbly with lenses of grey sand clay.
Oligocene – Miocene	Ogwashi – Asaba Formation	500	Unconsolidated, sandstones with carbonaceous mudstones, sandy clays, and lignite seams.
Eocene	Ameki Formation	1460	Sandstones with grey argillaceous sandstone shales and thin limestone units.
Paleocene	Imo Formation	1200	Blue to dark grey shale and subordinate sandstones. It includes three sandstone members, the Igbabu, Ebenebe, and Umunna sand.
Upper Maastrichtian	Nsukka Formation	350	White to grey coarse-medium-grained sandstone: carbonaceous shales, sandy shales, subordinate coals, and thin limestones.
Lower Maastrichtian	Ajali Sandstone	3504	Medium-coarse grained cross-bedded sandstones, poorly consolidated with subordinate white and pale grey shale.

Every single other Development except the Benin arrangement was incorporated to give a general review of the topography of the zone (Imo State). In any case, every one of the profundities of enthusiasm for this task work ended in the Benin development.

A striking element in the geography guide is the likeness in the example of surface outcrops of the Arrangements. Practically every one of the Developments at the investigation is happening along the NW – SE groups that were parallel to the territorial strike. The stone units likewise get more youthful southwestward, a course that is parallel to the local clasp of the Development.

2.2. Theoretic structure

2.2.1. The theory of Land use

Land use is just characterized as the human utilization of land. Land use includes the administration and alteration of regular habitats like fields, fields, and settlements. It has likewise been characterized as the game plan, exercises and sources of info individuals embrace in a specific land cover type to deliver, change or keep up with it (FAO., 1997a; FAO/UNEP., 1999). Land use rehearses change impressively across the world. The Assembled Countries Food and Horticulture Association (FAO), water improvement division clarifies that "Land use concerns the items and/or benefits got from the utilization of land just as the land the board activities (exercises) did by people to deliver those items and benefits"(FAO.,1997a). As of the mid-1990s, about 13% of the earth was considered to be arable land, with 26% recorded as metropolitan regions.

A specific space of land can be used by people in assorted manners which include: private, institutional, modern, business, rural/ranger service, and other moderately regular land employments. Every one of the more extensive classes can be further sub-partitioned dependent on the nature and force of the exercises that are attempted as given beneath:

i. Private Land use: In private land use, for instance, includes single-family homes on enormous or little plots or aggradations of numerous unit residences of different sorts. The most concentrated private land utilizes are related with bunches of building condos, which can uphold amazingly enormous densities of human populaces
ii. Institutional land use: This is for the most part connected with land that is involved by open structures like schools, colleges, government workplaces, craftsmanship exhibitions, and galleries. These offices are most regularly situated in metropolitan or sub-metropolitan regions.
iii. Business land use: These are fairly comparable in many regards and are for the most part connected with land that is appropriated in retail offices of different sorts and with places of business

iv. Industrial land use: This sort of land use has incredibly fluctuated, contingent upon the idea of the business being thought of Metropolitan modern land use, for the most part, alludes to the referring to of processing plants or oil processing plants or potentially different utilities, for example, power-producing stations, water and sewage treatment offices, and so on Modern land use in rustic regions might incorporate mines, smelters, and factories for the creation of minerals and metals; digs and well fields for the creation of petroleum derivatives like coal, oil and flammable gas; and enormous water holding repositories for the creation of hydro-power. Land use for Farming and ranger service is likewise sorts of mechanical land utilizes, for this situation, it is related with the creation of food or tree-fiber as inexhaustible assets. The idea of horticultural land utilizes relies upon the kind of yields and agronomic frameworks, which can shift from seriously oversaw mono-societies to more natural frameworks including yearly or perpetual harvests and little utilization of composts or pesticides. Essentially, the power of land utilizes in ranger service regions fluctuates from frameworks including clear-cuttings and the foundation of short revolution estates, to choice gathering framework with since a long time ago divided mediations. Some land utilizes related to parks and fairways additionally address escalated alterations of the regular land scarp. The administration rehearses needed to keep up with these grass overwhelmed environments are like those used in certain kinds of monoculture rural frameworks

2.2.2. Definition of Landcover

Land cover is the actual material at the outer layer of the earth. The land cover incorporates grass, black-top, trees, uncovered ground, water, and so forth There are two essential techniques for catching data ashore cover which incorporates field study and examination of distantly detected symbolism. Land cover is unmistakable from land-use notwithstanding the two terms regularly being utilized conversely. Land use is a portrayal of how individuals use the land regarding financial movement - metropolitan and horticultural land utilizes are two of the most generally realized land use classes. At any one point or spot, there might be various and substitute land utilizes, the particular of which might have a political measurement.

The beginnings of the 'land cover/land use' couplet and the ramifications of their disarray are examined in Fisher et al. (2005). One of the significant land cover issues (likewise with all normal asset inventories) is that each study characterizes also unexpectedly named classifications. For example, there are numerous meanings of 'Timberland' some of the time inside a similar association, that could fuse various distinctive woods highlights (stand stature, shelter cover, strip width, incorporation of grasses, paces of development for lumber creation). Regions without trees might be delegated timberland cover if the aim is to re-plant (UK and Ireland), regions with many trees may not be marked as backwoods if the trees are not developing quickly enough (Norway and Finland). It infers the physical or regular condition of the World's surface.

2.2.3. Basic Operational principles of Landsat Satellites

Landsat satellites are the US's most seasoned land surface perception satellite framework. The program has scored various accomplishments in logical and asset the executive's applications over its 30 years history and has denoted another bearing in a decrease of expenses of information and increments overall inclusion for utilizes in worldwide change research. Following the achievement of the Monitored Space Missions (MSM), Public Air transportation and Space Organization (NASA) and the US Branch of Inside (all in the US), fostered a trial earth assets satellite series to assess the utility of pictures gathered from an automated satellite. The primary Landsat satellite in this series was dispatched on July 23, 1972. This satellite continued board two instruments to take a gander at the world's surface – Return Shaft Vidicon (RBV) and a Multispectral Scanner Framework (MSS). Initially, the primary land satellite was called Earth Assets Innovation Satellite-1 (ERTS-1), a name that it held until January 1975 when it was renamed Landsat-1. The satellite's circle was high and quick at a height of 900km (+ 30km) and a speed of 6.5km/s. After Landsat-1, it was trailed via Landsat-2, 3, 4, 5, and 7. Landsat 6 sadly neglected to arrive at the circle

Return Beam Vidicons (RBV) and Multispectral Scanner System (MSS) were flown on the first three Landsats. The MSS ended up being a more valuable and dependable instrument than the RBV. Landsats 4 and 5 were in this manner furnished with an MSS and a further developed variant of the MSS individually. Landsat 5 was accordingly called the Thematic Mapper (TM). Landsat 6 conveyed an Enhanced Thematic Mapper(ETM) while Landsat 7 conveyed an Enhanced Thematic Mapper(ETM+). The Landsat-4 sensors were not functional after July 1987; the satellite was subsequently utilized for move testing. The information, called the Geo-cover informational index, covered the Assembled Territory of America, including Gold country and Hawaii. The informational index was gained by the earth satellite organization for NASA and contains around

900 TM pictures or scenes. Earth Landsat scene is around 115 miles in length and 115 miles wide (or 100 nautical miles long and 100 nautical miles wide or 185km long and 185km wide).

In ortho-rectified Landsat thematic mapper mosaics, under inclusion, the Geo-cover Landsat mosaics are conveyed in the Widespread Cross over Mercator (UTM)/world geodetic framework 1984 (WGS 84) projection. The mosaics by and large expand north-south more than five levels of scope and range east-west for the full width of the UTM zone. For mosaics between 60 degrees north and 60 degrees south scope, the width of the mosaics is the standard UTM zone width of 6 levels of longitude. For mosaics over 60 levels of scope, the UTM zone is augmented to 12 degrees, jogged on the standard UTM meridian. To guarantee cross-over between adjoining UTM zones, every mosaic stretches out for essentially 50km toward the east and west, and 1km toward the north and south.

The Thematic Mapper instrument on Landsat 5 and the ETM+ instrument on Landsat 7 noticed the earth with seven unique channels or "groups". Groups 1, 2, 3, 4, 5, and 7 on the two instruments are touchy to light energy from the sun reflected by the outer layer of the earth. Each band is delicate to an alternate piece of the reflected sunlight-based energy. The pieces of the reflected energy are characterized by the length of the light waves. Accordingly, band 1 of the TM and ETM+ instruments records mirrored light energy just in the scope of 0.45 microns (µm – a micron is one-millionth of a meter) to 0.52µm. The natural eye sees mirrored light in that band of frequencies as blue; consequently, band 1 is in some cases alluded to as a blue band. Likewise, groups 2 and 3 of the TM and ETM+ instruments record mirrored green and red light, respectively.TM and ETM+ groups 4, 5, and 7 records mirrored light in frequencies that natural eyes can't distinguish. These groups are alluded to as close to infrared (NIR, band 4) and short wave infrared (SWIR, groups 5 and 7). Groups 6 of the TM and ETM+ instruments is not quite the same as the wide range of various groups since it doesn't record mirrored light energy, but instead heat energy transmitted by the world's surface. Notwithstanding these groups, the ETM+ instrument likewise has band 8, called the panchromatic honing band. ETM+ band 8 is touchy to mirrored light energy across an expansive scope of frequencies that incorporates blue, green, red, and close to infrared. This panchromatic band has a spatial goal of 1.5 meters, instead of the 28.5 or 30 meters of bands 1, 2, 3, 4, 5, and 7.

The singular band pictures show up as dim scale pictures like older style highly contrasting photos. Be that as it may, they can be joined to shape composite pictures with an alternate dark scale picture taking care of various shading weapons (commonly a red-green-blue, or RGB blend). This band mix is the one that was utilized in the Geo-cover informational collection. It is incorporated into the Geo-cover information and can't be changed. Moreover, the difference and brilliance have been changed in the Geo-cover informational collection to make a more reliable by and large mosaic. The presence of the diverse surface elements for the distinctive composite pictures is summed up in table 1 underneath.

Table 2.1. The appearance of Features on Composite Images (Opara, et al.,2012).

	TRUE COLOUR	**FALSE-COLOUR**	**SWIR (GEO-COVER)**
	Red: Band 3 **Green: Band 2** **Blue: Band 1**	**Red: Band 4** **Green: Band 3** **Blue: Band 2**	**Red: Band 7** **Green: Band 4** **Blue: Band 2**
Trees and Bushes	Olive Green	Red	Shades of green
Crops	Medium to light Green	Pink to red	Shades of green
Wetland vegetation	Dark green to black	Dark red	Shades of green
Urban areas	White to light blue	Blue to gray	Lavender
Water	Shades of blue & green	Shades of blue	Black to dark blue
Bare soil	White to light gray	Blue to gray	Magenta, lavender, or pale pink.

Landsat MSS and TM scenes are computerized pictures, similar to pictures from advanced cameras. Each computerized picture makes a progress space of 185km x 170km (115 x 105 miles) and comprises a variety of dabs called picture components (pixels) in lines and sections. Each pixel contains mathematical qualities communicating its splendor. Every pixel in an MSS scene addresses a 68m x 82m ground region, while every pixel in a TM scene addresses a 30m x 30m ground region (except the far-infrared band 6 which utilizes a bigger 120m x 120m pixel). A standard computerized camera records just blue, green, and red brilliance esteems comparing to the scope of human vision. The Landsat MSS sensor has 4 groups that all the while record reflected radiation from the world's surface in the green, red, and close to infrared bits of the electromagnetic range. The Landsat TM sensor has 7 groups that all the while record reflected or produced radiation from the world's surface in the blue-green, green, red, close infrared, mid-infrared, and far-infrared segments of the electromagnetic range.

Far off detecting as an innovation (Remote sensing as a technology) alludes to the obtaining of information and subordinate data about an article or material situated at some separation from the sensors by inspecting radiation from a chose district (wave groups) of the electromagnetic (EM) range. For sensors mounted on moving stages (for example airplanes and satellites) working in or over the world's environment, the chief detecting areas are in the apparent, reflected close infrared, warm infrared, and microwave radar districts of the EM range. The specific frequency (or frequencies) noticeable by apparent infrared sensors rely primarily upon the degree to which the waveband radiation is assimilated, dissipated, or in any case changed by the environment ("windows of straightforwardness" idea). The radiation estimated from the space stage is generally auxiliary in that it is reflected or produced energy created from sub-atomic communication between approaching radiation (irradiant) and the earth material being detected. Normal essential energy sources incorporate the sun or dynamic radiation-producing gadgets like radar. Distantly detected warm radiation from the world's surface outcomes from inward warmth sources and the warming impact of sunlight-based radiation. Since most materials retain radiation over the detected pieces of the ETM range, just part of the approaching radiation is gotten back to the sensor.

Multiband photography uses a few cameras, each comprising of a drag located focal point and a shading channel that communicates a particular unearthly span or band through the optical train onto highly contrasting film. For each band, the film records the scene objects as different dark tones identified with the apparent shadings (or other radiation) dynamically communicated and consumed by the specific channel. Shading composite photos can be delivered by passing white light progressively through an essential shading channel and each particular highly contrasting straightforwardness after every one of the three pictures are superimposed and enrolled to each other on a shading delicate film. The red band initiates a red tone on the film whenever projected through a red channel. Light tones (clear in straightforwardness) addressing red articles pass red-sifted high onto the film while screening out blue and green channels. The subsequent composite is a characteristic shading photo. At the point when an infrared band straightforwardness is projected through a red channel, and red and green groups through green and blue channels, separately, vegetation, specifically, which is profoundly intelligent (exceptionally splendid) in the infrared, tolerably intelligent in the green and low in the red due to retention of red light by chlorophyll, will seem red in the shading composite (minimal blue and no green commitment). Subsequently, in a bogus shading composite, red is quite often a dependable pointer of vegetation.

A bunch of multispectral pictures is created by breaking the picture-shaping radiation into discrete ghastly stretches using waveband channels (or other light scattering or choice gadgets). On the off chance that a surface material has high reflectance or settlement in some given span, it will be recorded as a light (splendid) tone on a position film-based picture. Then again, a dull tone addresses a low reflectance or emittance. Since a similar material typically has a fluctuating worth of reflectance or emittance in various phantom districts, it will deliver some trademark dim level (on film) in the picture from every specific waveband. Various materials bring about various dark levels in any arrangement of waveband pictures, consequently making the changing apparent examples that spatially characterize classes, items, or components. Multispectral pictures of a similar scene are described by various apparent levels for the different classes starting with one band then onto the next.

Two strategies for the arrangement of composite pictures are usually utilized: unaided and regulated grouping techniques. The rationale or steps included can be gotten a handle on from the accompanying clarification. In the solo arrangement, any singular pixel is contrasted with each discrete group to see which one it is nearest to. A guide of all pixels in the picture, delegated to which bunch every pixel is probably going to have a place, is delivered (clearly or all the more usually in colors assigned to each group). This then, at that point should be deciphered by the client concerning what the shading examples might mean (as far as classes, and so forth) that is present in the reality scene. This requires some information on the scene's element/class/material substance from general insight or individual experience with the space imaged. In a solo characterization, the goal is to bunch multiband ghastly reaction designs into measurably distinguishable groups. In this way, a little scope of computerized numbers (DN's) for, say 3 groups, can set up one bunch that is separate from a predefined range mix for another bunch, (etc). The partition will rely upon the boundaries we decide to separate.
In the managed arrangement, the translator knows in advance what classes are available and where each is in at least one area inside the scene. These are situated on the picture; regions containing instances of the classes are encircled (making them preparing locales), while the factual examination is performed on the multiband information for every one of such classes. Rather than bunches, class groupings with suitable discriminant capacities that recognize each type is thought

of (it is conceivable that more than one class will have comparative ghostly qualities yet far-fetched when multiple groups are utilized because various classes/materials only occasionally have comparative reactions over a wide scope of frequencies). All pixels in the picture lying outside preparing locales are then contrasted and the class discriminants, with each being assigned to the class it is nearest to. This makes a guide of setting up classes (with a couple of pixels generally staying obscure) that can be sensibly exact (yet a few classes present might not have been set up, or a few pixels are misclassified.

Landsat information has been utilized by government, business, mechanical, non-military personnel, and instructive networks in the U.S. also, around the world. They have been utilized to help a wide scope of uses in such regions as worldwide environmental change research, horticulture, ranger service, topography, assets the executives, geology, planning, water quality, and oceanography. The pictures can be utilized to plan anthropogenic and regular changes on the Earth over times of a while to twenty years. The kinds of changes that can be distinguished incorporate horticultural turn of events, deforestation, desertification, catastrophic events, urbanization, and the turn of events and corruption of water assets. Remember that satellite pictures can be either arranged or unclassified. Arranged satellite pictures separate backwoods cover types just as other vegetation and land employments. An unclassified satellite picture is crude information and can be utilized as a background in GIS maps with different GIS information layers set on top.

2.2.4. Principles and applications of the Geographic Information System (GIS)

A geographic information system is a system intended to catch, store, control, investigate, oversee, and present a wide range of geological information. The abbreviation GIS is here and there utilized for geological data science or geospatial data studies to allude to the scholastic discipline or profession of working with geographic data frameworks. In the most straightforward terms, GIS is the converging of map making, measurable examination, and information base innovation

GIS can be considered as a system that is carefully made and controls spatial regions that might be jurisdictional, reason-driven, or application-arranged. For the most part, a GIS is specially crafted for an association. Consequently, a GIS produced for an application, purview, venture, or reason may not be fundamentally viable with a GIS that has been created for another application, locale, endeavor, or reason. From an overall perspective, the term portrays any data framework that incorporates stores, alters, dissects, shares, and shows geographic data for educated dynamic. GIS applications are apparatuses that permit clients to make intuitive questions (client-made inquiries), examine spatial data, alter information in guides, and present the aftereffects of this load of tasks.

The geographic information system(GIS) is the science fundamental geographic ideas, applications, and frameworks. It is a PC helped framework for the procurement, stockpiling, investigation, and show of geographic information. The expanding measure of various informational collections accessible to earth researchers has made a requirement for the effective catch, stockpiling, the board, recovery, and examination of geo-information. Today the earth researcher faces the troublesome assignment of relating and coordinating huge measures of various information types, gotten from various sources and gathered on various scales. To utilize this load of information for planning, translation, and demonstrating, the earth expert ought to have the option to spatially interface field perceptions with auxiliary information. This application acquaints the earth researcher with advanced handling strategies for the reconciliation, perception, improvement, and translation of various geo-informational indexes in a GIS climate

2.2.5. Applications of remote sensing in land use/ land cover

Remote sensing is characterized as the study of getting data about an article, region, or target through the examination of information procured by a gadget that isn't in touch with the item, region, or marvel being scrutinized. Since the dispatch of Landsat-1 – the principal Earth asset satellite in 1972, far-off detecting has turned into an inexorably significant apparatus for the stock, observing, and the executives of earth assets. The expanding accessibility of data items produced from satellite symbolism information has added incredibly to our capacity to understanding the examples and elements of the earth asset frameworks at all sizes of request.

Especially significant utilization of remote sensing is the generation of land use/land cover maps. Contrasted with more customary planning approaches, for example, earthbound review and essential flying photograph understanding, land use planning utilizing satellite symbolism enjoy the benefits of minimal expense, enormous inclusion, and calculability (Franklin, 2001). Subsequently, land use data items acquired from satellite symbolism, for example, land use guides, information, and GIS layers have turned into a fundamental apparatus in numerous functional projects including land asset the board. The possibility for the utilization of satellite symbolism information in land use the board and arranging is a very encouraging one. Because of the new improvement of sensor innovation, the nature of satellite symbolism accessible for land use planning is improving quickly. Especially significant in such a manner is the work on spatial and other diverse goals of the symbolism caught by new satellite sensors. The utilization of symbolism from high goal sensors on satellites, for example, IKONOS and Fast Bird have demonstrated that information from spaceborne sensors can give a practical option in contrast to elevated photography in numerous applications including point by point land cover planning, water assets evaluation, water system the executives, and harvest yield planning (Shamshad et al., 2004; Lillesand et al., 2004; Mesev et al.,2001; Trietz and Rogan., 2004). It has been anticipated that soon, more than 50% of the current ethereal photograph market will be supplanted by high-goal satellite symbolism (Fritz., 1996). Simultaneously, fast advances in software engineering just as other data innovation (IT) fields have offered all the more useful assets for satellite picture preparing and examination. Picture handling programming and equipment are turning out to be more proficient and more affordable. Admittance to quicker and more proficient PC stages has supported our capacity to store and handle bigger and more point-by-point picture and characteristics informational collections.

Digital image processing (advanced picture preparation) involves the manipulation and interpretation of digital images with the aid of PC innovation. As of late, advanced picture preparation is key to productive utilization of satellite symbolism in land use considers. A vital undertaking of satellite picture preparing is to foster picture information investigation approaches suitable to a specific asset the board application (Treitz and Rogan, 2004). The extraction and arrangement of land cover types from satellite symbolism is likely the main target of advanced picture investigation in studies of the planet and related fields. Regular picture order procedures depend on the otherworldly reaction examples of landscape highlights caught in satellite symbolism (Taib., 1997). The improved data content of high goal satellite symbolism and the drawn-out want of land use organizers to acquire nitty-gritty land use maps feature the requirement for all the more useful assets for examining multi-ghastly information. Accordingly, lately, an assortment of ways to deal with satellite picture grouping had created. A central purpose in this improvement is that, as well as utilizing upgraded phantom data of symbolism information, expanding consideration is being given to the spatial and semantical qualities of territory highlights (Dorren., 2003). Ongoing examinations showed that the higher data content of symbolism information joined with the enhancements in picture handling power brings about a huge improvement in characterization exactness (Liu and Zhou, 2004; Munchney and Strahler., 2002; Cihlar and Jansen, 2001; Congalton and Green., 1999).

Land use and land cover are dynamic and are significant factors for the appreciation of the cooperation and relationship of anthropogenic exercises inside the climate. Information on the idea of land use and land cover change and their design across spatial and transient scales is thusly vital for practical ecological administration and advancement (Turner et al., 1994). Metropolitan scenes are exemplified by the enormous convergence of populace, and quick development of metropolitan zones which lead to change in the land use and land cover design that subsequently impacts the scene climate (Long et al., 2008). The idea of progress discovery in land use and land cover can be performed on a transient scale, for example, 10 years to evaluate scene change caused because of anthropogenic exercises on the land (Gibson and Force., 2000). These anthropogenic exercises ashore are because of quick urbanization and industrialization. Land use and land cover changes have been perceived as significant drivers of worldwide climate change (Turner et al., 1994). Far off detecting and geographic data framework (GIS) advances have been used gainfully to recognize and measure changes in the scene and the important ecological effects. Studies have used distant detected information to analyze metropolitan land changes in present-day times with ends showing the fluctuating level of various examples of metropolitan extension and advancement which could be related with explicit ecological elements (Long et al., 2008). Subsequently, land-use changes as far as urbanization and industrialization affect the climate. The progressions measured utilizing distant detecting advancements give perceptions that might show antagonistic and bothersome natural effects, subsequently requiring critical economical land the board arrangements and practices to keep away from the imperiling of the climate. There are various instances of customary and master-based picture order frameworks for identification, observing, and planning of land-use change and land corruption utilizing distant detecting information.

Incorporated investigations inside a spatial data set structure (for example GIS) are frequently needed to allocate land cover to proper land-use assignments (Noordin., 1997). Success in land cover and land-use change examination utilizing multi-transient distant detecting information is subject to exact radiometric and mathematical correction (Schott et al., 1988; Dai and Khorram., 1999). These pre-preparing necessities ordinarily present the most difficult parts of progress recognition contemplates and are frequently disregarded, especially concerning exact and exact radiometric and climatic rectification (Chavez, 1996). For change to be related to certainty between progressive dates, a reliable air between dates should be displayed so varieties in environmental profundity don't impact surface reflectance to the degree that land cover change is identified mistakenly. This is especially significant in biophysical far-off detecting where analysts endeavor to gauge paces of essential efficiency and change altogether over the ground biomass (Coppin and Bauer, 1996; Treitz and Howarth, 2000; Franklin, 2001; Sell et al., 2003). Where the change is sensational (for example transformation of farming area to private), the 'change signal' is for the most part enormous contrasted with the air signal. Here, the exactness and accuracy of mathematical enlistment impact the measure of false change distinguished. Where exact and exact enlistment of one date to the next is accomplished, recognized surface changes can be unquestionably credited to land transformation. Error and lose co-enrollment can prompt orderly over the assessment of progress, even though techniques have been created to make up for these impacts (for example spatial decrease sifting). Examination keeps on zeroing in on the potential for computerized picture preparing of high-goal symbolism for recognizing, distinguishing, and planning spaces of quick-change (Longley et al., 2001). It has been noticed that the utility of per-pixel characterization of ghostly reflectance for recognizing spaces of land alteration, or land change is restricted, because of different wellsprings of mistake or vulnerability that are available in spaces of huge scene heterogeneity. For metropolitan regions, the mind-boggling mosaic of reflectance makes huge disarray between land use classes that have reflectance attributes like those of land cover types.

Ordinarily, the quality (for example accuracy and exactness) of computerized per-pixel orders in metropolitan regions utilizing distant detecting is poor, contrasted with non-metropolitan regions. Additionally, metropolitan regions present the issue of having legitimate correspondence between ghastly classes and useful land-use classes (Treitz and Howarth., 2000). Be that as it may, enhancements in conventional per pixel orders have been created throughout the last decade and incorporate the accompanying:

i. The extraction and use of prior probabilities or posterior processing (Barnsley, 1999; Mesev et al., 2001)
ii. Texture processing (Haralick, 1979; Barnsley et al., 2001)
iii. Artificial neural networks (Abuelgasim et al., 1999)
iv. Fuzzy set theory (Foody, 1996; Zang and Foody., 1998)
v. Frequency-based contextual approaches (Gong et al., 1992);
vi. Knowledge-based algorithms (Wang and Zhang, 2000)

vii. Image segmentation (Connerset al., 1984; Bähr, 2001); and the incorporation of ancillary data (Harris and Ventura., 1995; Treitz and Howarth, 2000). These approaches are necessary to accommodate the more complex spatial structures arising from heterogeneous spectral signatures, particularly in urban environments, but also for fragmented and heterogeneous canopies common in areas of secondary growth and human influence

Examination into modern spatial scientific techniques for land cover and land use characterization proceeds through the incorporation of land use morphology in regards to the arrangement, grammar, construction, and capacity with the inborn qualities of distant detecting information (Curran et al., 1998; Barnsley., 1999; Longley et al., 2001). For metropolitan regions, research has zeroed in on:

i. Empirical/statistical kernel-based techniques (Wharton., 1987)
ii. Knowledge-based texture models (i.e. relating spatial variations in detected spectral response to dominant land-use, using explicit spatial models of urban structure as opposed to empirical models) (Barnsley et al., 2001)
iii. Structural pattern recognition techniques (Barnsley, 1999). It remains difficult to map point and linear features, particularly digitally, because they are not always recognizable at the spatial resolution of the data.
iv. Location due to the sensor and panoramic distortions inherent in satellite data collection. It has also proven
v. Difficulties to digitally separate linear features such as road networks from surrounding land-cover and land-use or mixed vegetation in high mountainous areas (Wang and Zhang, 2000). This is largely due to the complexity of pattern recognition procedures required for tracing specific cultural edge features

2.2.6 Image interpretation methods

2.2.6.1. Normalized Difference Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) is an index of the plant (NDVI) is a record of plant "greenness" or photograph manufactured action and is one of the most normally utilized vegetation files. Vegetation records depend on the perception that various surfaces unexpectedly mirror various kinds of light. Photograph artificially dynamic vegetation specifically, ingests the majority of the red light that hits it while reflecting a significant part of the close infra-red light.

Vegetation that is dead or focused on mirrors has more red light and less close infra-red light. Similarly, non-vegetated surfaces have a substantially more even reflectance across the light range. By taking the proportion of red and close to infrared groups from a distantly detected picture, a list of vegetation "greenness" can be characterized. The Normalized Difference Vegetation Index (NDVI) is presumably the most widely recognized of these proportion lists for vegetation. NDVI is determined on a for every pixel premise as the standardized distinction between the red and close to infrared groups from a picture. The NDVI is numerically communicated as:

$$\boldsymbol{NDVI = \frac{NIR - RED}{NIR + RED}} \quad \textbf{(1)}$$

Where NIR is the near infra-red band value for a cell, RED is the red band value for the cell and therefore NDVI can be calculated for any image that has a red and near the infra-red band.

The biophysical translation of NDVI is the small part of assimilated photograph artificially dynamic radiation. Many variables influence NDVI esteems like plant photosynthetic action, absolute plant cover, biomass, plant and soil dampness, and plant pressure. Along these lines, NDVI is associated with numerous eco-framework ascribes that are important to analysts and administrators (e.g., net essential usefulness, shade cover, uncovered ground cover). Additionally, because it is a proportion of two groups, NDVI makes up for contrasts both in light inside a picture because of slant and perspective and contrasts between pictures because of things like a season of day or season when the pictures were procured. Accordingly, vegetation lists like NDVI make it conceivable to contrast pictures over the long haul with search ecologically significant changes.

As a result of the connection between ecosystem parameters, NDVI has seen far-reaching use in taking care of natural issues. The employments of NDVI incorporate the accompanying:

a. Vegetation dynamics or plant phenological changes over time
b. Biomass production
c. Carbon sequestration or CO_2 flux
d. Changes in rangeland condition and soil moisture
e. Vegetation or land cover classification

2.2.7. Drainage Analysis

Geoscientists dealing with remote sensing applications have examined stream seepage designs and their connections to landscape conditions. Many have concluded distinctive stone properties and constructions utilizing geological help understanding from the symbolism. They have represented and evaluated connections among chose rock properties, geological alleviation, and stream waste examples (Drury, 2001; Konecny, 2002; Lillesand and Kiefer., 1994; Pandey., 1987).

Stream drainage (seepage) thickness in disintegrating rock scenes can be clarified as an element of rock protection from enduring, geography, and environment. Rock protection from both substance and mechanical enduring is a significant factor in clarifying seepage designs. There is in this manner a setup connection between transfer waste thickness, NDVI, and rise. As far as geology, higher help makes a better-finished seepage as in our investigation picture. However, the relationship with the environment is more muddled. It is the measure of defensive vegetation cover, which can be corresponded to temperature and precipitation that fundamentally controls disintegration and waste thickness. In this way, gentler rocks, like shale regions, have higher seepage densities in drier environments than wetter environments. The insurance of the stone and soil surface by vegetation makes up for the expansion in precipitation. Stream seepage thickness typically shows the porosity and penetrability of the hidden materials. Materials with great penetrability for the most part have a medium to coarse waste thickness. Such materials incorporate sandstones, porch rock, limestones, volcanic remains, and sand rises. Stream waste thickness likewise shows that fine-grained or impermeable materials have little dampness on a superficial level. This dampness doesn't penetrate and should run off on a superficial level.

Likewise, stream waste examples can uncover bigger scope coarse designs of fundamental rocks, e.g., stream seepage designs with various straight equal or sub-equal sections can demonstrate broad jointing on plunging had relations with or foliated rocks. Predictable precise connections between transfer components show breaks. Concentric waste shows doming of layered arrangement of rocks identified with interruption or collapsing while outspread seepage designs show doming, volcanic movement, or little safe barrel-shaped interruptions in less safe rocks. Very much created dendritic seepage designs without all-around created equal components propose a uniform layer without bountiful discontinuities. This can comprise sedimentary, molten, or transformative shakes or sheets of moderately uniform icy or alluvial materials. Appropriated channel designs demonstrate alluvial fans, pediments, or deltas, and they are normally connected with an unexpected lessening in-stream speed.

Broad drainage (seepage) channels show solid foliation, plunging groupings of safe and non-safe rocks, or solid uni-directional breaking. The states of the fundamental directions in the stream seepage region additionally give signs about the topographical designs. For example, interlaced channels demonstrate effectively erodible coarse-grained materials, while wandering channels show medium to fine-grained materials. Moderately tight and straight channels show safe materials, however sudden changes in directions demonstrate changes in topographical designs. Outrageous changes in divert types demonstrate changes in the materials that make up the bank. The fundamental divert in the seepage region having discontinuities shows (breaks and cracks) or potentially blames, just as unconformities. For the most part, stream waste examples can be delegated as follows:

i. Dendritic: is the most well-known stream drainage (seepage) design. It resembles a tree with stretching diverts in numerous ways. This example appears on homogeneous, uniform soil and rock materials generally in sedimentary rocks
ii. Trellis: is a change of the dendritic example, with equal feeders and short equal gorges, which happen at almost right points. This example appears on a collapsed bedrock structure, taken apart waterfront fields, and collapsed and blamed sedimentary rocks, in which the fundamental equal channels follow the strike of the beds.
iii. Rectangular: is a variety of lattice designs. The feeders join the standard at practically the right points. This example appears on the outcropping edges of collapsed sedimentary rocks (powerless or safe) with long and generally equal belts
iv. Radial: is likewise called a diffusive example. Channels transmit out, similar to the spokes of a wheel, from a geologically high region. They appear on volcanoes, detached slopes, and arch-like landforms.
v. Annular is a round design that happens most habitually because of disintegration on underlying arches. This example is a bent lattice design and almost concentric. This sort of example creates on geological structures commonly like outspread examples. Stone or bedrock sedimentary vaults might foster this sort of example. Rock or bedrock sedimentary arches might foster this sort of example.
vi. Centripetal: is s contrary to Radial. In this sort of seepage, streams are coordinated toward an essential issue. They happen in spaces of limestone sinkholes, icy pot openings, volcanic focuses, outwash patios, alluvial sea shore edges, sandhills, and different touches of melancholy.

CHAPTER THREE
MATERIALS AND METHOD

3.1. Overview

This section describes the approaches which were employed in the study towards fulfilling the set goal and the objectives of the study. The section further highlights the materials and types of data used in the study as well as the sources of the same. The Chapter further details the data processing techniques used, image classification, and accuracy assessment as well as giving an account of how the findings of the study are presented. The examination tends to land use and land cover changes over a time of study from 2000 and 2020, It includes four vintages of Landsat information which incorporates information obtained from 2000 - 2020. The elements of urbanization and the horticultural changes and their spatial dissemination and examples are the essential focal point of this review. Land use/land cover change is characterized as the transformation starting with one land cover classification then onto the next (Riebsame, et al, 1994). This sort of marvel brings about a difference in reflected electromagnetic radiation (EMR) values which are illustrative of a proxy of the World's surface which frequently can be distantly detected. Inside the extent of this task, the idea driving the most common way of planning land use and land cover change over the long haul starts with planning the present (2020 satellite symbolism) and afterward thinking back on schedule to plan the previous (1996 satellite symbolism) to survey for change recognition. The production of land use/land cover guides of the three local government (North, west, and municipal) that made up of Owerri region inside a timeframe from 2000 and 2020 was gotten from three multi-fleeting Landsat Upgraded Topical Mapper in addition to (ETM+) pictures with the guide of extra auxiliary vector information. The picture handling procedures utilized in this review were led utilizing Picture Examination Augmentation of the Bend GIS 10.2 programming.

3.1.1. Materials

The materials used to achieve the aim of the project includes: a) Satellite data: (Landsat 7 ETM+, Landsat 8 Operational Land Imager (OLI) / Thermal Infrared Sensor (TIRS), Shuttle Radar Topographic Mission (SRTM) Version 3 Digital Elevation Model Data) downloaded from earth explorer United States Geological Survey (USGS) website.

b) Software: Geographical Information System (GIS) and Remote Sensing (RS) analyzing and processing software; ESRI ArcGIS 10.8, ENVI 5.2, PCI Geomatica 2018, Rockworks 17, Microsoft Office Excel.

c) Computer Hardware: Hp ProBook core i7, Garmin Montana 680t handheld Global Positioning System (GPS), Printer.

d) ABEM Terameter SAS3000B, Two current electrodes, two potential electrodes, A power source (12 Volt car battery), Electrical cables, Hammer, Measuring tapes

3.1.2 Methodology

The study which focused on the application of geographical Information systems and remote sensing to evaluate the spatiotemporal dynamics of land-use/landcover of Owerri and environs to ascertain its implication to solid was management was achieved using the following methods:

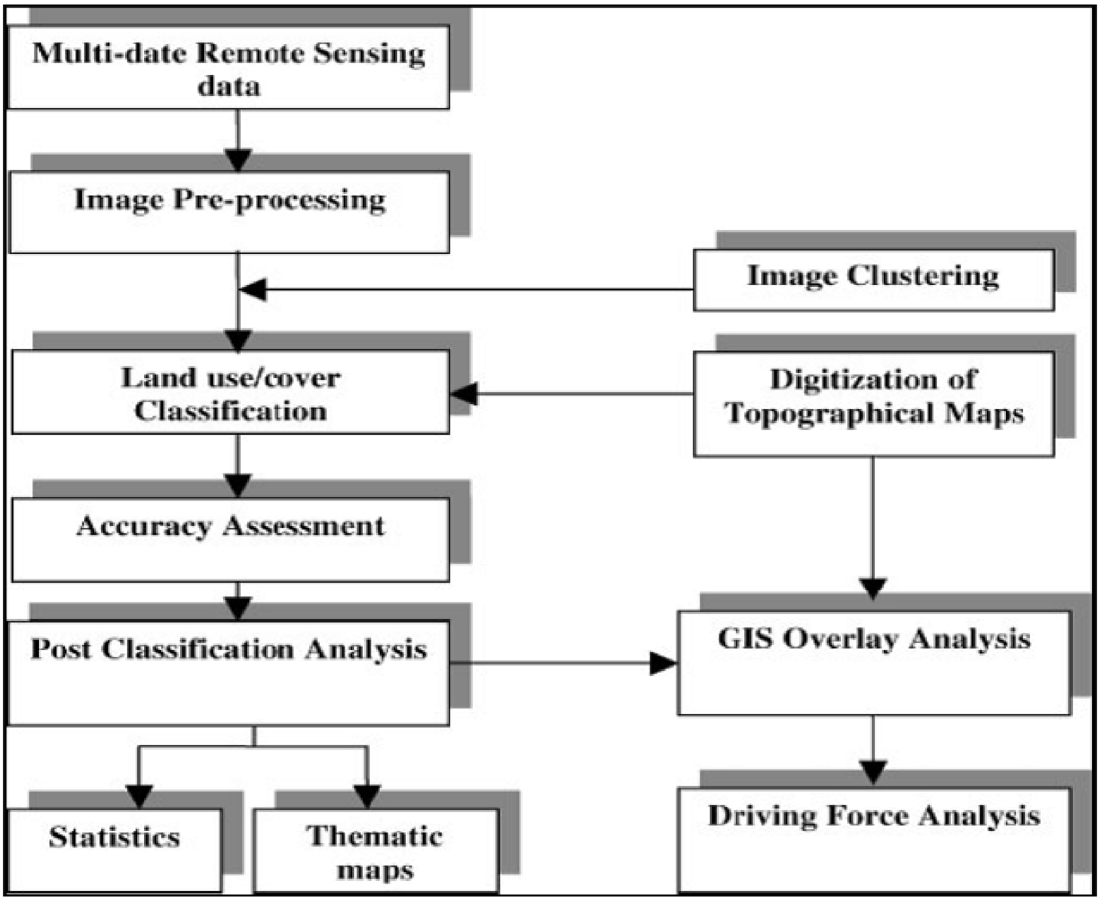

Fig: 2.1 flowcharts for the Analysis of LULC Dynamics (After Jensen, 1996)

3.2. Data Acquisition

3.2.1 Data Acquisition

For the study which evaluates the Spatio-temporal dynamics of land-use/landcover of Owerri, two satellite sensor data were used due to their different years of launching into space and the different dates of data acquisition. From the USGS earth explorer website, Landsat 7 EMT+ data acquisition date of upload to their website spans from the date 10/09/1999 to present while Landsat 8 OLI/TIRS data acquisition date of upload to their website spans from the date 10/04/2013 to present. The Landsat Scene path/row for the study area is 188/056. Landsat 7 ETM+ scene was downloaded for the year 2000, while Landsat_8 OLI/TIRS was downloaded for the year 2020. This twenty (20) years gap difference in the satellite data was used to study twenty (20) years Spatio-temporal Landuse/landcover changes in Owerri. Landsat 8 OLI/TIRS data was also used to extract the lineament map and lineament density map. The two Landsat datasets used for this study are cloud-free.

Also, Shuttle Radar Topographic Mission (SRTM) version 3 digital elevation model data was download from the United States Geological Survey (USGS) Earth Explorer website. This digital elevation data was used to create the topographical map and watershed/drainage map of Owerri.

3.2.2. GPS Ground Truth Data Acquisition

After the preparation and characterization of satellite symbolism started, a site visit to certain locales for check objects was finished utilizing Global Positioning System (GPS) hardware. Although there was no productive GIS information assortment framework utilizing the Worldwide Situating Framework, the region was ground-truthed through field surveillance planning. Ground-truth studies are fundamental parts for the assurance of precision evaluation for characterized satellite symbolism (Congalton, 1996). This study was acted to acquire exact locational point information for each land use and land cover class remembered for the characterization conspire just as for the production of preparing locales and for signature age as well as making a free informational index held for exactness appraisal. The land use/land cover classifications utilized in this review incorporates metropolitan regions, backwoods, rural land, desolate land, and water body.

The field overview was done in August 2020 during various observation trips. Before each field observation trip was made, mission pre-arranging was directed to guarantee fruitful information assortment. Explicit variables considered for information assortment incorporate the accompanying:

1. Geographic circulation - an endeavor to acquire point information uniformly all through the review region

2. Nearness courses - for movement coordination purposes

3. Thorough grouping - to guarantee point information was gathered for all land use classes utilized in this review

4. Security challenges presented by the unknown Gunmen region were also in the review region.

Each work was made during field information assortment to gather focuses inhomogeneous regions more prominent than 30 square meters to agree with the spatial goal of the TM symbolism. To represent transient contrasts between procurement of the Landsat symbolism bridge and the ground truth information study, point information was just gathered for regions that were unmistakably steady or unaltered. An aggregate of 324 information focuses was gotten from the field study from which 184 ground truth focuses were utilized for precision evaluation. The quantity of information focuses gathered was because of the trouble of finding homogeneous field destinations of somewhere around 30 square meters notwithstanding security challenges.

3.2.3. Image Pre-processing

Pre-preparing of satellite pictures preceding picture order and change identification is fundamental. Pre-handling ordinarily involves a progression of successive activities, including barometrical revision or standardization, picture enrollment, mathematical remedy, and concealing of provisions like mists, water, and other superfluous elements (Coppin and Bauer, 1996). The standardization of satellite symbolism considers the joined, quantifiable reflectances of the air, spray dissipating and retention, and the world's surface (Kim and Elman, 1990). It is the unpredictability of the environment that can present variety between the reflectance esteems or computerized numbers (Dn's) of satellite pictures procured at various occasions Albeit the impacts of the air upon distantly detected information are not viewed as mistakes, since they are essential for the sign got by the detecting gadget (Bernstein et al, 1983), thought of these impacts is significant. The objective appropriately expressed by Corridor et al (1991), ought to be that after picture preprocessing, all pictures ought to show up as though they were gained from a similar sensor. Mathematical amendment of the symbolism re-examples or changes the pixel framework to fit that of a guide projection or another reference picture. This turns out to be particularly significant when scene to scene correlations of individual pixels in applications, for example, change recognition are being looked for (ERDAS, 1999)

3.2.3.1 Data Pre-processing

The data used has already been pre-processed by the USGS agency. The following corrections were performed on Landsat 7 ETM+ collection 2 level 2 and Landsat 8 OLI/TIRS collection 2 level 2. The correction includes the following:

a. **Improved geometric accuracy:** This entails re-baselining the landsat8 OLI/TIRS ground control points (GCPs) to the European Space Agency Corpernicus Sentinel-2 Global Reference Image (GRI) improves the interoperability of the global Landsat archive spatially and temporally.
b. **Improved Digital Elevation Modeling:** The Shuttle Radar Topographic Mission (SRTM) collection 2 uses the 3-arc second digital elevation modeling (DEM).
c. **Improved Radiometric Calibration:** Collection 2 Landsat data such as Landsat 7 and Landsat 8 OLI includes several radiometric calibration improvements, including a correction for the thermal infrared sensors stripping effects.
d. **Global Level-2 Science and Atmospheric Auxiliary:** Collection 2 Landsat datasets is the processing and distribution of level 2 surface and surface temperature science products for Landsat 7 ETM+ and Landsat 8 OLI/TIRS.

3.2.4. Geometric Registration

To adjust the pixel frameworks and eliminate any mathematical twists in the Landsat symbolism, the Landsat symbolisms were enrolled to the UTM Zone 32N, WGS 1984 arrange framework, given ground control focuses. In particular, the TM picture of September 18, 2003, was enrolled to the UTM Zone 32N, WGS 1984 facilitate framework, in light of ground control focuses. Every one of the two 2020 scenes was enrolled in the august 6th, 2020 picture using comparative arrangements of ground control focuses (GCP's). GCP assortment, first request change, and closest neighbor re-testing of the uncorrected symbolism were performed. The first request change is otherwise called straight change which applies the standard direct condition ($y = mx + b$) to the X and Y directions of the GCPs. The closest neighbor resampling technique utilizes the worth of the nearest pixel to allocate to the yield pixel worth and consequently moves unique information esteems without averaging them as different strategies do, subsequently, the limits and nuances of the information esteems are not lost (ERDAS, 1999).

Enlisted vectors for the review region were overlaid upon the 2000 and 2020 uncorrected symbolism. Picture recognizable focuses were chosen and coordinated to vectors until a semi-customary framework of GCP's covered the whole scene. Those GCP's were then used to extend the uncorrected symbolism to a UTM arrange framework, Zone 32N, WGS 1984 for instance. Each GCP was requested by the remaining blunder it added to the polynomial fit. Focuses with high mistakes were disposed of before enlistment. Picture fit was considered satisfactory if the RMS blunder was < 15m or one-half pixel wide (RMS = 0.5). Generally speaking, RMS blunders of under 0.5 pixels were accomplished for every change. RMS blunder is the distance between the information (source) area of a GCP, and the resampled area of a similar GCP (ERDAS, 1999). Additional exploration by Dai and Khorram (1998) got after the pre-handling stage was finished, show that because of mis-enlistment, the precision of distantly detected change recognition can be generously corrupted. Aftereffects of their examination on Landsat TM information demonstrated that an enlistment exactness of short of what one-fifth of a pixel (0.2) is needed to accomplish a change location blunder of under 10%. The enrollment of all the four Landsat pictures utilized in this review didn't agree with such thorough control; notwithstanding, the four pictures fused in the change recognition process(2000 and 2020), were enlisted to an RMS mistake of under 0.5 pixels. This RMS blunder was considered satisfactory at the hour of enrollment.

3.2.5. Subset of Study Area

As a rule, the gained Landsat symbolism scenes are a lot bigger than the picked project concentrate on region. In this occurrence, it is useful to decrease the size of the picture document to incorporate just the space of revenue. This not just kills the unessential information in the document, yet it speeds up preparation because of the more modest measure of information to measure. This is significant while using multi-band information like Landsat ETM symbolism. This decrease of information is known as sub-setting. This interaction removes the favored review region from the picture scene into a more modest more reasonable document (ERDAS, 1999). This was done in the review region because the Landsat scenes were bigger than the picked space of study.

3.2.6. Image Classification

Inside the extent of this task, picture arrangement is characterized as the extraction of separated classes or topics of land use and land cover classifications, from crude distantly detected advanced satellite information (Gorham., 1999). For the motivations behind this undertaking, the terms land use and land cover have been joined as one element for the depiction of the scene inside the space of study. It ought to be noticed that while land use and land cover are perceived as discrete substances (Meyer, 1995), they have been joined in this review to adjust to the degree of subtleties utilized. Additionally, better degrees of request would no doubt have to utilize separate proportions of land use and land cover as well as to utilize more itemized levels of the arrangement plans.

A staggered, progressive land-use grouping was gotten from deduced information on the review region and is generally founded on Anderson level I arrangement (Anderson et al., 1976). For this review, five-level I classifications and eight-level II classifications create the progressive land use and land cover characterization utilized in this venture (Table 3). Level I and Level II land use and land cover classifications were extensively sorted intentionally to limit disarray between land cover classes that accomplished change throughout the time frame considered in this review.

Table 6: Land Use & Land Cover Classification Categories (Anderson et al, 1976)

Category No.	Level 1	Level II
1.	Metropolitan	Low Intensity Moderate Intensity High Intensity
2.	Agricultural Land	Cropland and Pastures Orchards, Grooves, etc.
3.	Forest Land	Deciduous Forestland Evergreen Forestland Mixed Forestland
4.	Water Body	Streams and Canal Lakes Reservoirs
5,	Barren Land	Dry Salt Flats Beaches Sandy Areas Other than Beaches Bared Exposed Rocks

The metropolitan level I class was gathered into three-level II classifications dependent on the aftereffect of an autonomous solo grouping and resulting conglomeration by a visual understanding of the crude ETM pictures. Metropolitan not really set in stone dependent on the splendor of every pixel group in metropolitan regions. All land cover classes comparative with water bodies in level II which incorporate streams and waterways, lakes, and supplies were converged into one level I classification given as water body. Level I forested grounds were just partitioned into three-level II classifications: deciduous, evergreen, and blended forestland. This depended on the GPS ground truth information gathered in the field.

3.2.7 Modification of Classification Techniques

Solo remote sensing characterization strategy was used in a multi-step approach for this task study. Still up in the air characterization approach for this review must be changed to some degree as starting order results were not considered good. The utilization of remote detecting methods in the planning of land use and land cover is acquiring worldwide acknowledgment. It has been taken on to broadly determine biophysical factors just as comprehend urbanization pattern, possible normal assets, and hydrological collections. For this exploration, land use and land cover items were gotten from the Unified State Geographical Review Landsat Upgrade Topical Mapper in addition to 2020 and from geological guides produced from a size of 1:50,000. These informational collections were exposed to ground-truthing utilizing field information. Every one of these datasets was brought under a similar co-ordinate framework in a GIS climate (Curve GIS 10.2) utilizing a Widespread Cross over Mercator (UTM) projection 32N.

Pre-handling of satellite pictures preceding picture order and change recognition is fundamental. Essentially, the standardization of satellite symbolism considers the consolidated, quantifiable reflectances of the climate, spray dispersing and assimilation, and the world's surface (Kim and Elman, 1990). The instability of the air can present varieties between the reflectance esteems or computerized numbers (Dn's) of satellite pictures procured at various occasions. Albeit, the impacts of the air upon distantly detected information are not considered as mistakes since they are essential for the sign got by the detecting gadget (Bernstein et al, 1983), thought of these impacts are anyway vital. The objective suitably expressed by Corridor et al (1991), ought to be that after picture pre-handling, all pictures ought to show up as though they were gained from a similar sensor. A mathematical correction of the symbolism resamples or changes the pixel lattice to fit that of a guide projection or another reference picture. This turns out to be particularly significant when scene-to-scene examinations of individual pixels in applications, for example, change location are being looked for (ERDAS, 1999).

3.2.7 Band Combination

Most earth perception satellites record different otherworldly groups. These groups can be joined with each other to empower more prominent perceivability for explicit land highlights. These mixes require an essential comprehension of the frequency of each band and the shading they reflect when they meet every particular component. This is because different land highlights show an assortment of shadings on the apparent range.This blend is routinely considered to create a bogus or composite tone. The vegetation here seems, by all accounts, to be in shades of red, while metropolitan settlements show up in the cyan blue tone. Soils shift from dull tans while coniferous trees show up in the shade of dim to light brown. By and large, the water body shows up in shades of blue.

3.2.8. Research Design

A research design is a programme to guide the researcher in collecting, analyzing, and interpreting observed facts (Messah and Kigige, 2011). The study was carried out through a case study design of Owerri. A case study design was considered as the research aimed at understanding the phenomenon in great depth (Skivington, 2012). In particular, Owerri was considered because it has not been able to meet the growing demand of its inhabitants. To achieve the set objectives, this case study drew on methodological best practices of previous work and adopting an integrated study that combines both quantitative and qualitative approaches. According to Zainal (2009, p.1), "by including both quantitative and qualitative data, a case study can assist in explaining both the process and outcome of a phenomenon through observation analysis of the subject under investigation."

In particular, the study utilized a combination of multispectral satellite remote sensing and descriptive survey is studying implications of land use and land cover dynamics on the environmental quality of Owerri. Primary satellite imagery was used to classify the land cover of the region supplemented by fieldwork to acquire first-hand data required for the research to improve mapping accuracies of land cover/ spatial changes. This approach has been quite significant in previous studies for instance; Mundia and Murayama (2009) used an integrated design while studying Land Use and Cover Changes and Animal Population Dynamics in a Wildlife Sanctuary in East Africa. Similarly, Codjoe (2007) employed an integrated research design while looking at Land Use and Land Cover Nexus in Ghana. An integrated study of this nature has potential scientific value particularly for land use and land dynamics-environment interaction (Codjoe,2007). In addition, an integrated design allows for complementary roles. Remotely sensed images can only show land cover change, but may not clearly show how land-use decision-making is reflected in images hence the importance of the descriptive survey. On the other hand, images offer a source of rich detail to aid in the interpretation of quantitative findings from the survey including the construction of validation/internal validity and interpretation of observed associations.

3.2.9. Vertical Electrical Soundings (VES)

Vertical electrical sounding furnishes facts concerning the vertical succession of various undertaking zones and their individual thicknesses and resistivity. For this reason, the technique is almost precious for investigations on horizontally or close to horizontal stratified earth. This technique is primarily based totally at the reality that the fraction of electrical current penetrating under any specific depth growing because the separation of current electrodes increases (Parasnis, 1972).

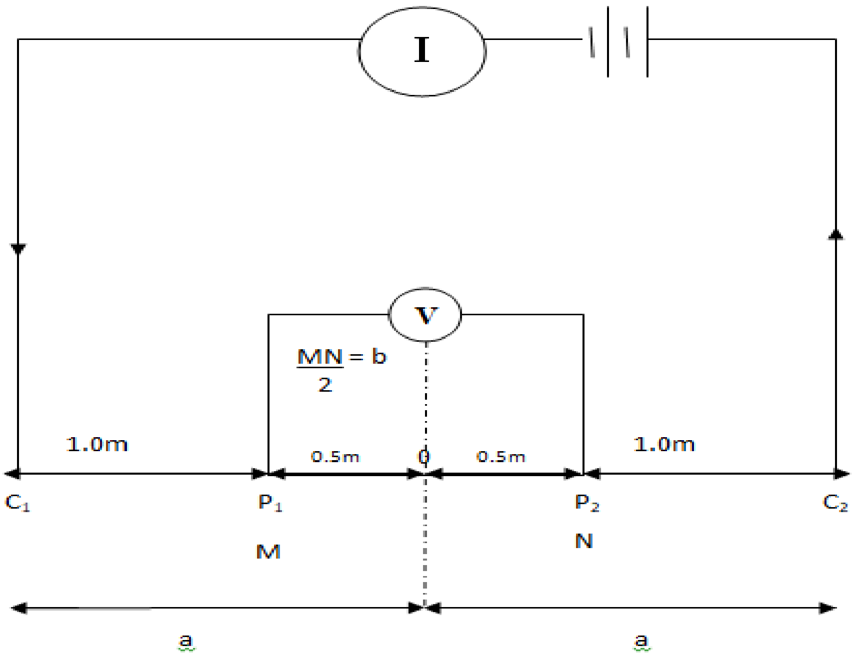

FIGURE 2.2: Diagram of Shlumberger array showing resistivity measurements

$$\rho_{a(s)} = \pi R\left(\frac{a^2}{b} - \frac{b}{4}\right) \quad (3.2.10$$

The Schlumberger approach with overall modern electrode of 100m, 200m and 300m have been employed. The electrode motion within the discipline is extraordinarily clean for the Schlumberger, as a result it's preference for the study. The presence of horizontal or lightly dipping Bed of various resistivities is quality detected through the increasing spread, as a result its use in detecting intensity of overburden, systems and resistivity of flat-mendacity sedimentary beds (Telford et al, 1967).

In the usage of both methods, the middle factor of the array is saved at a hard and fast locations, whilst the electrode places are various round it. The obvious resistivity values, and layer depths interpreted from them, are noted the middle factor. VES surveys with the Schlumberger array also are made with a hard and fast middle factor. And preliminary spacings (the space from the middle of the array to both of the modern electrodes) are chosen, and the modern electrodes are moved outward with the ability electrodes fixed. According to Van Nostrand and Cook (1966), mistakes in obvious resistivity are inside 2 to three percentage if the space among the ability electrodes does now no longer exceed 2s/5. Potential electrode spacing is, therefore, decided through the value ofs. Assis increased the sensitivity of the ability dimension decreases; therefore, at a few factor, ifs will become big enough, it'll be important to boom the ability electrode spacing.The ABEM SAS 4000 version includes a simple unit referred to as the Terameter SAS 4000. The Signal Averaging System (SAS) is a machine wherein collection of readings is taken automatically and the outcomes are averaged continuously. The instrument can perform in different modes. First, within the resistivity survey mode, it contains of a battery powered deep penetration resistivity meter with an output enough for a cutting-edge electrode separation of 1000meters below correct surveying conditions.

Secondly within the voltage measuring mode, the SAS 4000 contains of a self-capability device that measures herbal DC potentials. The end result is displayed in Volts (V) or millivolts (mV). The average variety extends from 0.01mV to500V. The transmitter, receiver and microprocessor- the 3 major devices of the Terameter SAS 4000 are all housed in a unmarried casing. The electrically insulated transmitter sends in well-described and controlled sign currents. The receiver discriminates noise and measures voltage correlated with transmitted sign cutting-edge and additionally measures uncorrelated DC capability with the identical discrimination and noise rejection. The microprocessor video display units and controls operation and calculates the very last resistivity end result of interest. The device allows herbal or caused sign to be measured at extraordinarily low degrees with exceptional penetration and coffee strength consumption.

Moreover, it may be utilized in a huge kind of software in which powerful sign/noise discrimination is needed. The approach begin via way of means of pegging the potential electrode to the floor of 1m apart, referred to as P1 P2, after which observed via way of means of dividing the space into of 0.5m from the middle. At the middle role the terrameter and hook the measuring tape from the middle you're taking size of 1.5m apart, to a brand new point referred to as C1 C2 ie the cutting-edge electrode role. Once the cable of P1 P2 and C1 C2 is hook to the Terrameter, you at the device to have reading. This you do at distance of 2.5m, three.5m, 4.5m, 6.0m, 8.0m, 10.5m, 14.0m, at 14.0m you change the position of P1P2 to 3.5m. then you definitely continue from 18.0m, 24.0m, 32.0m, 42.0m, 55.0m. at 55m you change P1 P2 to 14.0m and retain 75.0m, 95.0m, 125.0m, 160.0m, 200.0m at 200.0m you convert the P1 P2 to 50m and retain 200.0m, 250.0m, 300.0m, 350.0m, 400.0m, 450.0m, 500.0m etc. in each the depth of penetration is1/3 of AB. Say 1/3 x 300/1 = 100

The procedure worried in measuring the electrode spacing distances, pegging the points, coupling the equipment, planting the electrodes and connecting the cables and plugs to the reels for current and voltage readings. The Schlumberger electrode array changed into hired with the maximum half present day electrode spacing of AB=500-600m: and MN=60m had been made: and most intensity penetrations various among 82.2 and 115.3m had been attained. The gather facts are annexed as: The axes of all of the Geo-electric powered soundings had been aligned parallel to the geological strike in an effort to lessen the consequences of lateral versions. The middle factor of the electrode array stays constant however the spacing of the electrodes changed into accelerated in an effort to attain in-formation approximately the stratification of the ground.

The Schlumberger, facts are mainly taken in overlapping segments due to the fact at every step of AB spacing, the alerts of the resistivity meter end up weaker. Therefore, MN spacing changed into enlarged and values for the identical AB/2 had been measured, one for the fast and one for the lengthy MN spacing. The Schlumberger configuration changed into hired now no longer handiest due to the fact it's miles quicker and much less likely to be encouraged through lateral versions however additionally as it calls for a decrease wide variety of operators. Because of good sized dense forestation and swampy terrain, soundings had been finished alongside current foot paths or roads.

CHAPTER FOUR

RESULT PRESENTATION, INTERPRETATION, AND DISCUSSION

4.1. Result presentation

The Landsat images of the study area were carefully prepared and improved to deliver single band pictures, band proportions, shading composites, and ordered pictures supplemented by digitized geologic guides for the review region. Waste examples and surfaces, uncovered shakes, and vegetated regions were upgraded in single-band pictures while auxiliary elements like iron staining (Gossan) and dirt-rich dregs were recognized in picture proportions.

4.1.1. Digital Elevation Model of the study area

The SRTM information was used in the creation of the computerized height model (DEM), which is significant in the ID of surface elements. The shading composites were utilized as foundation information for both administered and unaided picture characterization. Data removed from these picture handling schedules were at long last coordinated into a geographic data framework (GIS) to produce a Land use/Land cover guide of the review region.

The topography of the area was extracted from Shuttle Radar Topographic Mission (SRTM) digital elevation model (DEM). SRTM scene that covered the area was downloaded from the USGS earth explorer website. The raster data was imported into ArcMap 10.8. The DEM for the study area extent was clipped by using the extraction by mask tool from spatial analyst tools of ArcToolbox extension. The spatial analyst tool of ArcToolbox in ArcMap 10.8 was used to generate contours for the clipped DEM of Owerri. The contours were labeled and symbolized. Other created feature classes shapefiles generated for the location map were imported and were overlain on the generated contour. The map was embellished and exported in JPEG format. Figure 3 above the topographical map of Owerri.

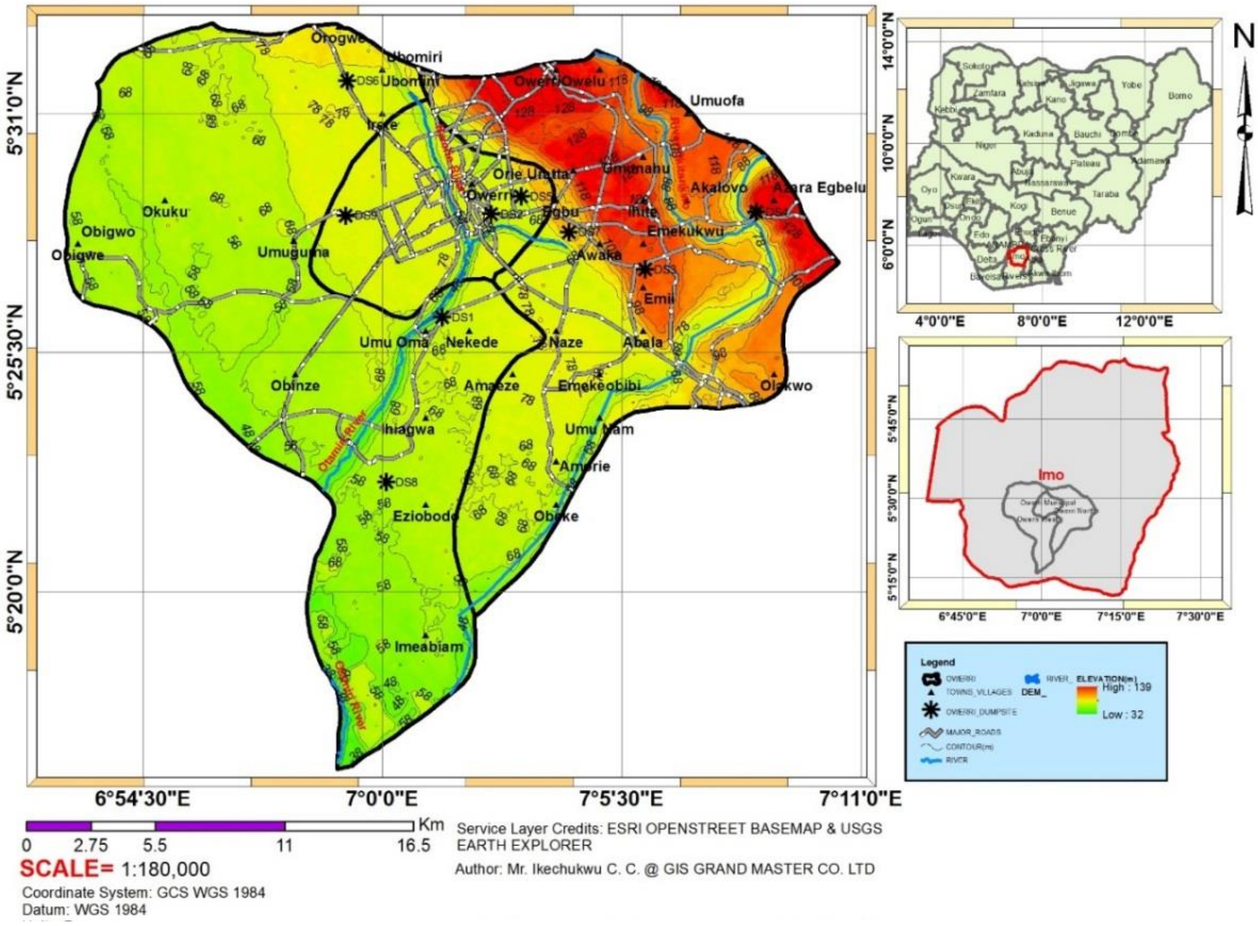

Figure 3: Topographical Map of Owerri (study area)

4.1.2 Watershed/Drainage Model Map of Owerri

Watershed model map which shows the direction and flows path of surface run-off during and after rainfall was created for the study area using void-filled SRTM raster data. In ArcMap 10.8, the model builder was used to design, verify and execute the model. The input data for the watershed model was the clipped SRTM raster data. The flow chart as shown in fig.4.2 below show the model used to create the watershed model of Owerri.

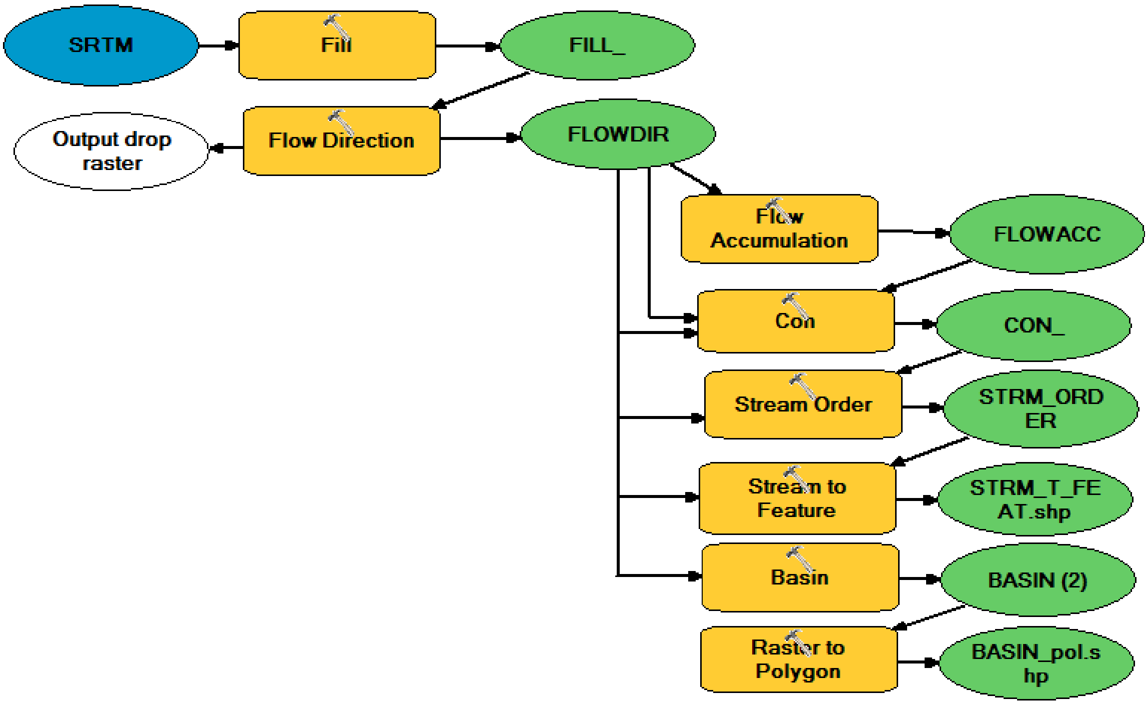

Figure 4: Watershed Flow Chart in ArcMap Model Builder

From the flowchart, the oval blue colour-filled shape represents the input data, the curved yellow rectangular shape with a hammer on it represents the hydrology tools, a spatial analyst tools of ArcToolbox, while the green oval shape represents the results from each processing by the hydrology tools. The clipped SRTM for Owerri is the input data. The fill tool was used to perform a fill operation on the DEM to remove any error due to peak and sink in the DEM. The output fill was used as input data into the flow direction tool. The flow direction processed the filled DEM and generated the flow direction for surface runoff. The flow accumulation tools were used to determine the direction of flow from every cell in the raster by using a deterministic 8 (D8) algorithm to show the flow direction. The flow accumulation tool was used to calculate the accumulated weight of all cells into each downward slope cell in the output raster. Flow direction is the input data used to calculate the flow accumulation.The conditional statement was performed on the flow accumulation using the Con hydrology tool. Con performs a conditional if/else evaluation on each of the input cells of an input raster. Con is used to evaluate the output flow accumulation by using a conditional if/else statement to query the flow accumulation raster data. The input data used by the Con hydrology tool are: flow accumulation, flow direction constant value true, and flow direction constant value false.

The stream order tool was used to assign a numerical order to segments of a raster representing branches of a linear network. The stream order utilizes both flow direction and output con raster as input data to generate the stream order of surface drainage order. The stream-to-feature tools were used to convert a raster representing a linear network to features representing the linear network. The algorithm used by the stream-to-feature tool is designed primarily for the vectorization of the stream network. The two input data are operated on by the stream to feature hydrologic tool flow direction and stream order output. The basins/drainage divide for the study extent was extracted by using the Basin hydrologic tool. The input data operated on by the basin tool is the flow direction. The basin creates a raster delineating all the drainage basins in the study area. The drainage basins are delineated within the analysis window by identifying ridgelines between basins. The created drainage basins raster data was converted to a vector polygon feature by raster to polygon conversion tool. A threshold of **(grid codes <>1 and grid codes <>2 and grid codes <>3)** was set to cut-off minor drainage networks for the polyline river network (stream to feature output data in the query builder of the stream to feature layer. The resultant watershed/drainage map from this model flow chart is seen in figure 3.4 below. The watershed map of Owerri shows the drainage pattern of the area during and after rainfall. From the overlay of the drainage network to satellite imagery, the model fits and conforms with the natural drainage river systems. The course/flow direction of the river (Otamiri, Nworie, Okitankwo, and Oramiriukwa river) seen on the location map conforms to the drainage network and this implies the model is correct. In theory and practice, the model used the surface elevation above sea level as contained in the SRTM DEM raster data to delineate the watershed of the study area.

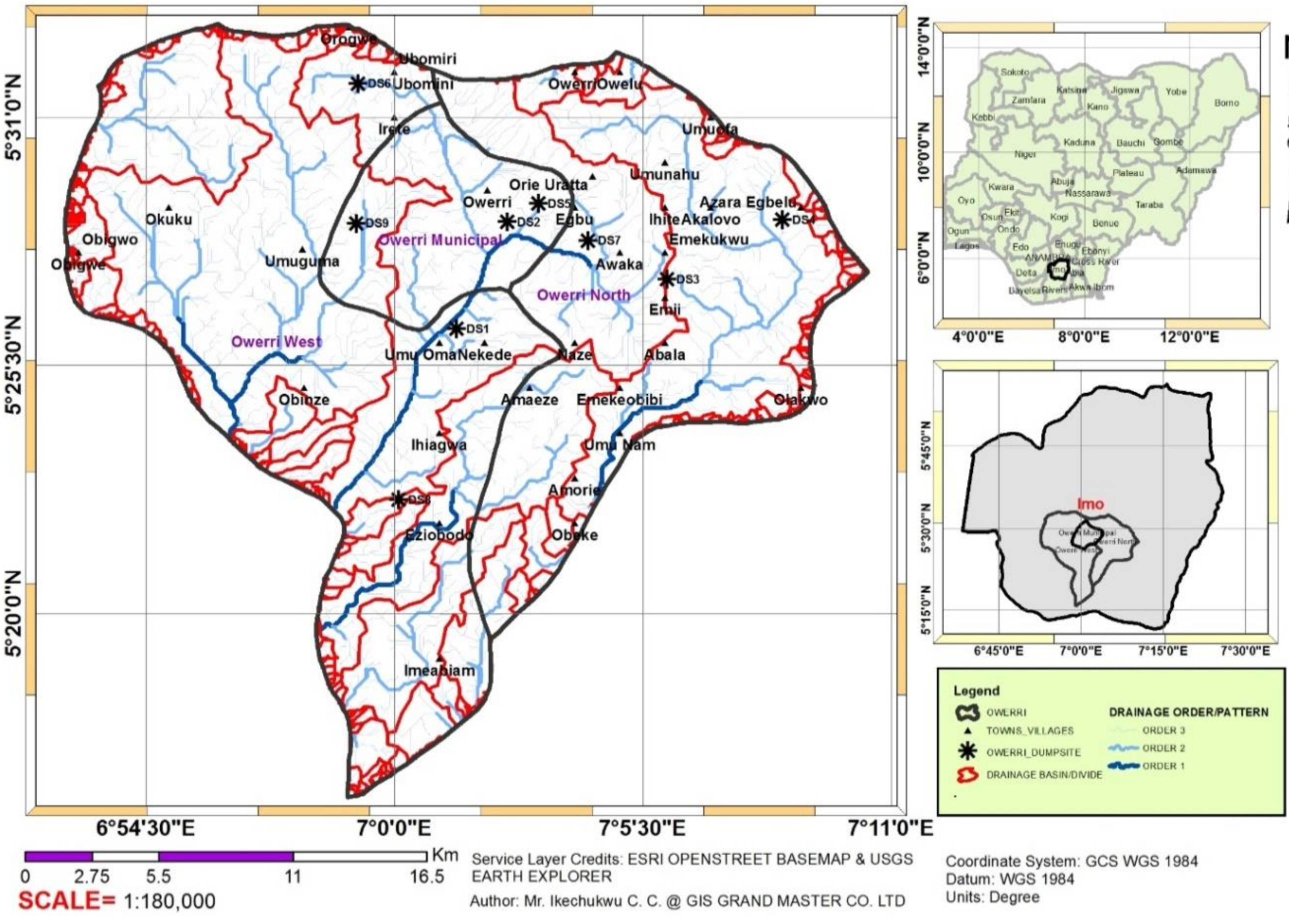

Figure 5: Watershed/Drainage Map of Owerri

4.1.3 Lineament / Lineament Density Map of the Owerri

Lineament is a linear feature in a landscape that is an expression of an underlying geological structure such as faults, fractures, joints e.t.c. The lineament density is the expression of the total length of all the recorded lineaments divided by the area under consideration (Edet et al., 1998). The lineament map for the study area was extracted from multispectral Landsat 8 OLI/TIRS satellite imagery. The Multispectral band of Landsat 8 OLI/TIRS was imported into ENVI 5.3.The multispectral band was enhanced by performing Gram-Schmidt spectral sharpened surface reflectance on it. The multispectral sharpened data was transformed by using forward PC rotation and the statistics & rotation was computed which gave out the Eigene values curve of the multispectral band. Principal Component Analysis (PCA) was generated for the multispectral band. Principal Component 1 (PC1) from the PCA bands was loaded and exported as a Tagged image file (.tif) format. PCI Geomatica 2018 was used to perform an automatic lineament extraction. Here the PC1 was used as the input data. The lineament extraction algorithm was invoked to extract lineament from the PC1 band. The extracted lineament was exported as an ESRI Shapefile and imported into ArcMap 10.8 for handling extracted lineament.

In ArcMap, the compound lines that are the constituent make-up of a lineament were split into simple lines. The resultant simple lineament attributes were edited to calculate the coordinates of the start and end of all the lineaments. The lineament density of the simple lineament was calculated. The edited simple lineament was exported as an AutoCAD .dxf file. The exported simple lineaments .dxf file was imported into Rockworks 17, where the datum, coordinate system, and projection were defined. The trend analysis of the lineament was calculated and a rose diagram was generated showing the trend of the lineament. The lineament map, the lineament density map, the statistics of the lineaments trends, and the rose diagram generated for Owerri is shown in fig. 6, fig. 7, table 4, and fig. 8 below.

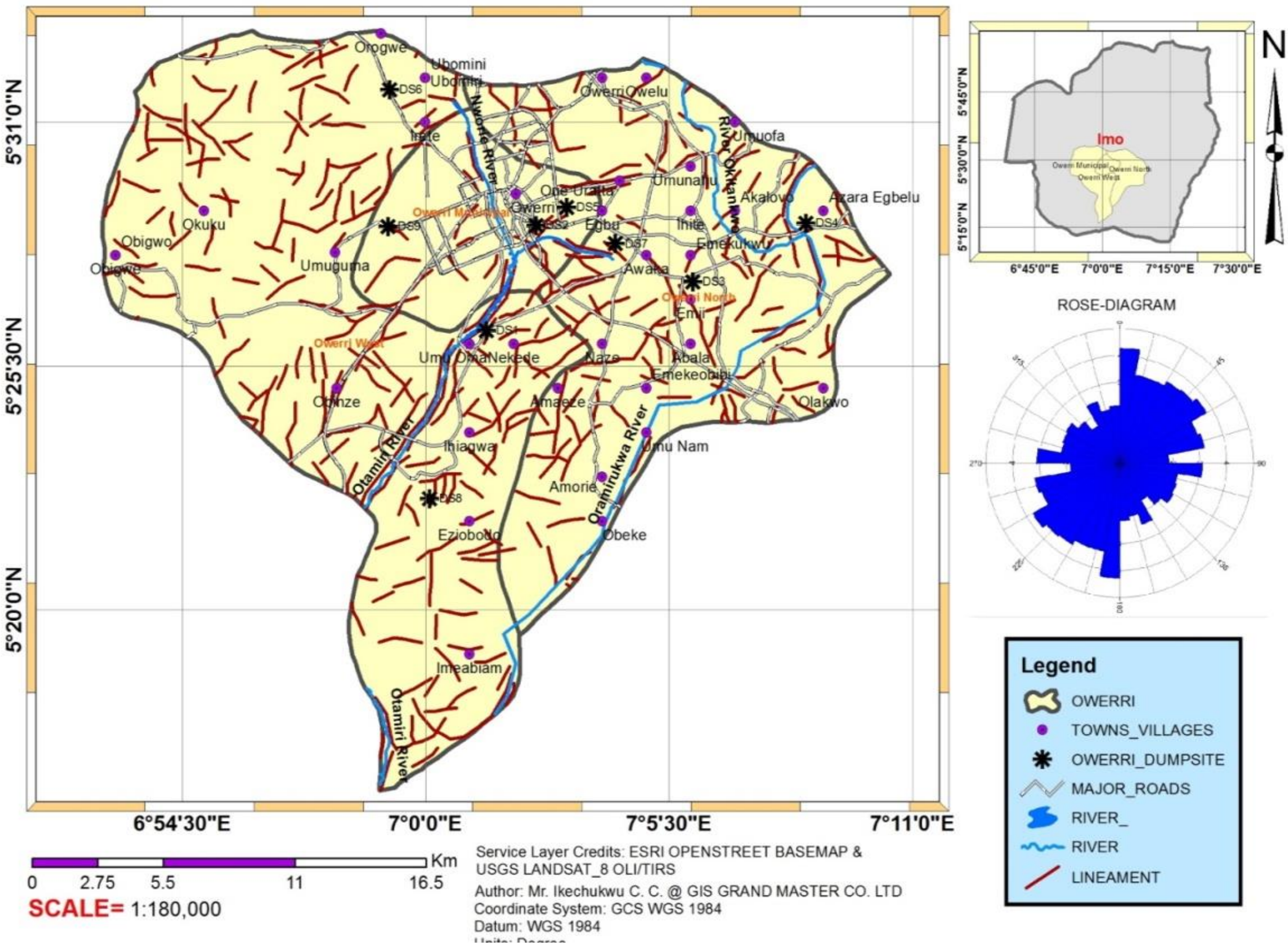

Figure 6: Lineament Map of Owerri

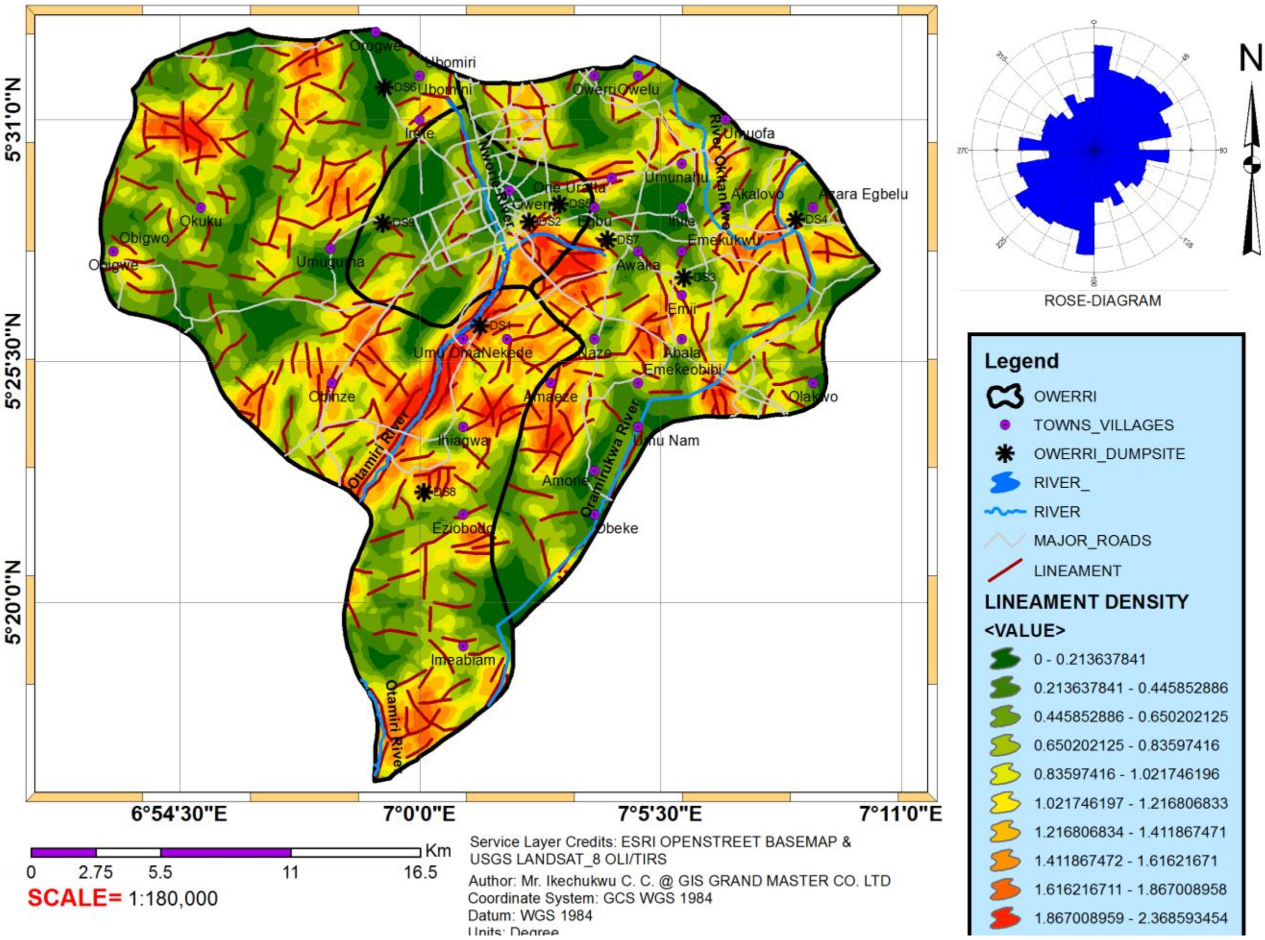

Figure 7: Lineament Density Map of Owerri

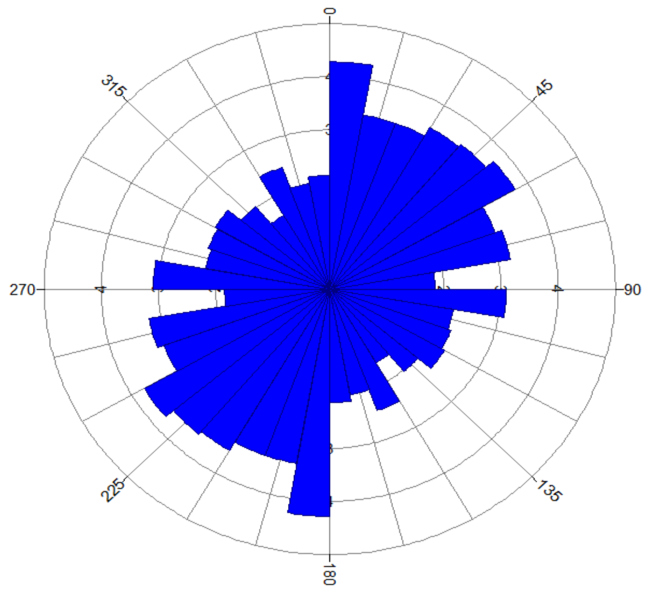

Figure 8: Lineament Rose Diagram of Owerri

Table 4: Statistical Summary of the Lineament Rose Diagram

Rose Diagram

Statistical Summary	
Calculation Method:	Frequency
Class Interval:	10.0 Degrees
Min.Length Filtering:	Deactivated
Max.Length Filtering:	Deactivated
Azimuth Filtering:	Deactivated
Data Type:	Bidirectional
Population:	841
Total Length of All Lineations:	900,148.4
Maximum Bin Population:	72.0
Mean Bin Population:	46.72
Standard Deviation of Bin Population:	12.76
Maximum Bin Population (%):	4.28
Mean Bin Population (%):	2.78
Standard Deviation of Bin Population (%):	0.76
Maximum Bin Length:	38,091.76
Mean Bin Length:	25,004.12
Standard Deviation of Bin Lengths:	7,575.14
Maximum Bin Length (%):	4.23
Mean Bin Length (%):	2.78
Standard Deviation of Bin Lengths (%):	0.84
Vector Mean:	42.6 Degrees
	222.62 Degrees
Confidence Interval:	10.4 Degrees
	(80 Percent)
R-mag:	0.17

4.1.4 Band Combination and Band Composition Map of Owerri.

Band combination is the act of combining and arranging three (3) bands out of the first 8 bands for Landsat 8 OLI/TIRS or out of the 7 bands for Landsat 7 ETM+ to extract unique and new information from the imagery. This is the case of extracting spectral signatures of objects in imagery. The study aim which is to evaluate the Spatio-temporal changes of 20 years gap of Owerri, used the Landsat 7 ETM+ for the year 2000 and Landsat 8 OLI/TIRS satellite data to study the changes that have occurred over time. Several band combinations include natural colour, false colour, colour infrared, and various normalized difference indexes which include: Normalized Difference Vegetation Index(NDVI), Normalized Difference Built-up Index (NDBI), Normalized Difference Water Index (NDWI) was computed in ArcMap 10.8 using the raster calculator. This evaluation was performed for the year 2000 and the year 2020 to study the

Spatio-temporal changes over time. The table below shows the band combination performed in ArcMap using both landsat7 ETM+ and Landsat8 OLI/TIRS.

Table 5: Band Combination according to Bhatta 2011, Y. Zha et al. 2003, Crippen 1990, Gao 1996, Chunyang et al. 2010, Xu 2005, Xu 2007, Zhao et al 2005, Hansen et al. 2012.

Renderer	**Landsat 7 ETM+**	**Landsat 8 OLI/TIRS**
Natural Colour	Band(3,2,1)	Band(4,3,2)
False Colour	Band(4,3,2)	Band(5,4,3)
NDVI	(Band4 – Band 3) / (Band 4 + Band 3)	(Band5-Band4)/(Band5 + Band4)
NDBI	(Band 5 – Band 4)/(Band5 + Band 4)	(Band 6 – Band 5) / (Band 6 + Band 5)
NDWI	(Band 2 – Band 5) / (Band 2 – Band 5)	(Band 3 – Band 6) / (Band 3 + Band 6)

The resultant composite map and the normalized difference map were generated using this band combination as seen from table 5. Above for the two Landsat sensors representing the composite band and normalized difference indexes for the two different years.

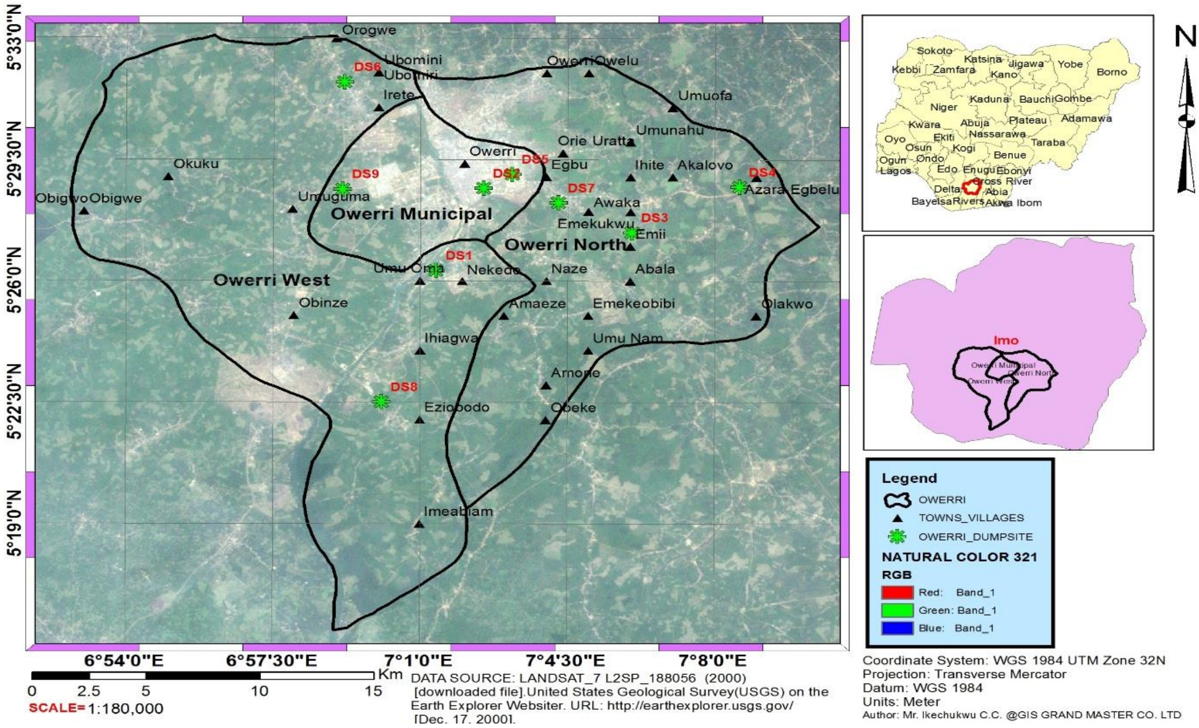

Figure 9: Natural Colour Composite Map of Owerri (2000)

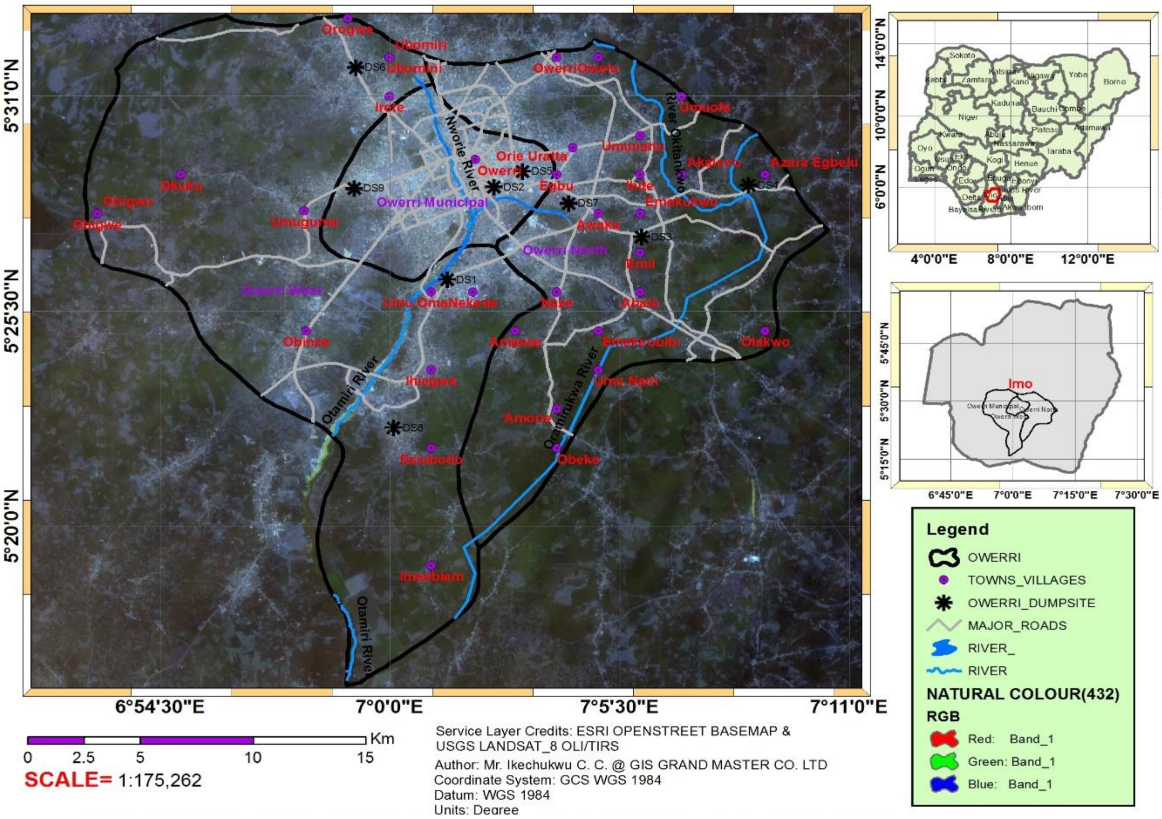

Figure 10: Natural Colour Composite Map of Owerri (2020)

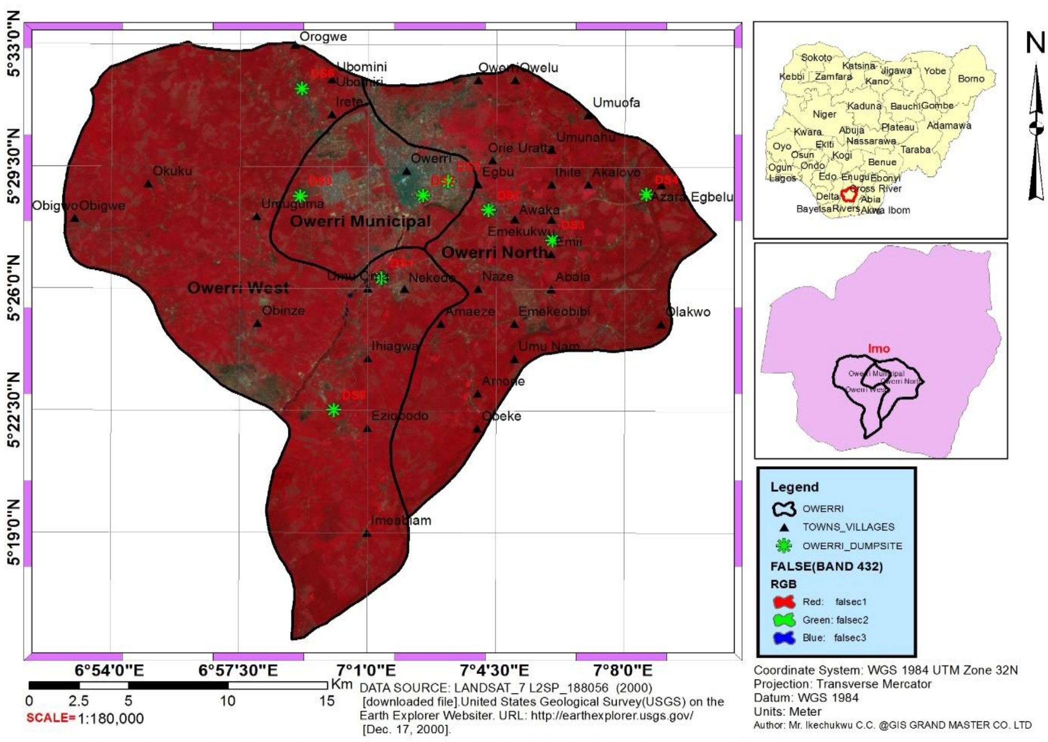

Figure 11: False Colour Composite Map of Owerri (2000)

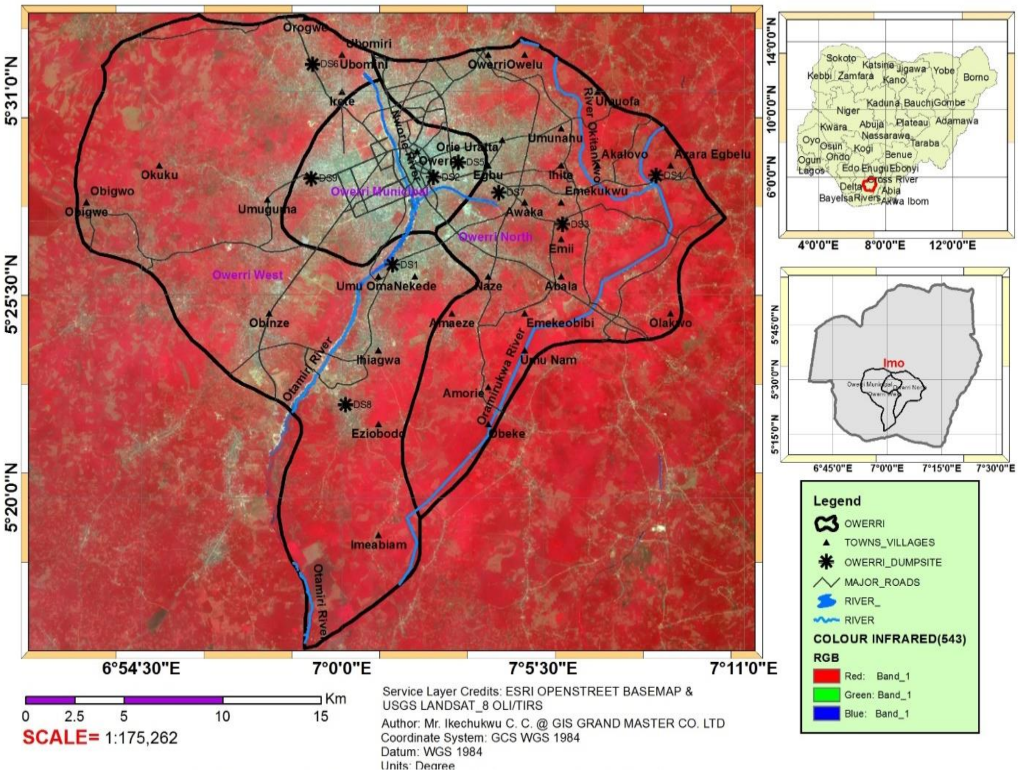

Figure 12: False Colour Composite Map of Owerri (2020)

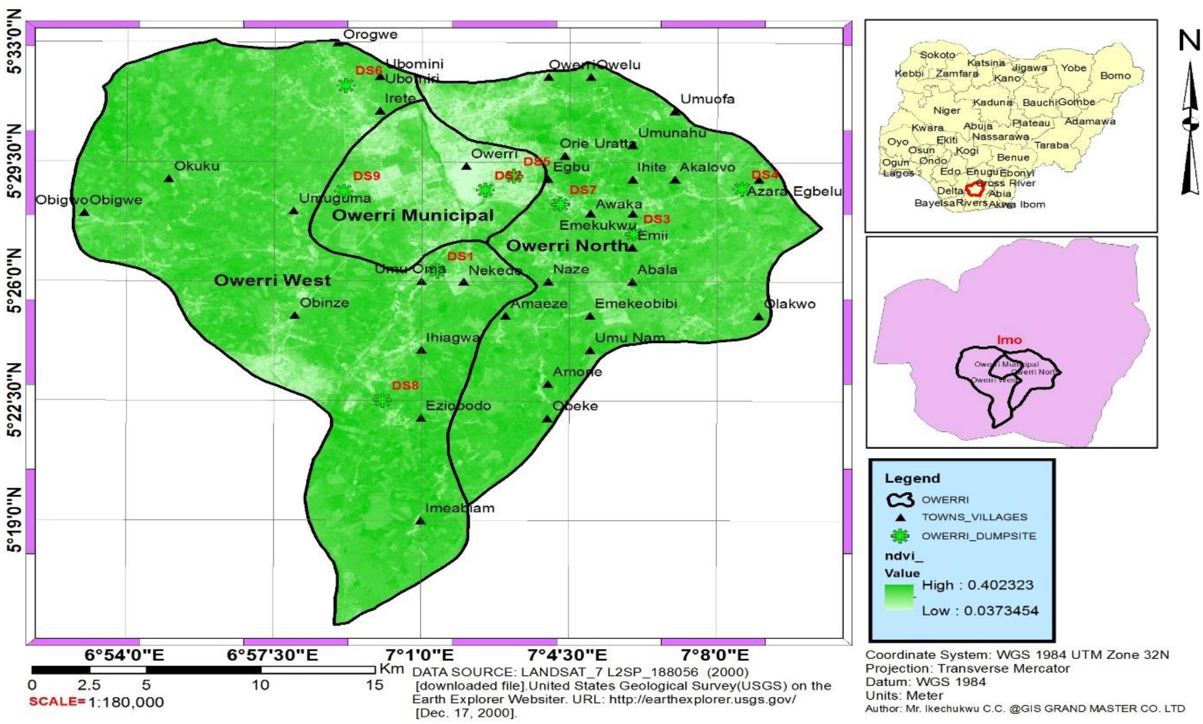

Figure 13: NDVI Map of Owerri (2000)

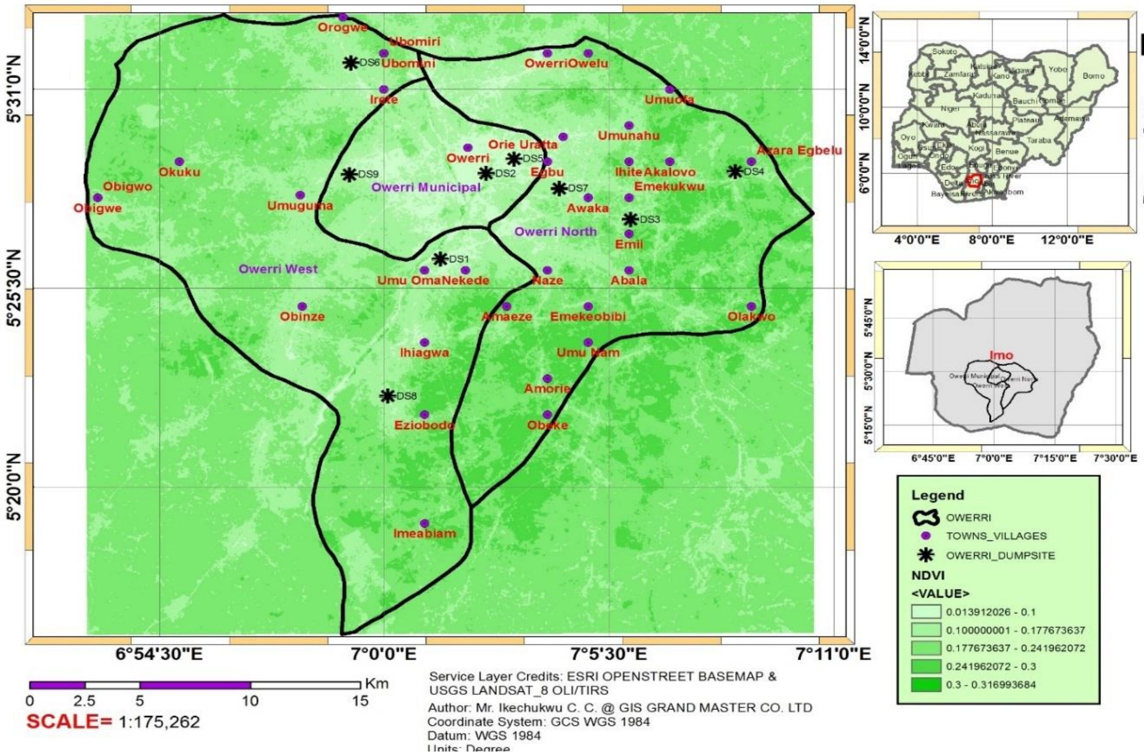

Figure 14: NDVI Map of Owerri (2020)

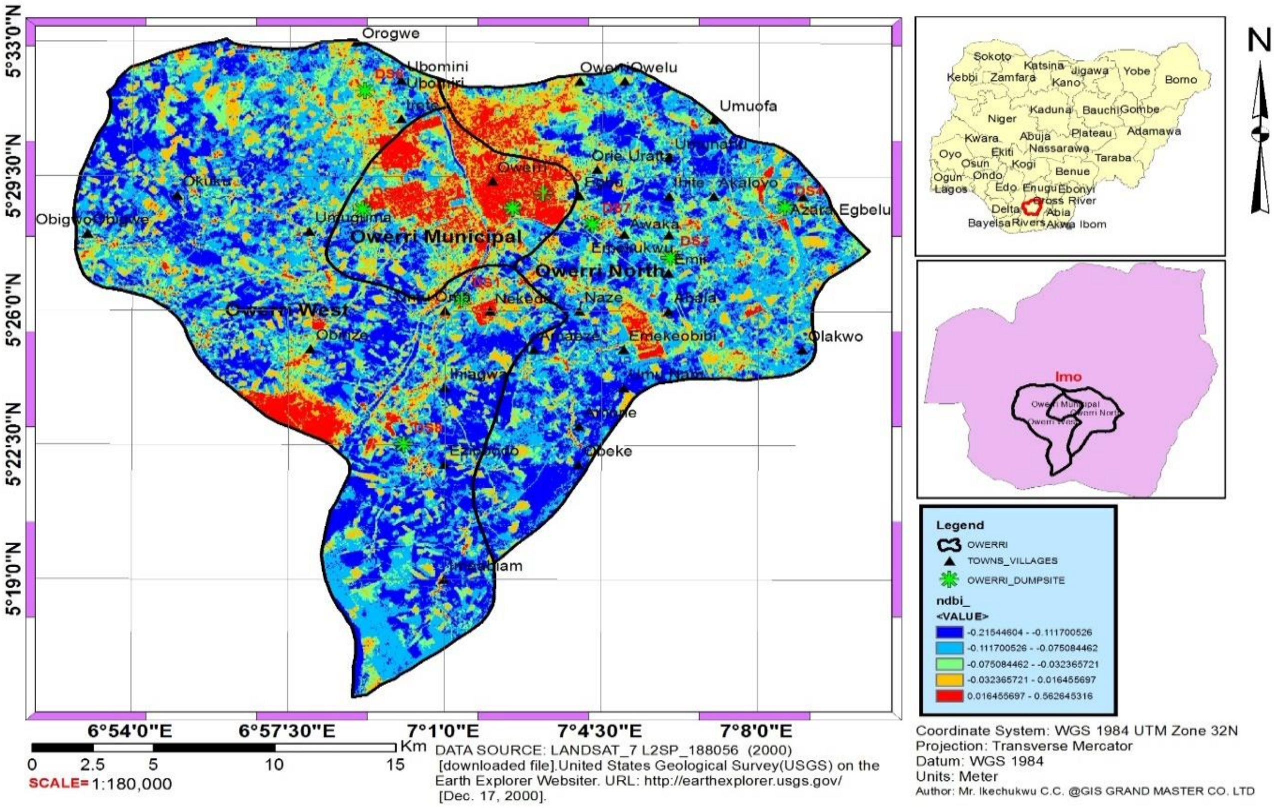

Figure 15: NDBI Map of Owerri (2000)

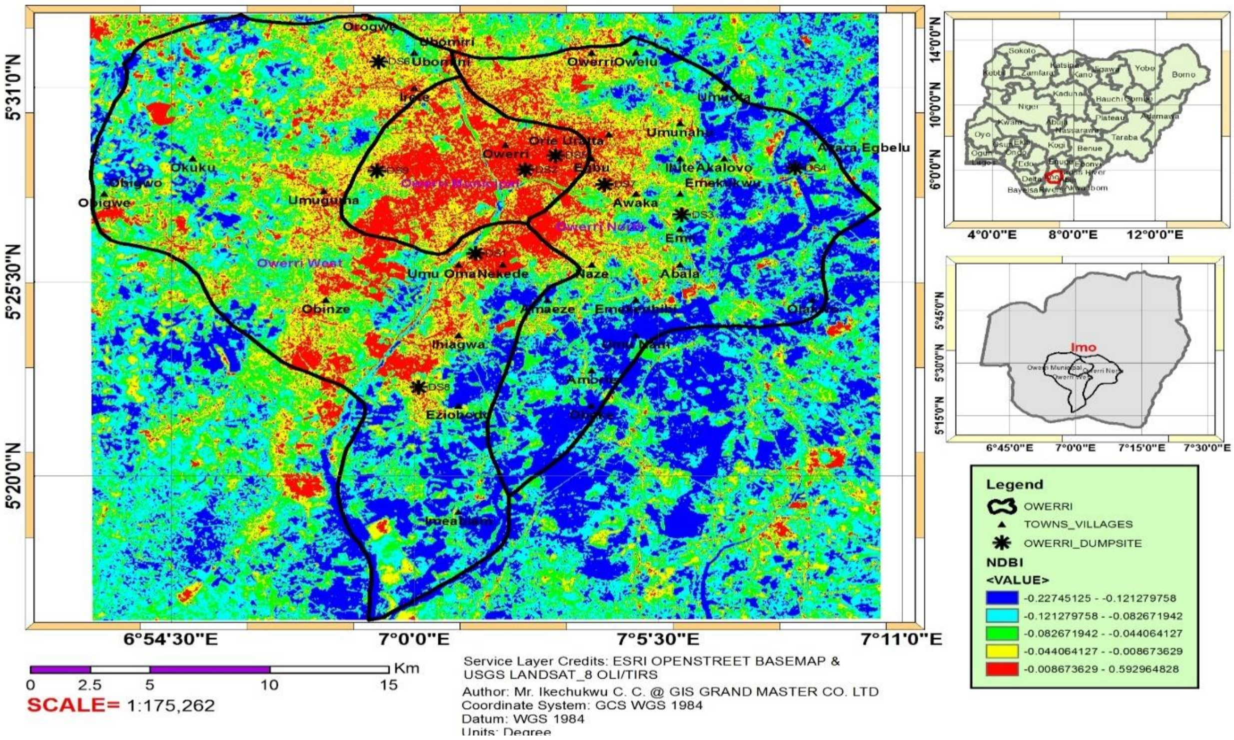

Figure 16: NDBI Map of Owerri (2020)

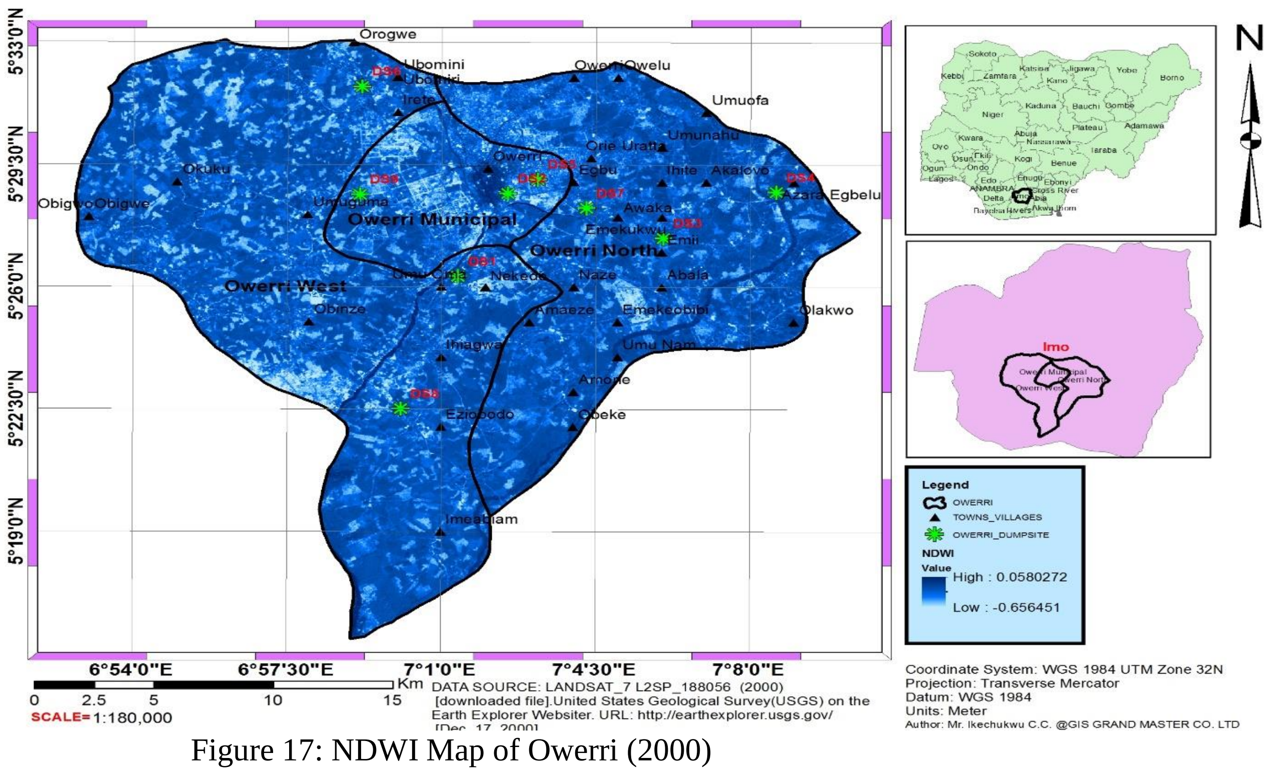

Figure 17: NDWI Map of Owerri (2000)

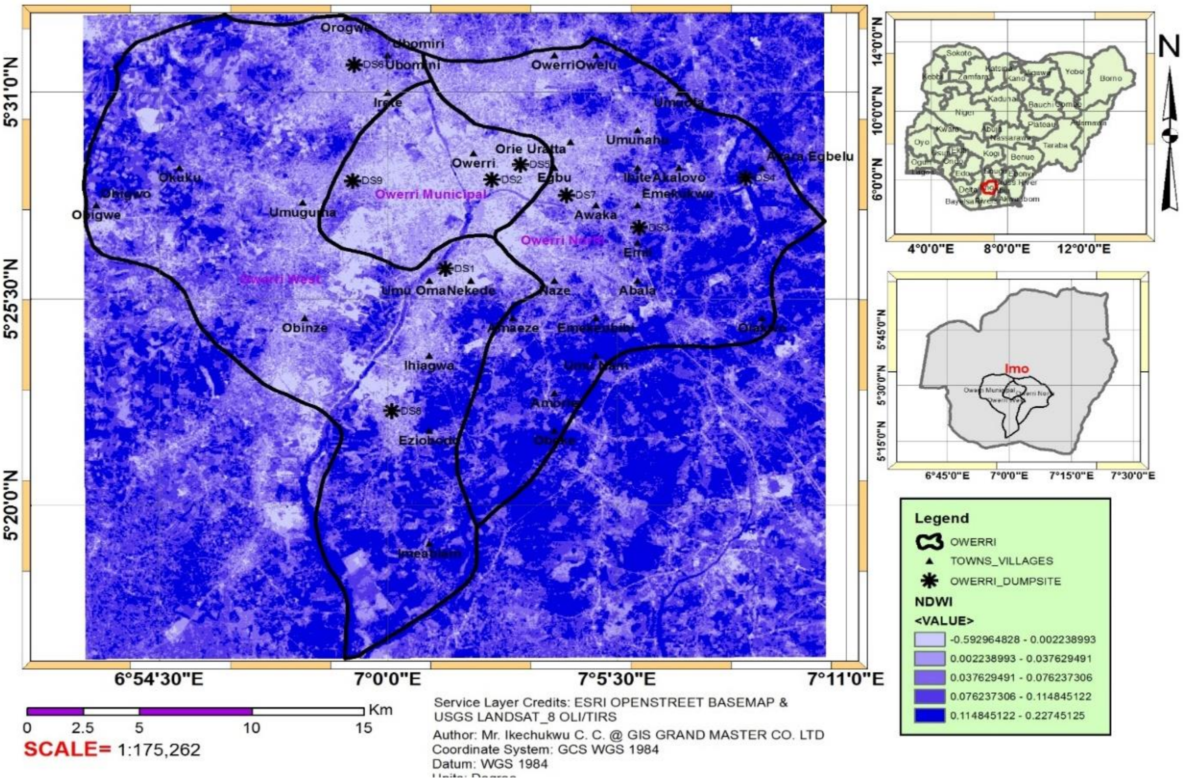

Figure 18: NDWI Map of Owerri (2020)

The natural colour composite replicates close to what our human eye can see. While healthy vegetation is in green, unhealthy flora is grown. Urban features appear white and grey and water is dark blue or black.The false colour is also known as the colour infrared or the near-infrared composite band. Because chlorophyll reflects near-infrared light, this band composite is useful for analyzing vegetation. In particular, areas in red have better vegetation health. Dark areas are water and urban areas are white.

The Normalized Difference Vegetation Index (NDVI) shows the vegetation index using a green colour ramp. The higher/greener the area, the more dense vegetation in that location while the lower/whiter the area, the lesser the vegetation in the area. A highly built-up area in the NDVI map is represented with very white colour. The Normalized Difference Built-Up Index map shows the areas that are highly built-up in red and orange colour, sparse vegetation in yellow and light green colour and dense vegetation in deep blue colour, and water body in cyan colour. The Normalized Difference Water Index map shows the index of water presence on the land. A deep blue colour ramp represents a very high presence of water while a light / white colour ramp indicates built-up regions.

4.1.5 Landuse/Landcover (LULC) Map of Owerri.

Landuse simply refers to the purpose of the land serves while land cover refers to the surface cover on the ground whether vegetation, urban infrastructure, water, bare soil, or others. The LULC mapping was performed on both Landsat 7 ETM+ and Landsat 8 OLI/TIRS imagery to ascertain the change detection that has occurred for the past twenty (20) years. Unsupervised Image classification by iso-cluster was first performed in ArcMap 10.8. This Unsupervised image classification used an automated algorithm to classify the imagery using various colour variations to group features with similar pixel numbers into one class. By making a visual inspection and comparison of the resultant unsupervised classification and the various band combination generated, training samples were created to perform a supervised classification by maximum likelihood cluster.

The supervised classification reduced the errors made by unsupervised classification and categorized the LULC classes into five classes: Bare soil, Built-up regions, waterbody, marshland, Vegetation. The resultant LULC map of Owerri is shown in fig.19 and fig. 20 below. Table 6 below shows the change detection observed for LULC classes of the year 2000 and year 2020 as seen in the difference in the LULC classes areas in square kilometers. The changes indicate rapid infrastructural development over the past 20years.

Table 6: LULC Classes Statistical Data

LULC Classes	**2000 LULC Area (sq. km)**	**2020 LULC Area (sq. km)**	**Difference (Remarks)**
1. Water Body	2.012609	2.743819	0.73121(increase)
2. Wet/MarshLand	44.720248	52.613083	7.892835(increase)
3. Bare Soil	173.305713	177.426776	4.121063 (increase)
4. Vegetation	264.435471	171.361	93.074471(decrease)

Table 7: LU and LC Classes in 2000

S/N	LAND LU/LC CLASSES	Area in km^2	Percentage %
1	VEGETATION	264.435471	48
2	BARE SOIL	173.30571	31
3	BUILT-UP REGIONS	66.28495	12
4	WET/ MARSHLAND	44.720248	8
5	WATERBODY	2.012609	1
	TOTAL AREA	550.758988	100

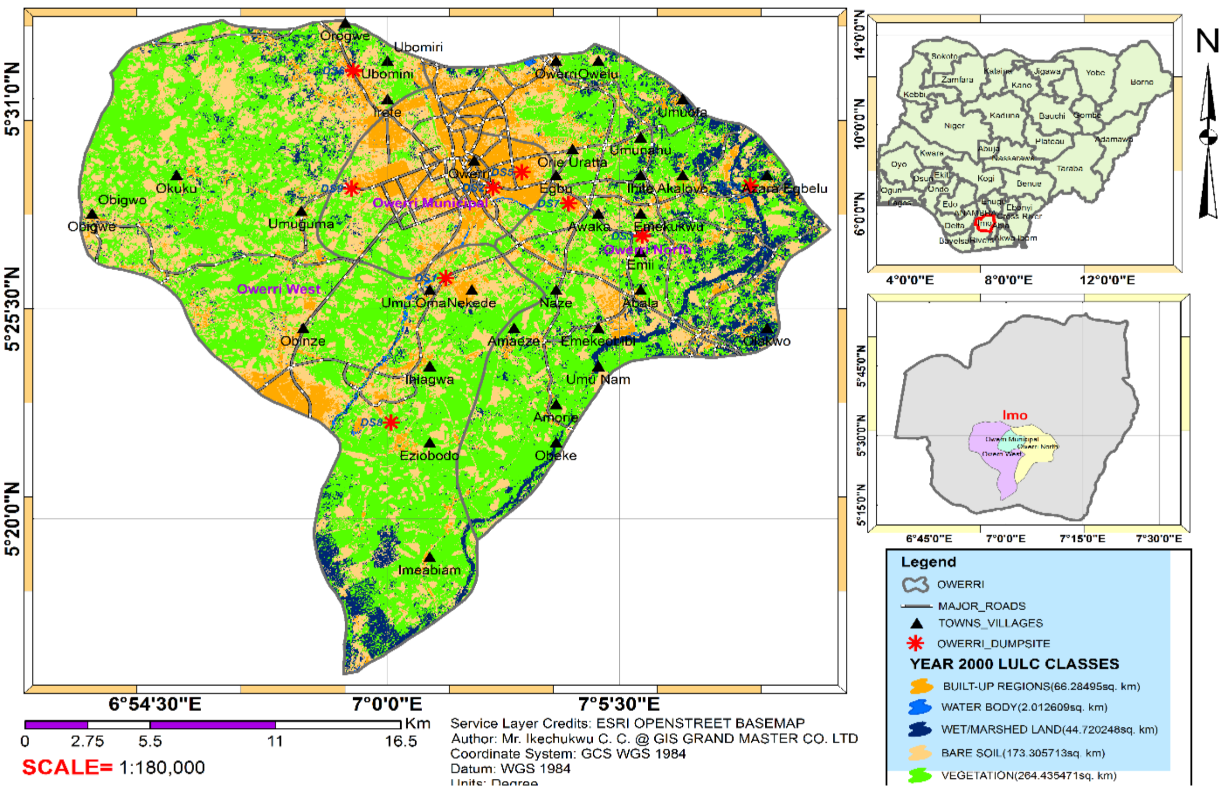

Figure 19: LULC Map of Owerri (2000)

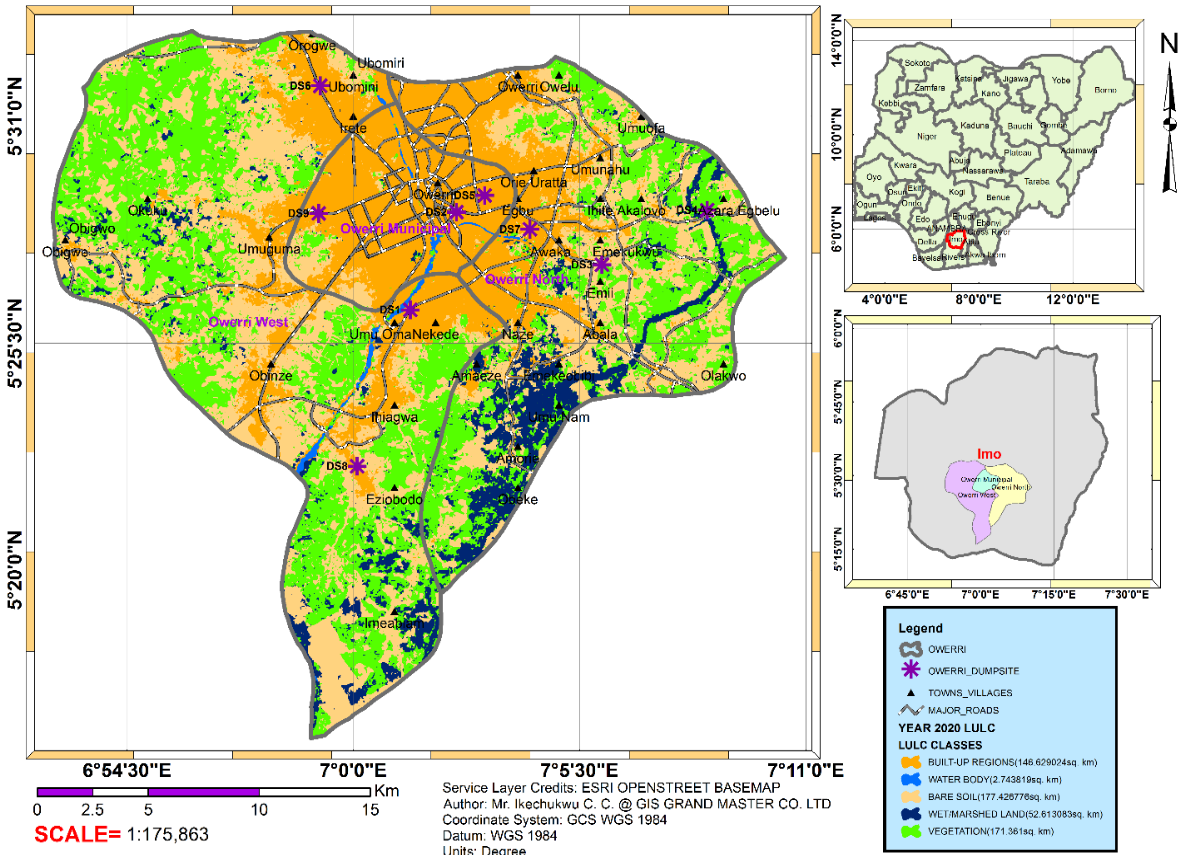

Figure 20: LULC Map of Owerri (2020)

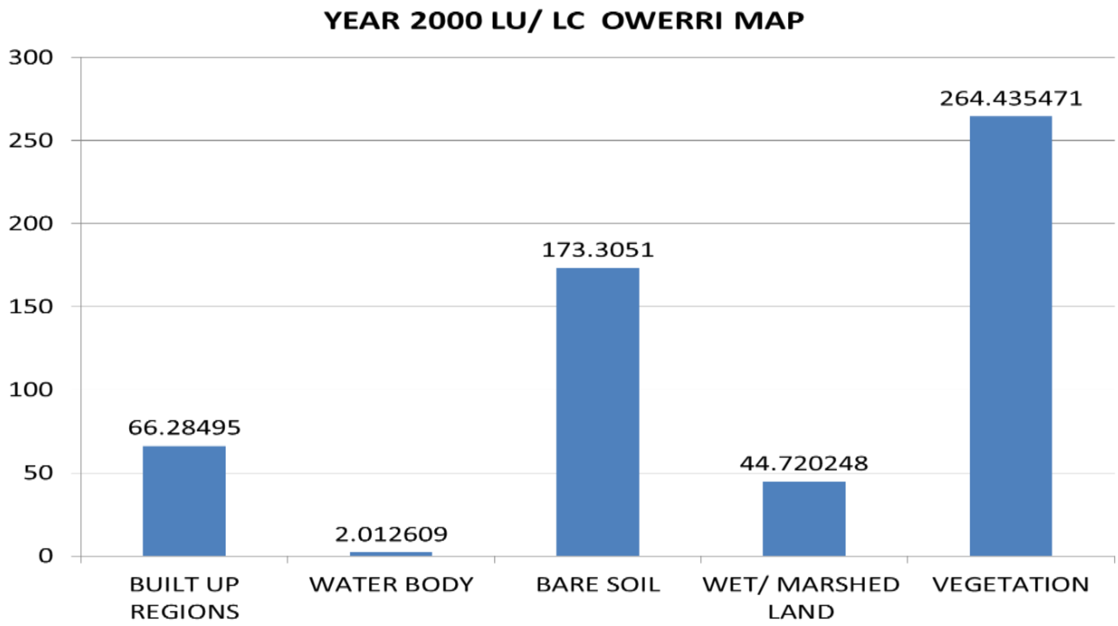

Figure 21: Bar chart showing the land use/the landcover 2000

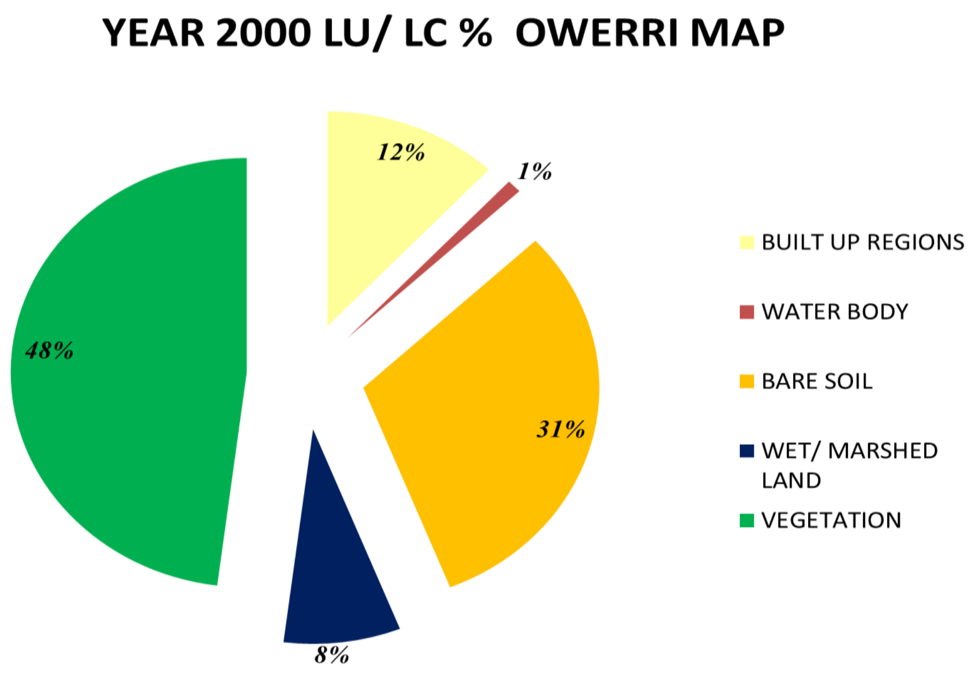

Figure 22: Chart showing the land use/the landcover 2000 PERCENTAGE

Table 8: LU and LC Classes in 2020

S/N	**LAND LU/LC CLASSES**	**Area in km^2**	**PERCENTAGE %**
1	VEGETATION	171.361	32
2	BARE SOIL	177.426776	32
3	BUILT-UP REGIONS	146.62902	26
4	WET/ MARS LAND	52.613083	9
5	WATERBODY	2.143819	1
	TOTAL AREA	550.783702	100

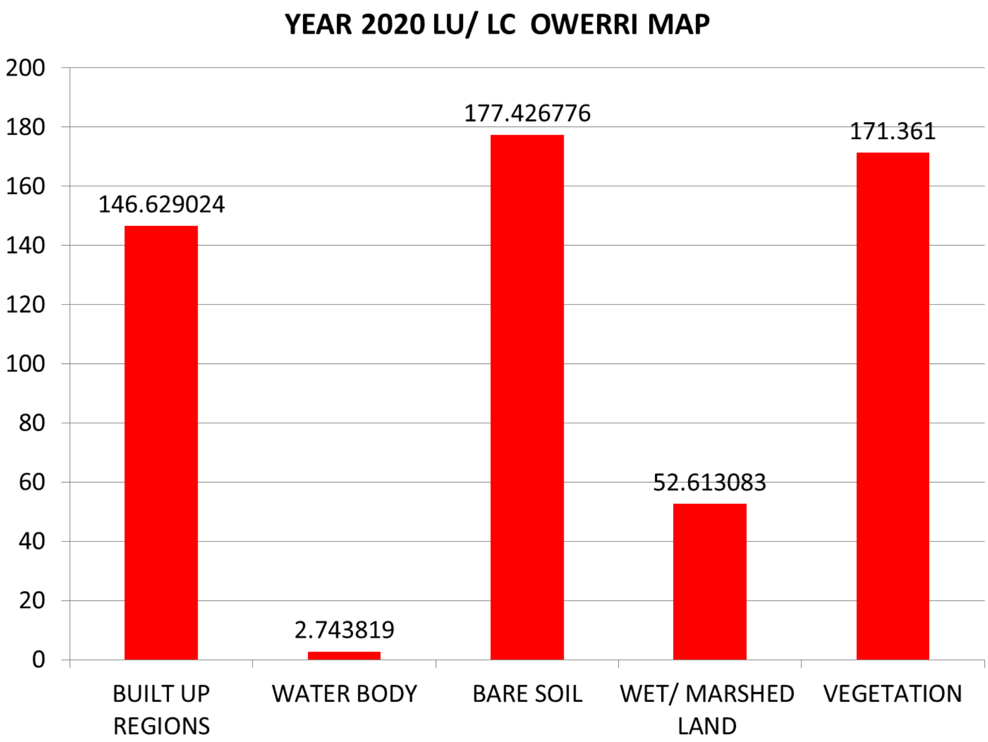

Figure 23: Bar Chart Showing the Landuse/Landcover Year 2020

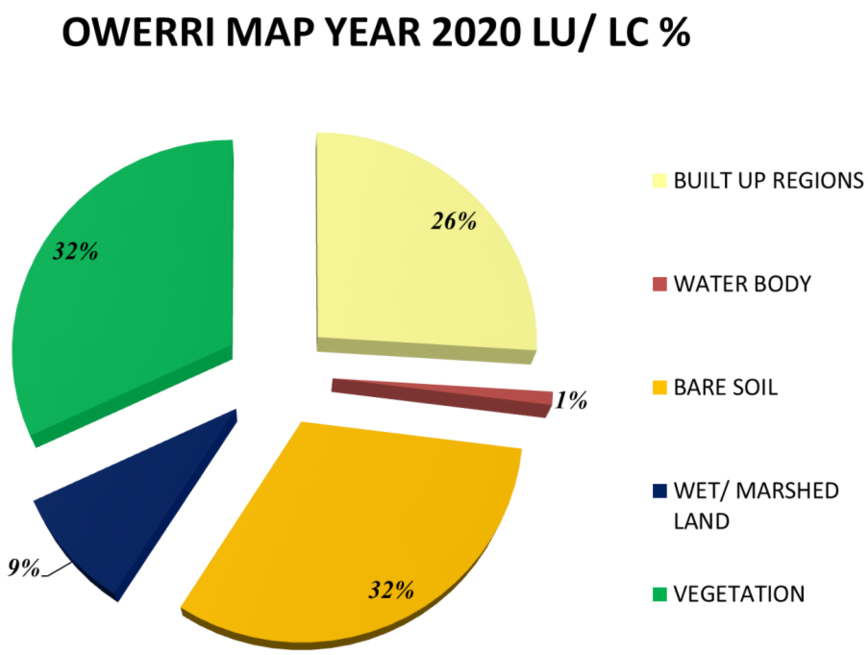

Figure 24: Chart showing the Landuse/land cover year 2020 PERCENTAGE

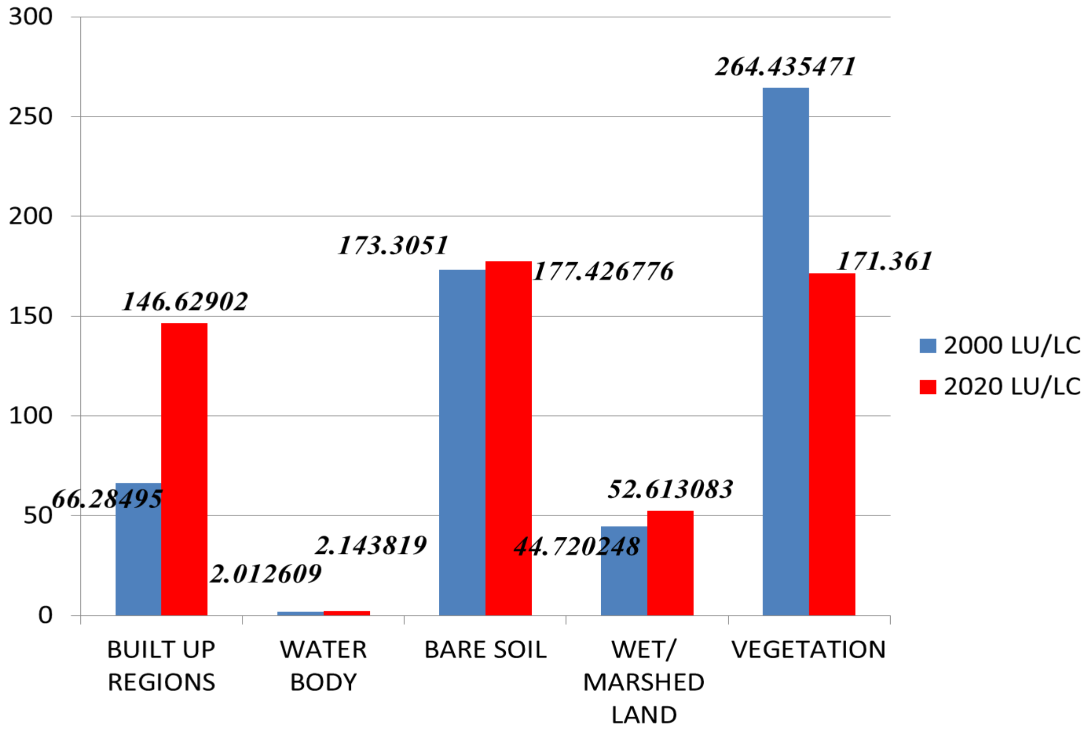

Figure 25: Bar chart showing the land use/landcover between 2000 -2020

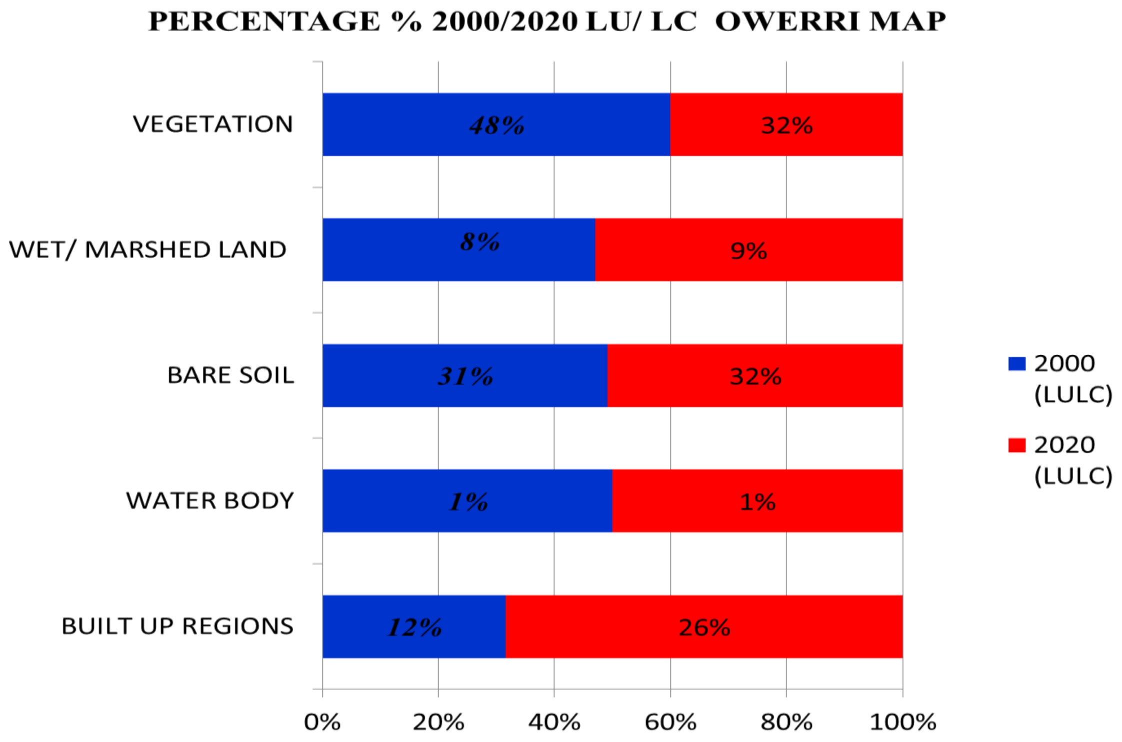

Figure 26: Bar chart showing the Landuse/landcover between 2000 -2020 Combine Percentage

4.1.6 Aquifer Geometric Parameters of the Study Area

The result of the Aquifer Depth map shows the value ranges from 17.2m at Njoku Sawmill (ves 2) and the highest value, 76.2 m at Shallom Home Uratta. and 76.4 m at Overcomers Church Aladinma Owerri, (ves 29, 35) The general review uncovered that areas of highs topographic like Owerri North with height elevation have higher value aquifer depth while in areas like Owerri West and Owerri Municipal have shallow and every low aquifer depth respectively, which suggest a shallow to higher aquifer vulnerability to Leachate migration from the dumpsites.

Table 9. Summary of Aquifer Geometric Parameters of the Study Area

S/N	Locations	Long. (E)	Lat. (N)	Aquifer Resistivity (ohm-m) ρa	Aquifer Depth (m)	Aquifer Thickness (m)
1	Akachi Road	7°02'34.9"	5°28'08.3"	1620	35.2	21.6
2	Njoku Saw Mill	7°02'29.4"	5°28'05.5"	2640	17.2	14
3	Sucoil Filling Station Naze	7°02'52.3"	5°24'40.0"	8800	30.6	20.1
4	Naze Owerri West	7°03'30.3"	5°26'18.0"	2420	37.5	16.7
5	Naze Industrial Cluster	7°02'53.6"	5°26'55.1"	7810	23.6	16.7
6	Nekede	7°01'19.9"	5°26'04.9"	346	51	27.2
7	Nekede Poly	7°01'48.5"	5°26'00.9"	6100	29.9	20.9
8	Ihiagwa	7°00'47.2"	5°24'08.9"	1150	37.7	22.9
9	FUTO	6°59'26.6"	5°23'25.7"	3860	42.7	40.8
10	Obinze	6°57'49.0"	5°24'51.9"	2560	29.8	11.6
11	Eke-Ukwu Avu	6°57'40.2"	5°26'43.6"	3160	43	23.9
12	Orji	7°03'34.8"	5°31'33.7"	2330	31.7	26.3
13	Umuori Uratta	7°05'20.1"	5°29'59.4"	1600	59	46
14	Shalom Home Uratta	7°05'04.7"	5°29'26.3"	8300	35.8	29.8
15	Overcomers Church Aladinma	7°03'05.2"	5°30'02.7"	3080	29.8	26.1
16	Ulakwo Market	7°07'33.1"	5°24'54.4"	9200	41.3	27.6
17	Ulakwo- Umuowa RD	7°08'29.1"	5°24'12.7"	1870	31.4	20.6
18	Obibiezena	7°03'44.2"	5°24'20.8"	7451	32	24.8
19	Agbala	7°06'08.8"	5°25'39.5"	6740	23.5	18.3
20	Emii	7°05'19.0"	5°27'58.0"	1450	45.5	32.3
21	Egbu	7°03'39.5"	5°28'34.5"	5400	27.3	7.9
22	Azaraegbelu	7°09'07.1"	5°28'46.3"	5260	49.9	19.4
23	Egbelu Obube	7°09'05.8"	5°25'32.1"	7500	38.4	35.4
24	Eziobodo Town School, Eziobodo, Owerri West	7.08.352'	5.24.934'	14300	48.8	30.9
25	Dump Site Nekede, Owerri West L.G.A.	7.01.398'	5.26.309'	5130	22.5	10.8

26	Baptist Church, Umuchima Ihiagwa Owerri West	7.01.689'	5.39.371'	1520	23.5	12.8
27	Concorde Hotel Owerri West L.G.A.	7.02.599'	5.47.601'	1080	33.3	17.9
28	Obibiezina Owerri North	7.03.793'	5.24.489'	1670	65.8	23.8
29	Overcomers Church Aladinma Owerri North	7.03.086'	5.30.045'	6400	76.4	46.6
30	Agbala, Owerri North L.G.A.	7.04.329'	5.23.071'	5050	63.7	32.5
31	Community Primary School Egbelu Obube Owerri North	7.04.654'	5.23.625'	13200	44.7	26
32	Azara Egbelu, Owerri North L.G.A.	7.09.118'	5.28.772'	5260	49.9	19.4
33	Ulakwu Market Junction Owerri North L.G.A.	7.07.552'	5.24.906'	1150	73	31.7
34	Umukabia Market Square Owerri North L.G.A	7.10.286'	5.21.280'	3200	54	51.7
35	Shallom Home Uratta, Owerri North L.G.A.	7.05.079'	5.29.439'	2300	76.2	40.4
36	Mission Emekuku, Owerri North L.G.A	7.06.414'	5.28.069'	10583	41.4	21.5
37	Orie Obibi market-Ama Orie, Owerri North L.G.A	7.03.734'	5.24.368'	3299	65.4	40.2

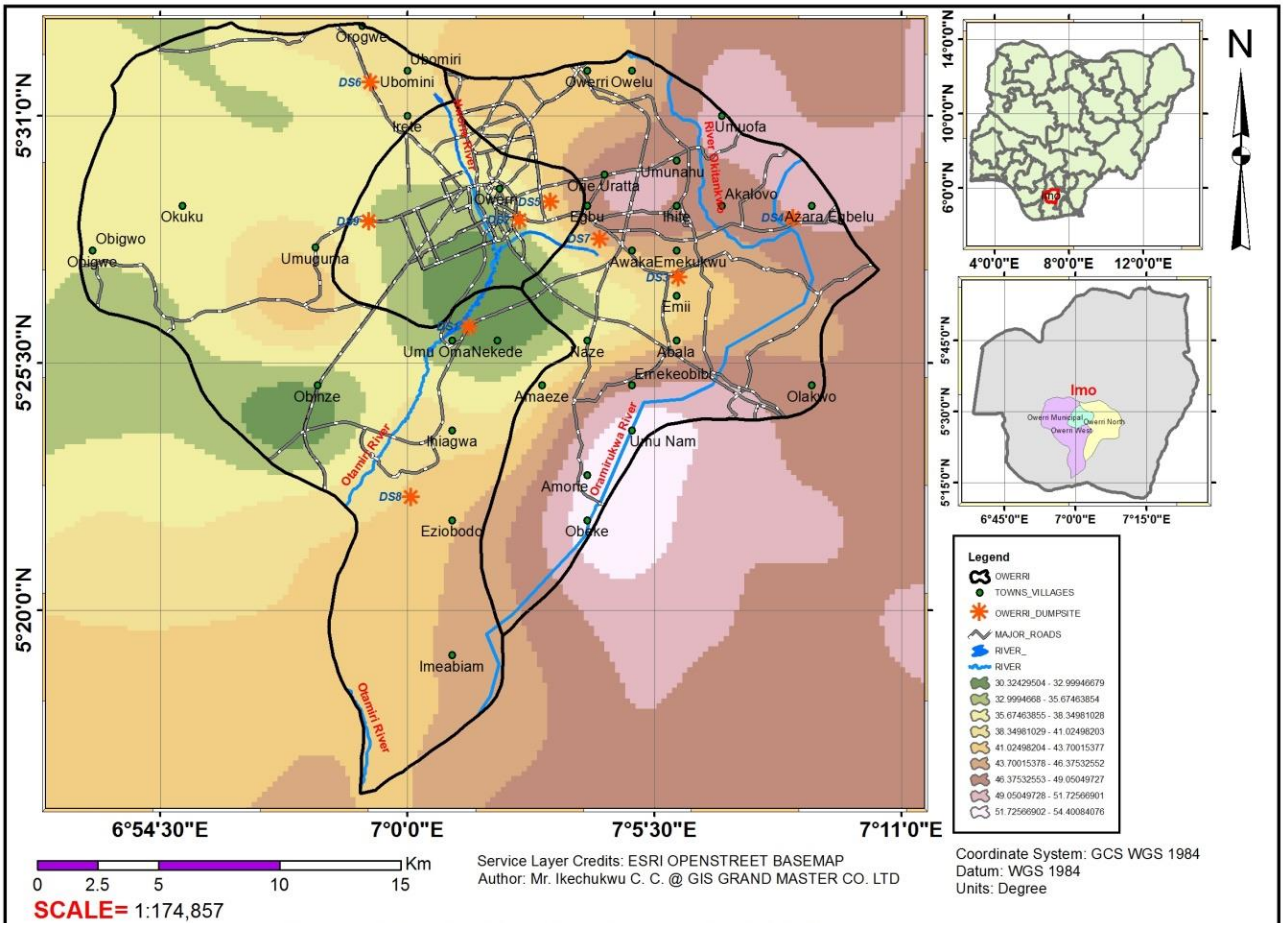

Figure 27: Aquifer Depth Map of the study area

4.2 Landfill Suitability Mapping

The current study of land use and land cover change in the study area shows significant ramifications on the environment, It is anyway obvious from the writing evaluated that there exist not very many investigations that address the impact of land use and land cover on waste management and environmental quality of Owerri Imo state Nigeria and that a couple of available studies on the topic are in isolated forms.According to Sam and Steven (2017), a minimum distance of 700 m buffer should be maintained for road suitability dumpsite location. Kontos et al. (2005), Al-Hanbali, Alsaaideh, and Kondoh (2011), and Irfan Yesilnacar, Lütfi, Basak & Vedat (2012) used multiple buffer ring extents and the grading values for roads. At present Owerri town has grown at an unexpected growth and as a consequence, the distance of the dumpsite to the nearest housing area is none but neighbours.

Finally, the landfill suitability map on Fig. 30 above indicates the areas that are most suitable to cite the engineered landfills within Owerri, from this research five suitable locations are indicated within the Owerri West and Owerri North Local government areas. Here the lineament density, Landuse, Landcover (LULC), and drainage maps were overlaid on the road network within the area of interest (Owerri). Therefore this process helps delineate properly the area's most suitable to site engineered landfill. The centroid coordinate of the proposed engineered landfill sites from this research is presented in table 10 above. This would surely help to improve solid waste management within the three local government areas of Owerri and will serve as a blueprint for other areas.

The appropriate sites in these areas are favoured because of the least effects that may cause on the environment and public. Most of the suitable landfill sites are situated in the northern part of the study area. Considering, the current open dumpsite is located in an unsuitable site, It is placed surrounding the built-up area, roadsides, and nearby river. Considering the effect of solid waste on the environment, health, economy, and other aspects of human life, the recommended selected site can be accessed by road. A study carried out by Olusina & Shyllon (2014) in Lagos, Nigeria indicated that landfill sites generated based on the criteria sets are to be accessible by road. Multi-criteria decision-making with GIS integrated methods would be useful for environmental, human wellbeing, and developmental issues and they should become legal commitments for the location of dumpsite selection in Owerri.

Moreover, the present study addresses a significant stage in a critical gap in the detection of waste disposal sites and enhancing the cost-effectiveness and efficiency of waste management efforts. Due to their ability to manage large volumes of spatial information from various resources, GIS is ideal for site selection studies (Kao et al., 1997), and are being widely applied in the recent past for site selection studies (Curtis & Hardin, 2000; Haaren & Fthenakis, 2011; Nikolakaki, 2003; Thomas, 2002; Woodhouse, Lovett, & Dolman, 2000). The reconciliation of both GIS and multi-criteria techniques improves decision-making because it establishes an environment for transformation and a combination of geographical data and stakeholders' preferences (Malczewski, 1997).

Table 10: Suitable landfill locations within the area

Landfill	**Longitude**	**Latitude**
Landfill 1	6°59’21.937’’E	5°32’17.206’’N
Landfill 2	6°59’9.902’’E	5°29’39.694’’N
Landfill 3	6°56’29.321’’E	5°26’23.344’’N
Landfill 4	7°1’59.449’’E	5°20’29.482’’N
Landfill 5	7°5’35.218’’E	5°29’13.802’’N

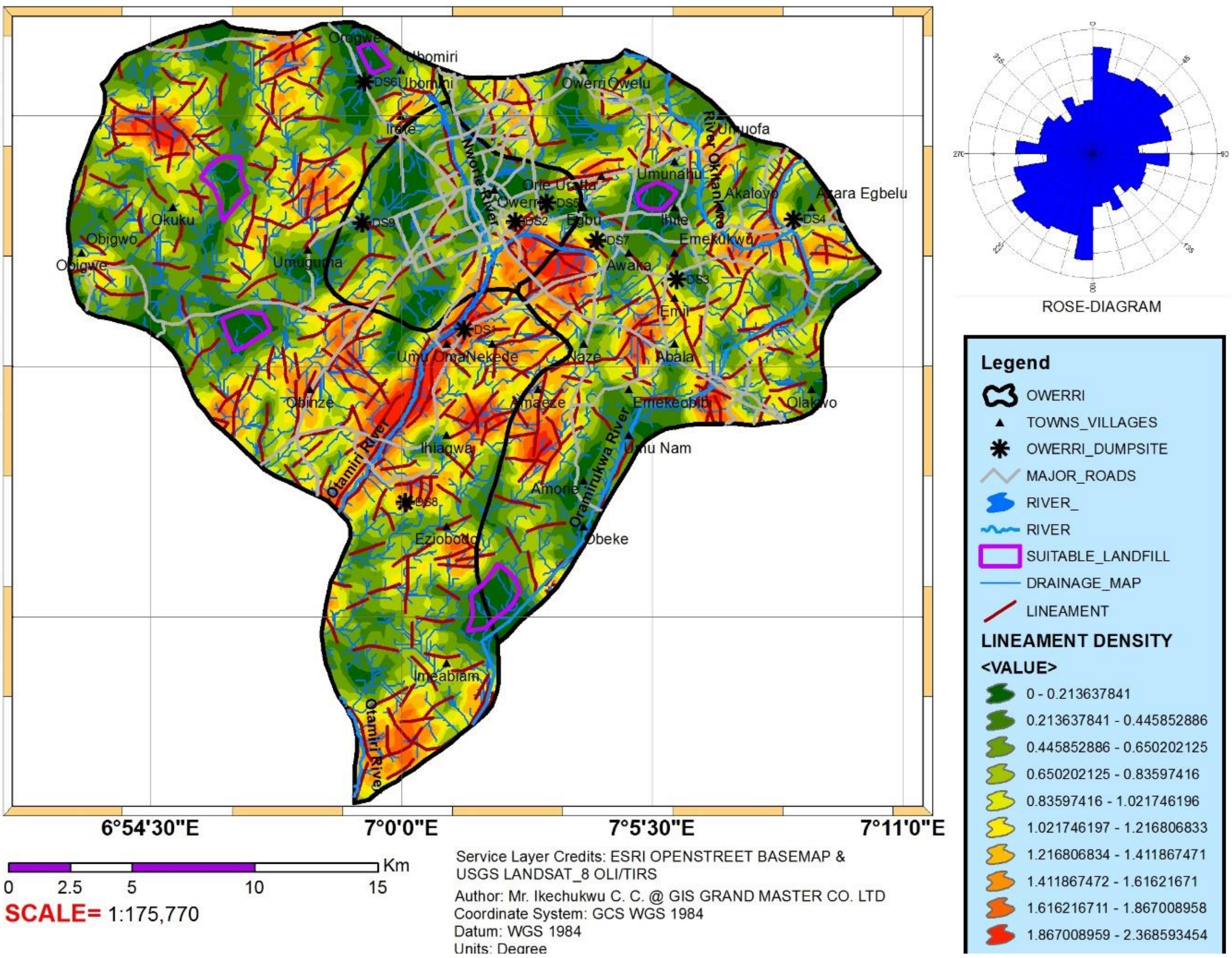

Figure 28: Landfill suitability map of Owerri

4.2. Discussion

The results of the present study of the land use and land cover changes in Owerri and environs has revealed significant environmental implications. Previously, only a few studies have holistically addressed the implications of land use and land cover changes on waste management and environmental sustainability in Owerri and environs, Imo state, Nigeria (Echebima et al., 2019; Onwe et al.,2020). Similarly, only a few studies have addressed the issue of the pattern, nature, and dynamics of land use and land cover over time, especially concerning waste management implications. For example, Njoroge et al. (2011) focused primarily on the dynamics of water level at the expense of other aspects of the environment that can be fundamentally influenced by changes in land use and land cover. Olang et al. (2011) investigated spatio-temporal changes in land cover and their environmental implications within the context of a river basin. Most previous studies have also had methodological flaws because they relied heavily on Geographical Information Systems (GIS), which has some limitations. Only Mundia and Aniya (2005) used both Landsat images and socio-economic data in a post-classification analysis to map the spatial dynamics of land use and cover changes while also identifying the city's urbanization process. This study, therefore, has revealed that the integration of GIS with remote sensing data has proved to effective in waste management, especially in siting of dumpsites/ landfills.

Topographical, watershed/drainage, lineament/lineament density, Normalized Difference Vegetation Index Map (NDVI), Normalized Difference Built-Up Index Map (NDBI), Normalized Difference Water Index Map (NDWI), and Normalized Difference Land use/Landcover thematic Maps for the years 2000 and 2020 have been used in this study to generate the engineering landfill suitability map of Owerri and environs to limit ecological and human health risks associated with unsustainable waste disposal in the study area. Earlier studies revealed contamination of the water resources of Owerri and its environs from anthropogenic sources including waste dumpsites as reported by various authors (Ibe et al., 2020a; Akakuru et al.,2021). These studies reported elevated levels of heavy metals like lead(Pb), iron(Fe), etc with little to no negative health hazard from the intake of the contaminated water samples(Ibe et al., 2020a; Akakuru et al.,2021). Similarly, the geo-environmental effects of unsustainable waste disposal have been extensively studied worldwide (Ibe et al.,2020a&b; Ibe et al.,2021; Onwe et al.,2020; Ihenetu et al.,2021). Anthropogenic contamination across the study area by dumpsites and other point sources is made worse by the soils in the area which are highly porous, permeable and with very high hydraulic connectivity (Ekwe and Opara.,2012; Ejiogu et al.,2019). The hydraulic conductivity and transmissivity within Owerri and its environs are also very high with values ranging between

6.19m/day at Ife and 24.7 m/day at Obinze. Transmissivity values also vary between 51.39 m2/day at Ife and 1379.56 m2/day respectively (Ekwe and Opara.,2012; Ejiogu et al.,2019). The downward flow of pollutants through rocks and soils is determined by the hydrogeological condition of the materials more specifically, hydraulic properties such as porosity, permeability, and transitivity (Tsegaye Mekuria, 2006). And they are influenced by a variety of factors, including agricultural and landfill-related reactions (Khan & Samadder, 2014). Several key studies have also reported pronounced environmental contamination from municipal dumpsites and other point sources in the study area with elevated levels of nitrate (NO_3^-), aluminium (Al) and chromium (Cr) concentrations above the World Health Organization (WHO) limits for drinking water samples recorded in some of the groundwater samples from the study area (Ibe et al.,2021; Ibe et al., 2020a; Akakuru et al.,2021a).

The findings and recommendations of the present study are therefore in line with some key publications within the study area (Echebima et al.,2019; Ibe et al.,2021; Onwe et al.,2020). Onwe et al., 2020 produced a composite waste dump/landfill suitability index map of Abakiliki and its environs, in south-eastern Nigeria using a multi-criteria and multi-parametric geospatial data and established that several geological and environmental factors usually control the siting of a landfill. These factors include soil type, slope, drainage, depth to the water table, etc (Onwe et al., 2020). Similar results reported worldwide have also revealed a high level of efficiency of geospatial techniques in the management of wastes, especially in the siting landfills and waste bins for waste disposal and evaluation of the environmental impact of buried waste (Petrescu.,2013; De Feo & De Gisi., 2014; Dutta & Goel 2017; Krishna et al.,2017; Singh, A.,2019; Iacoboaea & Karabulut et al.,2021; Debalke & Admas ., 2022). Similarly, other studies have used geospatial techniques to monitor the performance of several landfills worldwide (Krishna et al.,2017; Iacoboaea & Karabulut et al.,2021; Debalke & Admas ., 2022).

The current study has therefore addressed a critical challenge of detecting waste disposal sites and improving the cost-effectiveness and efficiency of waste management efforts. GIS is ideal for site selection studies due to its ability to manage large volumes of spatial information from various resources (Kao et al., 1997), and has recently been widely used for site selection studies (Curtis & Hardin, 2000; Haaren & Fthenakis, 2011; Nikolakaki, 2003; Thomas, 2002; Woodhouse, Lovett, & Dolman, 2000). The integration of GIS and multi-criteria techniques improves decision-making by creating an opportunity for transformation and a combination of geographical data and stakeholder preferences (Malczewski, 1997). According to Sam and Steven (2017), a minimum distance of 700 m buffer should be maintained for road suitability dumpsite location. Kontos et al. (2005), Al-Hanbali, Alsaaideh, and Kondoh (2011), and Irfan Yesilnacar, Lütfi, Basak, and Vedat (2012) used multiple buffer ring extents and road grading values. Presently, Owerri town has grown at an unexpected rate, and as a result, the distance between most of the open waste dumpsites and the nearest housing areas are nothing but unacceptable. According to a study conducted by Olusina and Shyllon (2014) in Lagos, Nigeria, landfill sites generated based on the criteria sets must be accessible by road as well as located at the minimum approved distances from built up areas.

However, a lot of factors which typically affect the siting of landfills in built-up areas including geological, environmental, and socio-economic are inter-related. For example, changes in land use and land cover are closely associated with population growth and intensive agriculture (Verburg et al. 1999). Because of the increase in population and the resulting need for food, the development of farmland has not only accelerated deforestation and grassland and wetland cultivation but has also resulted in ecological damage such as land degradation and ecosystem service recession (Verburg et al. 1999).Notwithstanding, generalized result of this study which revealed areas or environments where dumpsites are unsuitable to include rivers/streams, faults, roads, and the built-up area in the first order, followed by permeable locations, faults, geology, areas with a steep slope (>20°), built-up and forest, and areas near roads also included(Verburg et al. 1999; Tyowuah & Hundu, 2017). Ground/surface water-related criteria have a greater influence than the other criteria because they require protection from leachate contamination from dumpsites (Tyowuah & Hundu, 2017). Contamination of ground/surface water resources by leachate is a major concern for waste disposal sites, according to Tyowuah and Hundu (2017). Deep groundwater areas are preferable because the likelihood of groundwater pollution decreases as depth increases. Waste disposal should also be done away from faults (Rafee, Syed, Afshin & Nematolah, 2011). Following the elimination of confined land with a mix of environmentally sensitive, socially significant, and economically significant areas, only five sites in the study area were identified as suitable for engineered landfill sites.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The main aim of the use of multi-spectral and multi-criteria data sets is for the generation of individual thematic maps which were further used to produce the landfill suitability index map of Owerri and environs. Information extracted from the thematic maps have thus revealed a substantial change in the locations of dumpsites over the past twenty years, as seen on the land use maps for years 2000 and 2020 respectively. Because the rate of urbanization and population growth, efficient land use management is critical when it comes to solid waste management. Currently, nine(9) of the dumpsite locations are currently located near heavily developed areas on the land use map for the year 2020, with four dumpsite locations located near water bodies. In Owerri, there is a huge problem with solid waste management, which could lead to the contamination of groundwater resources from leaching. There are also issues with bad odours and a loss of environmental aesthetic appeal. Also, the depth of the water table in Owerri's Benin geological formation is known to be between 45 - 65 feet. . Because there is no shale/clay lining beneath the sandstone unit to protect the aquifer, the rate at which leachates leach down to the aquifer will be very high, as shown by the geological map of the study area, which is just one formation, the Benin formation, which is typically sandstone lithology with very high porosity and permeability. According to the study area's drainage map, which depicts the flow path and direction of surface run-off, some of the debris from these dumpsites gets washed down from their various positions and deposited into the drainage gutters, resulting in clogged drainage and flooding. Some of the garbage ends up in the river, putting aquatic life in jeopardy. The lineament and lineament density map, which depicts faulting, fractures, and cracks in the earth, also serves as a channel for leachates from dumpsites to damage the groundwater system. Six of the dumpsites, as seen on the lineament density map, are located in hotspot zones on the lineaments, which is a disastrous occurrence because the rate of contamination will be extremely high in those areas. As a result, unsustainable waste disposal throughout the environment will not only contaminate the air, water, and the aesthetic beauty of the environment, but will also jeopardize the health of a variety of living species, from humans to other living things.

The rate of development is directly proportional to the amount of solid waste generated, as evidenced by comparing the various maps generated over the two years of inspection. As a result, solid waste management should be included in land management schemes because the rate of development is directly proportional to the amount of solid waste generated. Finally, the landfill suitability map produced has indicated the areas that are most suitable for citing engineered landfills within Owerri and its environs based on this research, five suitable locations are indicated within the Owerri West and Owerri North Local government areas. The lineament density, Landuse, Landcover (LULC), and drainage maps were overlaid on the road network within the area of interest (Owerri). As a result, this process aids in properly delineating the area's most suitable site-engineered landfill. The centroid coordinates of the proposed engineered landfill sites from this research are shown in table 10 above. This will undoubtedly help to improve solid waste management within Owerri's three local government areas and will also serve as a model for other areas.

5.2 Recommendation

Solid waste management is the only option to stop solid waste from being dumped indiscriminately. The following recommendation area therefore proposed for a robust solid waste management measures:

1. To aid garbage management, the government should ensure that the lands identified in this study are developed into an engineered landfill.
2. The State government should establish solid waste management agencies and task groups at various levels (villages and towns) to ensure that waste is appropriately disposed of at the appropriate sites.
3. The state government should establish a solid waste recycling corporation and supply more incinerators for various areas.
4. As a penalty to offender, the government should levy/fine those who go against the rules and strategies adopted for robust waste disposal.
5. The government should fund trucks to transport solid waste from incinerators to the designed landfill.

6. The government should take steps to ensure that all of Owerri's dumpsites are adequately recycled or transported to a landfill.
7. . Environmental Impact Assessment: All proposed substantial developments that are anticipated to have environmental impacts should be subjected to an Environmental Impact Assessment (EIA) by the rules of the Environmental Impact Assessment Regulations of 2003.

5.3 Contribution To Knowledge

Based on the findings of this study, the following contributions to knowledge have been made: This study has successfully evaluated the land use/land cover changes of Owerri and its environs over 20 years.

1. The present land use management strategy of Owerri and its environs especially concerning waste disposal. has been assessed as unsustainable based on information extracted from remote sensing and GIS data.

2. Five suitable areas for the construction of engineered landfills in Owerri and its environs have been established using multi- criteria and multi-parametric approach.

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APPENDIX 1: Lineament Statistical Information of Owerri

X1	Y1	X2	Y2	Bearing	Length OF LINEAMENT	Midpoint-X	Midpoint-Y
Meters	UTM Meters	UTM Meters	UTM Meters	TEXT	Meters	Meters	Local Meters
276795	583515	276855	583665	21	162.4	1272608.99	595106.27
276855	583665	276975	583995	19	353.2	1272694.31	595351.8
278835	584145	278625	583875	217	343.1	1274505.27	595552.17
278625	583875	278235	583605	235	474.7	1274210.59	595274.11
278235	583605	277785	583365	241	510.1	1273795.66	595010.22
277875	584355	277755	584655	338	325.7	1273580.95	596048.37
277755	584655	277785	585045	4	394.1	1273529.27	596399.71
277785	585045	277785	585465	359	423.3	1273536.41	596812.77
277815	586185	278055	585645	156	595.6	1273673.54	597487.08
278055	585645	278085	585555	161	95.6	1273814.62	597167.17
278085	585555	278655	584895	139	877.6	1274121.82	596787.62
278655	584895	279075	584685	116	471	1274625.11	596348.7
279075	584685	279375	584505	121	351.2	1274988.79	596153.22
279375	584505	279945	584595	81	576.9	1275424.53	596111.37
279945	584595	280665	585105	54	883.1	1276063.52	596423.22
280665	585105	280935.2818	585292.1181	55	329	1276551.76	596783.19

281065.9646	585393.9389	281715	586515	29	1301	1277127.27	597559.4
281715	586515	281955	587235	18	763.5	1277553.78	598502.11
279165	585375	278685	584655	213	868.6	1274680.73	596578.67
278685	584655	278205	584415	243	536.7	1274210.18	596084.81
278205	584415	277815	584325	256	400.1	1273778.51	595912.54
277815	584325	277305	584055	241	577.2	1273332.14	595724.84
278325	585645	278775	585675	86	450.9	1274293.32	597232.81
278775	585675	279225	585765	78	458.7	1274742.03	597298.17
279225	585765	279645	585795	85	421	1275175.74	597363.39
276445.7331	583755.1011	276585	584505	10	768	1272288.98	595654
276585	584505	276547.0717	584723.0879	350	223.2	1272330.24	596147.92
277155	586245	277455	586425	58	350	1273035.55	597909.43
277455	586425	277875	586605	66	456.9	1273391.95	598096.31
277875	586605	278595	587025	59	833.9	1273955.95	598407.49
280425	586635	280065	586485	247	390	1275970.35	598166.19
280065	586485	279645	586245	240	483.9	1275584.25	597963.75
279645	586245	279225	585765	220	639.5	1275171.36	597592.8
282045	586815	282015	586515	185	303.7	1277752.81	598289.79
282015	586515	281697.1897	585919.1056	207	678.5	1277587.65	597831.44
278865	587145	278325	586305	212	1002.5	1274317.6	598319.09
279765	586935	279495	587505	334	635.7	1275342.68	598833.42
279495	587505	279285	587775	322	344.4	1275094.57	599259.41
279285	587775	278775	588285	315	725.5	1274727.06	599653.69
281865	587535	281355	586575	207	1092.1	1277325.34	598683.56
276255	586245	276705	585555	147	829.7	1272219.24	597458.21
276705	585555	276945	584355	168	1233.8	1272582.51	596497.96
276945	584355	277125	584085	146	326.8	1272806.71	595750.54
281685	588075	280875	587715	245	886.4	1276979.09	599536.98
280875	587715	280425	587715	270	450	1276352.76	599347.6
280695	588315	280185	588225	260	517.7	1276132.01	599911.53
280185	588225	279705	588315	280	488.9	1275637.14	599906.93
279705	588315	279315	588405	283	400.8	1275200.5	599994.64
276405	588555	277035	588735	74	655	1272405.66	600259.12
277035	588735	277425	588675	98	394.9	1272914.36	600325.08
277425	588675	278205	588525	101	795.1	1273501.26	600223.5
278805	589665	278775	588705	181	967.9	1274464.57	600829.07
280485	589755	279975	589665	260	517.7	1275893.95	601377.81
279975	589665	279795	589695	279	182.6	1275549.63	601344
279795	589695	278955	589875	282	860.1	1275037.7	601446.29
275280.6135	590177.8985	275325	589845	172	338.6	1270962.08	601638.93
275325	589845	275535	589455	151	446.3	1271096.32	601271.63
275535	589455	275775	588855	158	651.4	1271330.96	600769.08
284700.6401	591130.4753	284505	591165	280	198.9	1280237.58	602884.44
278535	590055	278535	590565	359	514	1274187.63	601973.71

278535	590565	278595	590985	7	427.3	1274208.52	602448.1
278595	590985	278625	591465	3	484.6	1274244.69	602907.33
278625	591465	278625	591795	359	332.6	1274251.74	603320.4
278625	591795	278625	592215	359	423.3	1274244.38	603702.74
284409.292	590808.8053	284235	590925	303	210.4	1279962.47	602595.48
277005	590625	276165	590235	244	926.1	1272235.76	602077.74
277035	590835	277485	590985	71	474.2	1272901.18	602573.48
277485	590985	277725	591015	82	241.8	1273244.34	602668.48
277725	591015	278295	591225	69	607.3	1273646.89	602794.64
279825	591135	280695	590595	122	1028	1275901.35	602555.73
276315	591135	276015	591165	275	301.6	1271801.73	602807.85
276015	591165	275595	591285	286	437.5	1271440.34	602880.92
275595	591285	275508.1509	591305.4351	283	89.3	1271185.6	602950.12
283785	590895	283815	591195	5	303.7	1279436.97	602772.24
283815	591195	283695	591495	338	325.7	1279386.11	603077.72
283695	591495	283485	592485	348	1020.5	1279208.52	603733.86
281385	591945	280965	591945	270	420	1276794.97	603665.46
280965	591945	280635	591945	270	330	1276420.05	603661.96
280635	591945	279885	592005	274	752.7	1275879.59	603687.49
285255	592275	284865	592065	241	443.1	1280674.65	603931.05
284865	592065	284235	591165	214	1102.5	1280175.64	603360.41
278025	591945	278505	592305	52	600.6	1273882.1	603821.7
278505	592305	278955	592425	75	465.6	1274342.28	604070.77
278955	592425	279645	592875	56	824.3	1274906.55	604366.71
282105	592425	280605	592155	259	1523.6	1276968.16	604018.91
277665	592875	276285	592425	251	1451.1	1272582.07	604344.81
279735	592215	280395	592335	79	670.6	1275678.75	603991.54
280395	592335	280875	592545	66	523.9	1276245.38	604165.12
280875	592545	281235	592725	63	402.5	1276661.46	604367.87
280845	593205	281115	592815	145	477.7	1276579.11	604749.53
281115	592815	281235	592725	127	150.7	1276778.78	604506.65
281235	592725	281535	592575	116	336.5	1276991.09	604386.26
282645	593475	283185	592515	150	1109.9	1278513.97	604752.32
283485	593325	284025	593535	68	579.3	1279345.24	605203.7
284025	593535	284535	593625	80	517.7	1279867.18	605361.54
284535	593625	284985	593655	86	451	1280345.9	605427.19
277575	594285	277875	593955	137	448.8	1273302.96	605850.64
277875	593955	278055	593415	161	573.9	1273551.48	605409.4
277245	593835	277395	594225	20	420.2	1272899.82	605755.05
277395	594225	277545	594705	17	505.9	1273041.21	606199.98
277545	594705	277755	595035	32	392.7	1273213.18	606614.6
281175	593955	280035	593445	245	1248.9	1276190.62	605449.54
280035	593445	279825	593445	270	210	1275520.78	605183.2
275354.7933	594584.7933	275445	594675	44	127.8	1270968.27	606348.46

283965	594285	283275	594465	284	714.2	1279191.7	606166.02
283275	594465	282735	594555	279	548	1278574.18	606297.92
282735	594555	282165	594795	293	620.1	1278016.04	606460.97
279285	594345	279465	594795	21	487.3	1274943.75	606325.02
279465	594795	279555	594945	30	175.7	1275072.8	606632.17
279555	594945	279585	595455	3	514.8	1275126.28	606969.2
280755	594555	280425	594825	309	428.5	1276156.13	606458.81
280425	594825	280095	595005	298	377.2	1275821.76	606685.12
280095	595005	279855	595215	311	320.6	1275532.97	606881.25
278565	594195	278745	594555	26	404.4	1274227.74	606119.41
278745	594555	278775	594945	4	394.1	1274325.32	606502.74
278775	594945	278775	595275	359	332.6	1274333.21	606869.93
279075	594555	279195	595125	11	586.4	1274698.47	606598.05
279195	595125	279195	595185	359	60.5	1274752.24	606919.78
279195	595185	279165	595515	354	334.1	1274733.4	607118.46
286215	594105	286485	594405	41	404.6	1281923.48	606069.07
286485	594405	286605	594825	15	439.6	1282111.36	606437.97
286605	594825	286695	595245	11	432.5	1282208.08	606867.22
278145	595215	278775	595275	84	632.7	1274015.61	607004.6
278775	595275	279165	595515	58	458.2	1274522.55	607162.35
279165	595515	279825	595545	87	660.6	1275044.78	607304.95
274312.2616	595103.2152	274305	595125	341	23.2	1269867.64	606831.73
274305	595125	274275	595215	341	95.6	1269847.91	606888.54
274275	595215	273675	596025	323	1014.9	1269524.06	607344.31
275093.2736	594733.925	275115	595125	3	394.6	1270666.64	606651.06
275115	595125	275325	595575	24	499.1	1270774.17	607080.91
275325	595575	275505	595995	22	459.3	1270960.53	607526.26
286695	595245	287115	595665	44	595.2	1282454.77	607297.86
287115	595665	287265	596085	19	448.6	1282731.45	607728.79
287265	596085	287775	597015	28	1065.5	1283048.09	608420.16
280815	595545	280965	595815	28	310.2	1276436.55	607471.04
280965	595815	281235	596175	36	451.5	1276640.29	607794.2
281235	596175	281325	596745	8	581.2	1276811.07	608270.01
281265	595515	280965	595815	315	426.8	1276661.8	607457.87
280965	595815	280665	596085	312	405.8	1276356.23	607745.63
280665	596085	280125	596595	313	747	1275928.61	608139.32
284055	595245	284205	595725	17	506	1279679.75	607302.6
284205	595725	284445	596235	24	566.5	1279864.95	607809.16
284445	596235	284805	596685	38	578	1280155.43	608301.4
284805	596685	284835	596805	13	124.5	1280344.77	608593.83
284835	596805	285375	597405	41	809.3	1280622.61	608963.58
285375	597405	285705	597555	65	362.5	1281050.12	609350.02
283155	595365	283755	596055	40	916.8	1279000.45	607525.71
283755	596055	283995	596505	27	512.4	1279409.12	608110.84

283995	596505	284415	596955	42	617	1279730.18	608572.78
277695	596265	277185	595935	236	607.9	1272978.91	607866.66
277185	595935	276615	594975	210	1121.1	1272451.77	607203.93
276615	594975	276165	594615	231	577	1271954.91	606526.19
276165	594615	275894.1895	594073.3791	206	608.4	1271603.48	606063.16
291067.3019	597652.9623	290955	597915	336	287.4	1286514.25	609710.86
290955	597915	290895	598215	348	308.5	1286422.57	609996.64
290895	598215	290745	598755	344	565.2	1286309.3	610423.96
282615	596265	282915	596295	84	301.4	1278299.34	608100.44
282915	596295	283245	596205	105	342.6	1278614.87	608072.8
283245	596205	283935	596205	90	690.1	1279125.66	608031.7
283935	596205	284265	596055	114	363.5	1279637.04	607960
272794.018	595923.5709	272775	596025	349	104	1268326.78	607694.11
272775	596025	272745	596505	356	484.8	1268296.51	607990.25
272745	596505	272595	597045	344	565	1268196.41	608509.32
278955	596205	278715	596025	232	300.3	1274373.35	607895.17
278715	596025	277575	595845	261	1153.8	1273687.04	607705.12
276135	596505	276465	596715	57	391.4	1271829.02	608375.8
276465	596715	276885	596985	57	499.6	1272199.2	608624.05
276885	596985	277215	597255	50	427	1272568.78	608902.9
277215	597255	277485	597645	34	476	1272862.19	609242.2
277485	597645	277875	598215	34	693.1	1273182.61	609734.73
277875	598215	278085	598605	28	444.9	1273473.03	610226.97
278085	598605	278205	598725	44	170.1	1273632.94	610488.53
278205	598725	278445	598875	57	283.2	1273810.23	610627.88
275145	596985	274005	595995	228	1512.2	1270106.72	608237.01
271151.8795	597460.1458	271155	597465	32	5.8	1266666.45	609195.7
271155	597465	271365	597765	34	367.5	1266769.96	609352.12
271485.7718	597166.8008	271575	597375	22	227.7	1267047.14	609003.93
271575	597375	271605	598185	1	816.7	1267096.62	609523.51
271605	598185	271845	599055	15	908.1	1267214.87	610381.15
271845	599055	271935	599145	44	127.5	1267370.28	610872.08
271935	599145	272175	599595	27	512.3	1267529.87	611148.93
281625	596865	281715	597195	15	344.2	1277189.73	608854.87
281715	597195	281805	597375	26	202.2	1277274.67	609115.72
281805	597375	281805	597735	359	362.8	1277314.32	609391.44
272595	597045	272835	597525	26	539.2	1268231.27	609029.69
272835	597525	272925	597675	30	175.6	1268389.98	609352.41
272925	597675	272955	598515	1	847	1268440.13	609857.63
283755	597285	282765	597135	261	1001	1278775.88	609053.35
274275	597105	274485	597255	54	258.3	1269898.06	608938.6
274485	597255	275265	597345	83	785	1270390.6	609065.67
275265	597345	275925	597615	67	713	1271106.9	609256.06
275925	597615	276045	597675	63	134.2	1271493.56	609428.01

276045	597675	276255	597915	40	319.7	1271655.55	609582.51
276255	597915	276405	598425	16	534.9	1271828.07	609966.55
283725	596385	283815	597045	7	670.9	1279295.56	608553.41
283815	597045	283815	597135	359	90.7	1279333.14	608936.2
283815	597135	283935	597525	16	410.6	1279388.39	609181.48
283935	597525	283905	598035	356	515	1279424.48	609640.75
283905	598035	283965	598515	6	487.3	1279429.69	610145.62
283965	598515	283995	598575	26	67.4	1279469.33	610421.35
283995	598575	284265	599745	12	1208.8	1279607.12	611049.85
290731.8846	597656.3078	290775	597915	9	264.1	1286256.55	609710.18
290775	597915	290895	598215	21	324.9	1286332.59	609995.8
276405	598425	276765	597435	160	1062	1272087.79	609724.3
291429.0639	597653.5258	291315	597735	305	140.8	1286876.83	609622.7
285375	597705	285435	598065	9	367.6	1280907.14	609761.73
285435	598065	285585	598545	17	506	1281003.82	610190.98
285585	598545	285525	599115	353	577.9	1281038.42	610726.73
284835	596805	284565	597585	340	832.2	1280215.9	609051.56
284565	597585	284505	597705	333	135.2	1280042.04	609508.86
284505	597705	284265	597915	311	320.6	1279888.81	609675.7
278625	597585	278895	597795	51	342.5	1274267.18	609500.29
278895	597795	279135	598065	41	362.2	1274517.38	609747.41
279135	598065	279375	598545	26	539.2	1274749.9	610132.03
279375	598545	279675	598845	44	425.2	1275012.11	610532.23
279675	598845	279945	599085	48	361.8	1275291.71	610810.22
271365	597765	270765	597945	286	627.5	1266570.22	609594.9
270765	597945	270705	597945	270	60	1266238.48	609683.47
270705	597945	270636.0437	597955.8878	279	69.9	1266173.9	609688.4
280365	597135	281145	597525	63	872.2	1276268.96	609152.12
281145	597525	281445	597915	37	493.6	1276801.14	609554.87
281445	597915	281685	598275	33	434.3	1277063.67	609939.77
281685	598275	281895	598575	34	367.5	1277282.09	610278.37
281895	598575	282285	598995	42	574.5	1277574.9	610648.26
280215	598035	281085	597705	110	932.7	1276153.28	609701.71
286815	597525	286665	597795	331	311.3	1282246.34	609544.77
286665	597795	286305	598095	310	471.1	1281985.76	609833.01
286305	598095	286125	598365	326	326.9	1281710.17	610121.1
273885	597015	274095	597405	28	444.9	1269507.54	608965.45
274095	597405	274215	598155	8	764.9	1269661.19	609548.15
274215	598155	274125	598695	350	551.9	1269663.36	610205.87
274125	598695	274125	599445	359	755.8	1269605.53	610863.01
292853.9038	597620.6151	292935	597945	13	336.6	1288397.21	609727.04
292935	597945	293115	598485	18	572.7	1288519.22	610168.99
293115	598485	293295	598755	33	325.7	1288691.2	610583.66
282915	598185	282375	598065	257	553	1278142.88	609980.54

282375	598065	282165	598005	254	218.3	1277769.73	609885.24
282165	598005	281805	597735	232	450.5	1277488.05	609714.32
293715	598695	293925	598395	145	368.9	1289307.56	610512.84
293925	598395	294585	598065	116	740.4	1289748.69	610195.59
281805	597375	282615	597825	60	926.9	1277718.35	609441.14
281475	597315	281445	597915	357	605.6	1276968.19	609449.36
281445	597915	281265	598335	336	460.6	1276853.11	609968.38
281265	598335	280995	598875	333	608.5	1276618.63	610455.66
271005	598215	271215	598575	29	418.5	1266604.46	610145.84
271215	598575	271365	598695	51	192.3	1266779.64	610392.25
271365	598695	271785	599025	51	534.8	1267060.12	610624.37
280575	598635	279975	597945	220	916.8	1275770.02	610126.4
291075	598755	291285	598305	155	500.6	1286668.35	610473.19
291285	598305	291315	597735	176	575.5	1286798.39	609954.21
274425	598305	274485	598815	6	517.2	1269945.63	610346.23
274485	598815	274515	598965	11	154	1269984.05	610683.1
274515	598965	274905	599805	24	930.7	1270184.16	611189.77
277875	598545	277665	598875	327	394	1273257.1	610530.84
277665	598875	277455	599295	333	473.2	1273039.69	610911.17
277455	599295	276915	599775	311	726.4	1272655.79	611366.39
276915	599775	276645	600135	323	453.1	1272242.49	611790.72
276645	600135	276225	600615	318	641.9	1271889.17	612215.63
291705	598695	291135	598965	295	632.7	1286902.38	610781.34
291135	598965	290655	599085	284	495.5	1286373.63	610975.33
290655	599085	290325	599205	290	352	1285966.33	611093.95
284895	599055	284145	598095	217	1222	1280008.65	610457.01
294765	599295	294165	599145	255	618.3	1289939.14	611207.15
294165	599145	293685	598995	252	502.8	1289402.19	611049.21
293685	598995	293325	598995	270	360.1	1288983.75	610968.85
270645	599355	271365	598695	132	982.1	1266486.91	610787.08
288465	599265	288105	599415	292	391.1	1283757.86	611272.29
288105	599415	287685	599445	274	421.3	1283366.14	611360.43
287685	599445	287385	599595	296	336.5	1283004.42	611448.84
289455	598695	288105	598665	268	1350.4	1284265.82	610603.88
282945	598755	283125	598095	164	689.8	1278526.87	610290.1
283125	598095	283485	597585	144	628.7	1278808.41	609696.15
290865	599475	290655	599085	208	445	1286233.61	611234.12
290655	599085	290415	598725	213	434.3	1286016.06	610849.62
290415	598725	290325	598425	196	315.2	1285857.61	610511.57
275055	599505	274695	598755	205	836	1270354.22	610931.38
274695	598755	274695	598425	179	332.6	1270184.99	610379.12
290385	599535	290775	599535	90	390.1	1286048.6	611492.49
290775	599535	291285	599475	96	513.9	1286499.12	611466.07
291285	599475	291705	599505	85	421	1286964.33	611455.08

293235	599265	293055	599565	329	352.5	1288615.52	611393.85
293055	599565	292965	599745	333	202.9	1288475.81	611637.35
292965	599745	292905	600315	353	577.9	1288393.41	612019.09
283515	599565	283245	599775	308	343.7	1278847.13	611562.81
283245	599775	282825	599955	293	458.2	1278498.31	611758.38
282825	599955	282525	600345	322	495.4	1278132.71	612045.58
282915	599505	283245	599775	50	427	1278547.77	611529.39
283245	599775	283695	599955	68	484.6	1278933.25	611762.49
283695	599955	284025	600195	53	408.5	1279319.01	611980.29
284025	600195	284355	600555	42	489.6	1279643	612289.29
284355	600555	285135	601065	56	932.6	1280189.28	612738.07
272205	599085	272445	599595	24	566.4	1267800.43	611120.95
272445	599595	272505	599775	18	190.9	1267943.52	611474.11
272505	599775	272595	600075	16	315.1	1268013.72	611719.51
273765	599385	273675	599715	344	344.9	1269191.03	611348.47
273675	599715	273705	599925	7	213.6	1269155.65	611623.45
273705	599925	273585	600765	351	855.5	1269100.18	612158.24
286065	599355	284925	599595	282	1166.5	1280965.65	611383.86
284445	599805	284745	599955	63	335.5	1280057.77	611788.37
284745	599955	284925	600075	56	216.5	1280295.05	611928.29
284925	600075	285375	600135	82	453.9	1280608.21	612023.02
269612.5265	599672.5265	269895	599955	44	400.3	1265220.12	611579.06
269895	599955	270105	600405	24	499	1265459	611954.8
270105	600405	270375	600645	48	361.8	1265692.07	612308.83
270375	600645	270675	600765	68	323.1	1265973.43	612495.09
270675	600765	271005	601155	39	512.3	1266283.29	612758.1
282105	599565	282165	599985	7	427.3	1277600.24	611658.12
282165	599985	282135	600255	353	273.9	1277608.39	612010.03
282135	600255	282225	600855	8	611.1	1277629.73	612453.85
281895	599985	281655	599385	201	649.8	1277242.09	611562.95
281655	599385	281325	599115	230	427	1276965.77	611116.72
275715	600045	275985	599835	128	343.7	1271312.93	611766.53
275985	599835	276165	599475	153	405.6	1271543.58	611478.12
276165	599475	276375	599205	142	344.4	1271744.82	611158.83
276375	599205	276885	598995	112	553	1272109.54	610917.59
277785	599475	276945	598365	216	1396.5	1272848	610741.09
287475	600345	287805	599925	142	537.8	1283097.22	612076.95
287805	599925	287895	599415	169	522.2	1283316.4	611604.74
287085	600285	287565	601005	33	868.6	1282772.15	612594.05
287565	601005	287745	601455	21	487.4	1283090.49	613193.67
287745	601455	287955	601695	40	319.8	1283278.61	613547.3
287955	601695	288105	601815	51	192.3	1283455.01	613732.53
288105	601815	288375	601995	56	324.8	1283661.99	613887.46
287085	600285	286575	600285	270	510.1	1282284.37	612222.32

286575	600285	286215	600165	251	379.4	1281850.63	612157.07
286215	600165	285435	600105	265	782.2	1281282.51	612059.95
273045	599565	272985	600015	352	457.7	1268481.35	611586.36
272985	600015	273045	600255	13	249	1268474.46	611938.08
273045	600255	273225	600825	17	601.3	1268586.36	612352.13
281145	599595	280935	599865	322	344.4	1276506.31	611601.87
280935	599865	280665	600045	303	325.9	1276261.88	611829.01
280665	600045	280095	600645	316	832.6	1275834.18	612222.66
276465	599955	275865	600405	307	753.5	1271623.1	612014.23
275865	600405	275565	600465	281	306.3	1271168.08	612269.9
275565	600465	275205	600735	307	452.1	1270834.84	612434.95
274095	600555	274245	599565	171	1009.5	1269630.79	611872.74
293055	600825	293445	600645	115	430.8	1288694.41	612740.95
293445	600645	293805	600675	85	361.2	1289070.84	612667.93
293805	600675	294225	600495	113	458.2	1289462.25	612595.05
279825	600675	279585	600015	199	706.3	1275159.29	612216.25
279585	600015	279645	599235	175	788.6	1275083.62	611481.29
279645	599235	279435	598575	197	696.8	1275022.94	610746.48
295428.405	600869.54	295215	600585	216	356.9	1290765.92	612752.18
295215	600585	294825	600345	238	458.2	1290469.46	612481.93
288225	600135	288165	600735	354	608	1283646.18	612388.05
288165	600735	288135	600795	333	67.6	1283594.64	612724.13
288135	600795	288015	601125	340	354.1	1283515.79	612922.28
288795	600195	288735	600705	353	517.8	1284215.79	612408.67
288735	600705	288525	601095	331	446.4	1284071.89	612866.28
288525	601095	288525	601425	359	332.6	1283959.76	613232.4
280275	600945	281025	600405	125	928.4	1276097.58	612561.69
292515	600135	291705	599505	231	1027.4	1287572.7	611797.3
275684.6057	594288.3093	275865	594735	21	484.4	1271345.43	606231.48
275865	594735	277305	596565	37	2335.7	1272132.97	607399.76
277305	596565	277575	597045	29	553.1	1272964.95	608585.45
277575	597045	278355	597945	40	1194.1	1273476.19	609293.93
278355	597945	278835	598815	28	998	1274088.52	610202.23
278835	598815	279075	600315	8	1529.8	1274424.92	611413.84
279075	600315	279525	601125	28	930.7	1274746.88	612594.74
295215	600585	295125	601065	349	492.5	1290612.31	612850.45
295125	601065	295155	601365	5	303.8	1290574.6	613247.91
295155	601365	295215	601665	11	308.1	1290613.66	613554.27
290265	600825	290505	601305	26	539.3	1285823.34	613050.9
290505	601305	290535	601665	4	364	1285949.99	613480.46
290535	601665	290565	601995	5	333.9	1285973.14	613832.55
282225	600855	282855	601035	74	655	1277981.92	612854.91
282855	601035	283185	601005	95	331.5	1278460.36	612935.92
283185	601005	283725	601185	71	569.1	1278893.8	613016.51

283725	601185	284115	601395	61	443.1	1279354.86	613219.73
284115	601395	284415	601665	47	404.3	1279695.03	613467.7
274245	601125	274605	601215	75	371	1269863.59	613006.84
274605	601215	274965	601305	75	371	1270221.75	613102.06
274965	601305	275235	601455	60	309	1270534.31	613227.43
275235	601455	275535	601845	37	493.6	1270813.87	613505.44
275535	601845	276285	602295	58	875.1	1271330.4	613938.69
280845	600945	280995	601275	24	364.3	1276358.88	613007.79
280995	601275	281085	601665	12	402.9	1276471.69	613375.99
281085	601665	281325	601965	38	385.3	1276629.79	613729.32
290475	599955	289905	601335	337	1505.3	1285636.69	612620.79
289905	601335	289905	601785	359	453.6	1285333.6	613551.21
289905	601785	289575	602445	333	743.8	1285157.6	614115.63
289575	602445	289395	602715	326	326.9	1284893.4	614587.42
289395	602715	288975	603345	326	762.7	1284584.48	615043.5
282735	601515	282165	601485	267	570.8	1277880.89	613419.95
282165	601485	281505	601125	241	752	1277269.86	613215.3
270015	601245	269925	601545	343	315.8	1265404.69	613193.11
269925	601545	269715	602025	336	528.1	1265246.9	613589.22
269715	602025	269565	602355	335	365.3	1265058.8	614000.34
269565	602355	269565	602565	359	211.6	1264978.39	614274.85
269565	602565	269505	602865	348	308.4	1264943.27	614534.51
282975	601185	283155	601575	24	431.7	1278498.19	613303.42
283155	601575	283275	601755	33	217.1	1278642.49	613595.43
283275	601755	283515	601965	48	319.4	1278818.58	613795.97
287955	601695	288315	601695	90	360.1	1283561.18	613672.33
288315	601695	288615	601785	73	313.1	1283890.24	613721.31
288615	601785	289065	601935	71	474.2	1284262.8	613847.18
287565	601335	288525	601095	104	991.1	1283480.73	613182.02
286065	601725	285765	601965	308	386.1	1281338.52	613804.45
285765	601965	285585	602325	333	405.7	1281092.59	614108.09
285585	602325	285255	602925	331	690.1	1280828.06	614595.14
292065	601425	293205	601545	84	1146.2	1288064.66	613500.1
294225	601845	293505	601605	251	758.8	1289289.71	613756.24
293505	601605	293205	601305	224	425.2	1288785.14	613476.18
293205	601305	292485	601005	247	780	1288281.17	613165.52
266415	602085	266322.8389	602029.7033	238	107.5	1261790.79	613833.14
275535	601845	275235	601935	286	313.8	1270809.07	613750.13
275235	601935	274905	602265	315	469.4	1270489.91	613961.19
274905	602265	274125	602565	291	837.7	1269928.68	614276.98
274125	602565	273855	602565	270	270	1269400.74	614424.84
273855	602565	273165	602745	284	714.2	1268919	614511.95
282465	602385	282045	602145	240	483.9	1277670.67	614198.12
282045	602145	281805	602145	270	240	1277343.11	614072.63

281805	602145	281505	602025	248	323.1	1277074.34	614008.89
291345	601875	291705	602355	36	602	1286942.34	614132.26
291705	602355	291915	602505	54	258.3	1287221.04	614456.14
291915	602505	292065	602805	26	337.1	1287396.55	614687.26
292065	602805	292185	603195	16	410.6	1287524.67	615040.34
292185	603195	292365	603705	19	544	1287665.7	615500.64
292365	603705	292665	604005	44	425.2	1287897.61	615915.89
292665	604005	292905	604305	38	385.4	1288161.61	616224.33
292905	604305	293205	604545	51	384.7	1288426.2	616502.19
283875	602475	284775	601785	127	1139.6	1279743.07	614080.06
288825	602115	288825	602535	359	423.3	1284238.56	614321.22
288825	602535	288795	602745	351	213.9	1284217.3	614642.29
288795	602745	288375	603825	338	1168.4	1283979.49	615297.9
288375	603825	287595	604635	316	1131.4	1283360.73	616255.9
288045	602745	286995	602115	238	1225.1	1282931.66	614416.06
286875	602835	286515	602715	251	379.4	1282099.9	614760.1
286515	602715	286005	602625	259	517.7	1281667.05	614648.94
286005	602625	285585	602325	234	516.6	1281206	614445.72
285585	602325	285195	602175	248	417.8	1280805.54	614212.48
285195	602175	284925	601875	221	404.6	1280480.06	613979.94
284925	601875	284775	601785	238	175	1280273.98	613779.12
284775	601785	284475	601275	210	594.2	1280054.98	613471.1
278085	602865	277485	602715	255	618.3	1273190.76	614690.76
277485	602715	276945	602535	251	569.1	1272624.14	614517.07
276945	602535	276645	602505	264	301.4	1272206.29	614405.98
276645	602505	276285	602565	279	365.3	1271876.03	614418.1
276285	602565	275595	602415	257	705.9	1271352	614367.18
291315	602715	290655	602415	245	725	1286393.48	614586.13
290655	602415	290445	602355	254	218.3	1285962.12	614398.52
290445	602355	290115	602265	254	342	1285693.65	614319.52
293295	602415	292665	602295	259	641.2	1288392.36	614390.52
292665	602295	292455	602115	229	277	1287975.39	614233.66
282645	602535	282885	603015	26	539.2	1278170.43	614722.97
282885	603015	283215	603315	47	446.8	1278447.61	615123.33
283215	603315	283575	603585	52	450.5	1278786.87	615417.2
275475	599865	275835	600615	25	836	1271111.98	612070.52
275835	600615	276555	601125	54	883.1	1271639.34	612718
276555	601125	276915	601185	80	364.9	1272173.57	613013.74
276915	601185	277545	601395	71	663.9	1272665.81	613156.12
277395	602655	277245	602235	199	448.5	1272732.72	614334.56
277245	602235	276735	601725	224	722.7	1272412.06	613857.3
276735	601725	276555	601125	196	630.3	1272078.19	613288.15
267945	603015	267645	602955	258	305.8	1263198.05	614792.74
267645	602955	267105	602925	266	540.8	1262779.01	614742.76

267105	602925	266595	602985	276	513.8	1262253.77	614752.9
266595	602985	266055	603315	301	635.3	1261724.9	614946.52
294855	602085	294795	602415	349	338.3	1290239.16	614300.52
294795	602415	294765	602835	355	424.6	1290186.73	614682.54
294765	602835	294885	603585	8	765	1290220.11	615279.55
294885	603585	294345	605295	342	1808.4	1289985.69	616531.98
285855	603615	284715	603285	253	1186.5	1280676.63	615435.09
284715	603285	284385	603045	233	408.5	1279947.41	615137.54
277815	603165	278175	603615	38	578	1273388.73	615304.51
278175	603615	278235	603675	44	85	1273593.6	615566.51
278235	603675	278685	604005	53	558.6	1273844.66	615767.77
286245	603705	285825	603705	270	420.1	1281421.45	615702.19
285825	603705	285255	603675	267	570.8	1280926.81	615682.22
285255	603675	284505	603525	258	764.6	1280268.69	615584.21
284505	603525	283905	603105	234	733.1	1279599.46	615287.22
283905	603105	283635	603015	251	284.5	1279169.61	615023.09
283635	603015	283305	602655	222	489.6	1278874.14	614790.83
265905	604065	266625	603525	127	904.2	1261651.92	615603.42
264982.3098	603841.3175	265905	604065	76	949.1	1260827.48	615756.55
270375	603675	271425	603465	101	1072	1266290.94	615419.42
280125	603585	279735	603975	315	554.8	1275315.69	615720.67
279735	603975	279585	604215	328	285.1	1275039.42	616039.26
279585	604215	279375	604545	327	394	1274853.73	616328.11
295635	604125	295635	604515	359	393.1	1291007.94	616419.05
295635	604515	295605	604815	354	304	1290986.08	616770.75
295605	604815	295545	605115	348	308.5	1290935.12	617076.29
282135	604185	281775	602835	194	1406.1	1277345.85	615464.7
281775	602835	280635	601455	219	1795.1	1276623.2	614065.79
280635	601455	279675	600825	236	1149.1	1275593.39	613031.1
279675	600825	279375	600405	215	517.9	1274973.94	612489.83
279375	600405	279105	598725	188	1713.6	1274709.87	611416.56
279105	598725	278475	597705	211	1203.7	1274286.76	610035.85
278475	597705	277875	597075	223	872	1273688.23	609188.87
277875	597075	277635	596535	203	594	1273279.9	608588.44
271785	602835	272325	603285	49	703.9	1267456.05	614910.74
272325	603285	272625	603495	54	366.5	1267869.38	615251.24
272625	603495	273345	603765	69	768.8	1268374.5	615500.86
271545	604215	272265	603585	131	961.8	1267289.2	615765.62
268395	604215	268965	604155	96	573.5	1264058.81	616024.69
268965	604155	269415	604005	108	475.3	1264570.87	615922.64
269415	604005	269805	604065	81	394.5	1264991.73	615880.87
289245	603915	289425	604305	24	431.7	1284712.95	616146.22
289425	604305	289665	604695	31	459.8	1284915.15	616545.88
289665	604695	289965	604995	44	425.2	1285178.23	616900.22

284775	604515	285015	604185	144	410.9	1280268.71	616349.1
285015	604185	285795	603765	118	889	1280786.14	615971.55
284265	604635	284775	604515	103	524.7	1279889.25	616574.97
284775	604515	285045	604515	90	270	1280280.41	616517.49
285045	604515	285825	604545	87	780.6	1280805.04	616537.75
283635	603015	283635	603555	359	544.3	1279030.13	615251.23
283635	603555	283455	604035	339	516.9	1278929.96	615770.4
283455	604035	283425	604665	357	635.8	1278813.88	616335.3
283785	603705	283455	604035	315	469.5	1279003.45	615847.58
283455	604035	283185	604305	315	384.1	1278697.49	616150.63
283185	604305	282705	604815	316	704.7	1278314.73	616544.72
283425	604665	283245	604875	319	278.4	1278700.48	616762.55
283245	604875	282945	605025	296	336.5	1278456.91	616943.81
282945	605025	282495	605265	298	511.8	1278078.04	617139.06
282495	605265	282135	605385	288	380.3	1277669.48	617318.73
282705	604815	282945	605025	48	319.4	1278187.54	616910.65
282945	605025	283155	605445	26	471.8	1278406.2	617233.97
283155	605445	283515	605865	40	554.7	1278682.76	617664.93
283515	605865	284295	606255	63	872.2	1279244.58	618083.32
267165	604305	266775	604185	252	407.9	1262347.78	616069.07
266775	604185	266355	604245	278	424.6	1261943.43	616034.5
266355	604245	265965	604305	278	394.9	1261537.26	616091.68
281805	604395	281535	603015	190	1415.8	1277056.98	615660.81
281535	603015	280605	601815	217	1522.9	1276482.83	614339.8
280605	601815	280005	601425	236	716.1	1275733.8	613521.94
277155	604545	276795	604335	239	416.9	1272347.8	616365.22
276795	604335	275895	603105	215	1529.2	1271732.31	615625.09
278145	604395	277155	604545	278	1002.2	1273022.12	616402.31
293955	604095	293835	604425	340	354.1	1289269.37	616341.73
293835	604425	293775	604965	353	547.9	1289170.72	616784.51
293775	604965	293625	605325	337	393.2	1289056.77	617242.45
293625	605325	293595	605535	351	213.9	1288961.1	617532.25
293595	605535	293385	606045	337	556.1	1288833.93	617898.26
281385	604605	281325	604275	190	337.7	1276727.31	616407.22
281325	604275	280875	603675	216	752.4	1276481.65	615930.67
297168.686	604486.843	297045	604425	243	138.3	1292476.88	616571.27
297045	604425	296685	604305	251	379.4	1292236.88	616476.31
296685	604305	296475	604335	278	212.3	1291952.81	616427.79
296475	604335	295815	604455	280	671.6	1291516.38	616500.25
295815	604455	295635	604515	288	190.2	1291094.65	616588.16
295635	604515	295005	604515	270	630.1	1290689.11	616615
290775	604605	291195	604275	128	536.8	1286356.16	616498.18
291195	604275	291465	604125	119	310	1286705.9	616256.66
291465	604125	291825	603615	144	628.8	1287027.43	615923.08

272415	604785	271995	604935	289	447	1267569.86	616747.22
271995	604935	271635	604965	274	361.4	1267178.09	616835.18
271635	604965	271305	605175	302	392.7	1266830.7	616954.15
292185	604815	291435	605355	305	928.6	1287168.2	617163.64
291645	604755	292065	603735	157	1112.2	1287229.94	616307.45
296625	604575	295815	605085	302	961.2	1291582.72	616944.58
295815	605085	295455	605205	288	380.3	1290991.53	617260.41
295455	605205	295095	605355	292	391.1	1290628.89	617394.75
274485	604815	274665	605085	33	325.7	1269937.81	616861.99
274665	605085	274725	605115	63	67.1	1270054.78	617016.08
274725	605115	275025	605535	35	517.9	1270230.24	617247.21
269205	604695	269325	605085	16	410.5	1264629.55	616749.1
269325	605085	269475	605325	31	284.1	1264758.18	617071.54
269475	605325	269535	605835	6	517.2	1264855.61	617454.84
285855	605145	286215	604845	130	471.1	1281395.68	617017.58
286215	604845	286425	604695	125	259.3	1281685.14	616790.85
286425	604695	286755	604395	132	448.5	1281959.61	616563.97
292875	605205	292425	604395	208	930.8	1288013.78	616880.84
290925	604635	291045	605205	11	586.5	1286346.59	616987.66
291045	605205	291315	605655	30	527	1286531.39	617509.57
291315	605655	291435	606105	14	468.8	1286717.38	617970.29
283755	605205	284835	604695	115	1198	1279656.77	616955.21
267735	604905	267975	605115	48	319.4	1263217.26	616857.59
267975	605115	268275	605355	51	384.7	1263482.7	617089.61
268275	605355	268575	605655	44	425.1	1263777.22	617367.79
284295	605265	284685	604995	124	476.5	1279848.15	617140.6
284685	604995	286155	604635	103	1515.7	1280784.35	616828.22
266415	604575	266175	604815	315	341.4	1261663.77	616521.14
266175	604815	265725	605025	295	498	1261314.26	616747.1
265725	605025	265425	605295	312	405.8	1260934.45	616988.04
272925	605325	272835	604395	185	941.2	1268244.79	616753.79
293085	605295	293565	605475	69	512.6	1288677.03	617483.71
293565	605475	294045	605565	79	488.3	1289154.28	617625.85
294045	605565	294405	605595	85	361.2	1289573.04	617690.95
276735	605835	277395	605565	112	714.9	1272412.48	617650.71
277395	605565	277665	605295	135	384.1	1272882.86	617379.92
279735	605025	280215	605295	60	550.9	1275333.03	617128.13
280215	605295	280575	605295	90	360.1	1275750.28	617269.8
292455	605115	292665	605655	20	582.7	1287912.13	617476.57
292665	605655	292935	605955	41	404.7	1288143.72	617907.12
292935	605955	293205	606225	44	382.7	1288408	618200.28
290415	605685	290685	605895	51	342.5	1285894.27	617870.78
290685	605895	290805	606165	23	297	1286084.46	618117.35
290805	606165	291285	606525	52	600.7	1286378.13	618441.38

287565	605565	287115	605895	306	560.7	1282685.83	617779.39
287115	605895	286845	605955	282	277	1282321.97	617974.83
286845	605955	286425	606225	302	501.4	1281973.7	618139.81
272025	604995	272415	606075	19	1154.8	1267571.26	617435.51
272415	606075	272415	606405	359	332.6	1267752.03	618156.13
272415	606405	272505	606945	9	551.3	1267788.25	618600.03
272415	606075	273165	605895	103	772.4	1268132.14	617899.82
273165	605895	273285	605835	116	134.6	1268569.52	617781.72
273285	605835	273885	605595	112	647.8	1268932.51	617632.3
274665	606075	273885	605595	238	916.3	1269620.03	617761.34
283695	606225	282945	605655	232	943.1	1278662.04	617955.39
282945	605655	282825	605445	209	242.9	1278234.91	617553.59
296055	605775	295785	606255	330	555.1	1291259.16	618150.31
295785	606255	295605	606585	331	378.9	1291026.11	618561.25
295605	606585	295580.5406	607172.0253	357	592.4	1290914.74	619027.91
293325	606195	293415	606855	7	671	1288699.27	618646.69
293415	606855	293835	607695	26	943.7	1288939.25	619413.92
293835	607695	294015	607965	33	325.7	1289228.12	619982.71
294015	607965	294345	608355	39	512.3	1289476.49	620321.63
293355	607545	293685	607965	37	535.8	1288824.66	619902.44
293685	607965	293805	608385	15	439.6	1289041.23	620332.86
293805	608385	293865	608745	9	367.6	1289123.41	620731.43
267855	606435	267765	606015	191	432.4	1263147.73	618095.71
267765	606015	267915	605475	164	565	1263187.43	617606.7
274905	605955	275415	606165	67	551.5	1270500.42	617999.31
275415	606165	275805	606375	61	443.1	1270946.14	618217.77
275805	606375	276315	606615	64	563.7	1271391.57	618451.52
275415	606165	275385	606525	355	364.2	1270734.65	618292.2
275385	606525	275385	606855	359	332.6	1270712.7	618643.78
275385	606855	275355	607275	355	424.5	1270690.14	619025.95
274605	606165	274665	606645	6	487.2	1269968.51	618345.95
274665	606645	274785	606975	19	353.1	1270050.34	618759.72
274785	606975	274875	607605	7	640.9	1270145.64	619250.1
280575	606705	279795	605865	222	1149	1275520.42	618277.18
279795	605865	279615	605325	198	572.6	1275054.33	617569.06
270285	606255	270285	606705	359	453.5	1265617.37	618379.97
270285	606705	270195	606915	336	230.3	1265565.71	618715.94
270195	606915	269925	607395	330	554.9	1265378.75	619065.87
265635	608145	265575	607635	186	517.2	1260909.18	619771.16
265575	607635	265515	607395	193	249	1260856.79	619388.31
265515	607395	265275	606765	200	677.9	1260715.62	618943.41
265275	606765	265125	606615	224	212.6	1260528.54	618543.93
265125	606615	265035	606285	195	344.2	1260413.41	618298.1
267495	606645	266775	606015	228	958.2	1262470.67	618196.09

274515	607335	274125	606795	215	668.3	1269640.23	619015.75
274125	606795	273615	606555	244	563.7	1269198.13	618613.77
273885	607065	274215	607725	26	741.4	1269363.59	619349.55
274215	607725	274305	608235	9	521.5	1269561.75	619948
274305	608235	274365	608625	8	397.4	1269627.65	620407.5
268875	606705	268515	606975	307	452.1	1264020.22	618731.34
268515	606975	268305	607305	327	394	1263729.18	619034.36
268305	607305	268155	607635	335	365.3	1263542.51	619368.98
269445	607125	269805	607095	94	361.4	1264944.69	619015.73
269805	607095	270195	606915	114	430.8	1265321.78	618912.37
270195	606915	270585	606855	98	394.9	1265714.18	618793.87
276285	606735	276765	607245	43	702	1271846.56	618960.69
276765	607245	276825	607485	13	249	1272108.98	619345.62
276825	607485	276945	607875	16	410.5	1272192.61	619667.65
276945	607875	276915	608205	354	334	1272230.35	620035.12
276915	608205	276855	608715	353	517.7	1272176.87	620462.88
276855	608715	276975	609045	19	353.1	1272198.38	620891.38
290835	607245	291075	607485	44	340.1	1286267.72	619480.69
291075	607485	291345	607845	36	451.5	1286516.69	619789.02
291345	607845	291555	608085	40	319.8	1286750.65	620097.2
286935	607575	285195	607125	255	1796.8	1281378.49	619419.21
267285	607335	266955	607305	264	331.3	1262435.63	619205.12
266955	607305	266355	607575	294	659.8	1261968.23	619322.85
266355	607575	266175	607635	288	190.1	1261574.91	619487.19
266175	607635	265815	607815	296	403.8	1261302.5	619606.84
290145	607365	290175	607725	4	364	1285469.19	619656.77
290175	607725	290085	607995	341	287	1285432.88	619977.71
290085	607995	290115	608715	2	726.3	1285392.95	620482.2
276495	607455	275715	606825	230	1003.9	1271423.57	619109.55
274995	607665	275205	607905	40	319.7	1270405.63	619757.38
275205	607905	275325	608085	33	217.1	1270566.38	619973.08
275325	608085	275655	608295	57	391.4	1270787.42	620174.07
287415	607965	285705	607635	259	1741.1	1281864.41	619882.77
285705	607635	285225	607635	270	480.1	1280772.82	619704.12
285225	607635	284475	607425	254	778.6	1280159.98	619591.2
284475	607425	284055	607485	278	424.6	1279576.54	619509.15
292365	607995	291885	607185	210	945.6	1287433.1	619721.12
271035	608595	270765	608745	299	310	1266188.01	620618.56
270765	608745	270615	608865	308	193	1265975.29	620754.12
270615	608865	270225	609255	315	554.8	1265700.14	621011.41
273105	607995	272775	608025	275	331.5	1268241.24	619965.7
272775	608025	272535	608175	302	284.2	1267954.44	620054.67
272535	608175	272235	608205	275	301.7	1267682.64	620143.78
288855	608235	289395	608715	48	723.7	1284415.63	620595.36

289395	608715	289995	608865	75	618.3	1284979.25	620921.96
287385	608355	286935	608325	266	451	1282453.5	620439.1
286935	608325	286665	608325	270	270.1	1282093.84	620420.38
286665	608325	285705	607845	243	1073.5	1281483.71	620169.82
280785	607725	280425	608355	330	731.1	1275905.07	620070.59
280425	608355	280395	608535	350	184	1275701.92	620481.65
280395	608535	280155	609705	348	1204.3	1275553.3	621168.57
268455	608415	268815	608505	75	370.9	1263927.42	620382.18
268815	608505	269325	608655	73	531.4	1264359.96	620508.8
269325	608655	269805	608625	93	481.1	1264853.71	620574.84
266415	608595	267195	609075	58	916.3	1262089.92	620746.35
287625	608775	288135	608175	139	792.7	1283170.73	620583.58
288135	608175	288435	608055	112	324	1283582.93	620220.32
294345	608355	294580.7563	608406.2514	77	241.2	1289754.92	620549.27
290865	608325	291255	608745	42	574.5	1286349.26	620674.8
291255	608745	291465	608985	40	319.8	1286642.61	621014.14
291465	608985	291735	609195	51	342.5	1286878.07	621245.84
283155	608235	282885	608475	311	363.2	1278313.53	620414.94
282885	608475	282735	608745	331	311.3	1278098.41	620672.93
282735	608745	282375	608985	303	434.6	1277838.29	620930.49
273345	608505	273285	608085	187	427.3	1268610.45	620259.92
273285	608085	272895	607575	217	644	1268394.87	619783.67
276345	608835	275685	608445	239	767	1271303.29	620637.95
275685	608445	274845	608265	257	858.8	1270559.1	620340.1
274845	608265	274395	608385	285	466.5	1269914.75	620303.23
288165	608475	288405	608895	29	485.9	1283571.48	620801.56
288405	608895	288465	609405	6	517.3	1283712.12	621277.15
288465	609405	288465	610155	359	756	1283729.44	621919.85
285045	609105	284745	609045	258	305.9	1280173.89	621167.01
284745	609045	284325	608985	261	424.2	1279815.13	621102.39
284325	608985	284025	608925	258	305.9	1279456.36	621037.77
272535	608925	272745	609195	37	343.1	1267920	621033.21
272745	609195	272835	609585	12	402.9	1268063.31	621371.1
272835	609585	273105	610125	26	606.6	1268233.87	621846.92
282585	609345	283515	609285	93	932.4	1278324.18	621394.07
291105	608175	291555	608655	42	659.5	1286621.64	620554.96
291555	608655	291945	608805	68	417.8	1287035.28	620880.14
291945	608805	292335	608925	72	408	1287422.54	621021.47
290565	608745	290895	609045	47	446.8	1286012.06	621038.8
290895	609045	291135	609435	31	459.8	1286290.1	621393.3
291135	609435	291375	609675	44	340.1	1286523.76	621716.78
268605	608895	268545	609225	349	338.1	1263855.24	620993.23
268545	609225	268455	609615	346	403.5	1263772.94	621359.47
268455	609615	268395	609975	350	367.9	1263690.32	621741

268395	609975	268425	610245	6	273.6	1263668.92	622061.96
268425	610245	268425	610935	359	695.3	1263674.15	622551.42
266865	609435	268275	609435	90	1410.1	1262842.68	621365.55
269985	609345	270525	609375	86	540.8	1265529.06	621315.62
270525	609375	271155	609705	62	711.3	1266110.37	621504.87
289305	609075	289035	609555	330	555	1284443.74	621452.36
289035	609555	288825	609915	329	420	1284195.31	621878.37
288825	609915	288585	610365	332	514	1283962.17	622289.23
277455	609105	278295	609285	77	858.8	1273151.95	621221.84
278295	609285	278595	609195	106	313.8	1273721	621273.24
270015	608835	269565	609495	325	804.5	1265068.04	621112.25
269565	609495	269295	609645	299	310	1264699.84	621521.56
269295	609645	269115	609795	310	235.5	1264471.81	621672.25
269115	609795	268725	610245	319	599.3	1264180.72	621975.26
282105	609165	282195	609675	9	521.5	1277422.13	621492.5
282195	609675	282105	610005	344	344.9	1277413.65	621920.73
282105	610005	281955	610545	344	565.1	1277284.86	622363.11
280005	608115	280365	607785	132	491.1	1275486.91	619974.79
280365	607785	280665	607125	155	730.8	1275826.86	619473.27
266205	609825	266233.8079	609983.4433	10	162.1	1261482.61	621830.47
266378.0292	610409.3157	266385	610425	23	17.2	1261634.27	622354.94
266385	610425	266475	610725	16	315.1	1261679.54	622516.32
273495	609615	273195	609915	315	426.8	1268610.67	621758.84
273195	609915	273075	610185	336	297.8	1268394.9	622047.33
273075	610185	272565	610605	309	664.1	1268072.91	622395.96
267645	610065	268035	609945	107	408.8	1263101.08	621949.28
268035	609945	268455	609615	128	536.7	1263510.63	621723.93
268455	609615	269175	609225	118	821.7	1264087.92	621362.58
269175	609225	268965	607905	188	1345.9	1264360.26	620493.51
284025	608925	283905	609045	315	170.7	1279245.77	621066.35
283905	609045	283695	609705	342	698.4	1279072.92	621462.43
283695	609705	283725	610155	3	454.4	1278971.73	622027.47
283725	610155	283605	610635	345	498.9	1278917.34	622501.17
283605	610635	283545	611025	351	397.9	1278818.56	622943.85
283545	611025	283245	611415	322	495.4	1278630.68	623339.78
283245	611415	283096.295	611712.4101	333	335.1	1278399.38	623688.08
274455	610485	273615	609975	238	983.2	1269291.2	622239.65
274125	610095	274635	610035	96	513.9	1269639.53	622074.81
274635	610035	275175	610095	83	543.2	1270164.51	622079.94
275175	610095	275865	609945	102	707	1270780.39	622040.06
289005	610485	289455	610155	126	560.7	1284483.51	622477.75
289455	610155	289665	609915	138	321	1284819.23	622190.25
289665	609915	289965	609765	116	336.5	1285078.13	621993.82
268215	610245	267465	610365	279	760.2	1263094.98	622255.09

267465	610365	267045	610575	296	471.1	1262506.64	622417.49
267045	610575	266655	610875	307	494.4	1262096.47	622673.4
287715	610425	286785	610005	245	1020.5	1282505.76	622351.88
268995	610005	269505	610425	50	661.6	1264506.74	622177.3
269505	610425	269565	610485	44	85	1264786.85	622424.78
269565	610485	269895	610905	37	535.7	1264976.96	622671.36
269895	610905	270255	611175	52	450.5	1265314.92	623026.47
270255	611175	270525	611685	27	579.7	1265621.97	623427.16
266835	610545	266745	609585	185	971.2	1262049.91	622000.03
266745	609585	266865	609015	168	587.2	1262080.47	621220.36
273225	610275	273195	610635	355	364.2	1268461.68	622460.95
273195	610635	273225	611145	3	514.7	1268452.84	622904.42
273225	611145	273345	611565	15	439.5	1268518.39	623379.21
282375	610785	282945	610635	104	590.4	1277906.03	622812.71
282945	610635	283155	610635	90	210	1278297.53	622739.98
283155	610635	283545	610665	85	391.1	1278597.21	622758.16
283545	610665	283785	610725	75	247.3	1278911.28	622807.07
283785	610725	284115	610725	90	330.1	1279195.66	622840.39
278835	610695	277995	609975	229	1108	1273668.85	622389.37
279675	610455	278385	609855	244	1422.8	1274287.46	622211.8
278385	609855	278205	609645	220	277.3	1273560.7	621791.76
271095	610605	271095	610995	359	393	1266339.76	622791.87
271095	610995	271125	611355	4	363.9	1266347.13	623174.31
271125	611355	271335	611865	22	554.5	1266458.27	623618.95
286545	611115	286575	610125	178	998.4	1281807.63	622758.28
279615	611085	280155	610275	146	980.6	1275131.79	622755.35
279615	611085	279225	611115	274	391.4	1274658.3	623179.07
279225	611115	279045	611145	279	182.7	1274372.71	623206.9
279045	611145	278565	611235	280	488.9	1274041.51	623264.87
286545	611205	287385	610875	111	904.8	1282204.13	623190.41
275205	610965	274755	611355	311	598.7	1270217.28	623197.02
274755	611355	274335	611505	289	447	1269776.81	623468.03
274335	611505	273855	611715	293	525.4	1269323.17	623647.12
272745	611505	273225	611685	69	512.5	1268213.52	623620.94
273225	611685	273735	611955	61	577.2	1268703.92	623855.18
273735	611955	274215	612105	72	502.8	1269194.63	624074.13
277455	610755	278145	611055	66	752.4	1273042.33	622964.54
278145	611055	278415	611025	96	271.8	1273519.57	623106.84
287025	611175	287235	611505	32	392.7	1282363.06	623497.9
287235	611505	287595	611715	59	417	1282642.59	623775.93
287595	611715	288195	612105	56	716.1	1283116.5	624086.42
288195	612105	288382.3374	612409.4233	31	358.9	1283503.14	624444.22
290859.0362	610771.0308	290805	610725	229	71.1	1286076.8	622929.38
282195	610785	282248.5145	611667.989	3	891.4	1277457.36	623335.12

281145	611355	281895	610695	131	1004.5	1276759.72	623122.9
281145	611355	281126.6217	611685.8093	356	334	1276365.52	623624.31
275055	611475	275265	612075	19	639.4	1270384.78	623825.78
275265	612075	275355	612225	30	175.6	1270527.15	624209.56
275355	612225	275595	612525	38	385.3	1270687.56	624440.56
289185	611325	289550.6704	611657.4277	47	495.1	1284597.72	623673.38
267105	611715	267015	612015	343	315.8	1262283.21	623837.57
267015	612015	267015	612403.6554	359	391.6	1262231.18	624188.12
279741.0526	612171.5129	279645	611235	185	948.4	1274919.08	623796.78
272475	612225	272775	612435	54	366.5	1267838.57	624366.7
272775	612435	273255	612705	60	550.9	1268223.67	624615.21
273255	612705	273735	613065	52	600.6	1268697.23	624941.07
273345	612465	273585	612675	48	319.4	1268673.65	624619.64
273585	612675	274065	612885	66	523.9	1269029.36	624837.27
274065	612885	275145	613335	67	1169.9	1269802.62	625181.36
284655	611385	284976.6572	612166.1675	22	849.4	1280040.2	623919.92
274095	612435	274035	612795	350	368	1269272.72	624671.41
274035	612795	274065	612885	18	95.4	1269253.14	624900.65
274065	612885	274005	613395	353	517.7	1269232.02	625206.34
270075	611475	269505	611505	273	571	1265020.77	623482.39
269505	611505	269055	611715	295	498.1	1264508.34	623599.67
269055	611715	268755	612105	322	495.4	1264127.24	623901.77
269265	613005	268815	612825	248	484.6	1264241.72	624927.61
268815	612825	268395	612855	274	421.3	1263808.26	624846.84
279049.1105	612479.7116	279255	612315	128	265	1274364.05	624499.22
272895	612885	272565	612945	280	335.8	1267931.64	624964.12
272565	612945	272085	613125	290	513.9	1267524.2	625082.46
272085	613125	271755	613335	302	392.8	1267115.23	625277.25
269713.9916	613591.8902	269685	613215	184	380.8	1264891.22	625432.08
269685	613215	269265	612585	213	759.9	1264677.02	624916.64
274442.6906	613569.2023	274755	613365	123	374.7	1269789.19	625545.36
273841.8479	613501.6764	274005	613395	123	195.8	1269114.16	625519.59
278109.1775	613067.0439	277995	612855	208	241.9	1273252.66	625063.2