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AN APPRAISAL OF RENEWABLE ENERGY RESOURCES AS ALTERNATIVE SOLUTION TO POWER SUPPLY INADEQUACIES IN ADO-EKITI, NIGERIA

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ABSTRACT

The development of the society and the grid cannot be achieved unless there is an immense impact on the electricity generation, distribution, and utilization of electrical energy by the citizenry. The changes that can positively have an impact on the grid and society are changes in production; utilization changes and the changes in the grid, this is being centered upon as a function of the sufficiency of its electricity supply of the distribution companies and the effective distribution of reliable, adequate, and economically priced power to the end-users. More than three-quarters of power generation in Nigeria comes from non-renewable (coal, fossil fuel) energy sources which is epileptic and has several risks associated with their use. The increase in greenhouse gases, global warming, and climatic change associated with it, represent one of the greatest environmental challenges of our time and the greatest social dangers in the future. Non-renewable sources are gradually depleting and therefore, the need to harness clean, reliable, and environmentally friendly renewable energy sources that abound in Nigeria for the generation of power for socio-economic development. This paper reviews renewable energy that abounds in Ado-Ekiti which can be accessed for energy security. The future trend of this research should include a collection of renewable data and assessment as well as power generation with the view of injecting it into the grid.

KEYWORDS: Electricity; Economy; Energy; Power; Grid, Renewable; Development

INTRODUCTION

In Nigeria today, electricity is becoming an increasingly essential commodity, and constant power supply is hardly ever enjoyed in the country. Recent studies show that only 40% of Nigeria's population of over 200 million have access to electricity. The lack of reliable grid power means that most Nigerians have to resort to other measures of generating electricity, the most common of which is the use of fossil fuel (Adeoye et al., 2014). Due to the high cost of fuel and maintenance which is too expensive to be used in residences, offices, and health facilities, they have to operate without electrical power (Sygnite, 2020). The demand for energy in Nigeria exceeds the supply, which is epileptic at times due to a lack of generating and transmitting capacity, Ado-Ekiti, the Ekiti state capital is also being affected by this ugly trend of epileptic power supply. Ekiti is an agrarian State located in the eastern part of southwestern Nigeria, a typical rainforest belt (Adeoye et al., 2014). The State is bounded in the north by Kogi and Kwara; to the south and east by Ondo while in the west, it is bounded by Osun State. The State is located within the tropics between latitudes 70 151 to 80 51 north of the equator and longitudes 40 451 to 50 451 east of the prime meridian, the state capital's power grid is mentioned in the latitudes and longitudes with 16 local government areas of a land mass of 5887.89km2 as it is being shown in Fig 2 and 3 respectively. Ado-Ekiti, town, capital of Ekiti state, southwestern Nigeria. It lies in the Yoruba Hills, at the intersection of roads from Akure, Ilawe Ekiti, Ilesha, Ila-Orangun, and

Ikare, and is situated 92 miles (148 km) east of Ibadan. The current metro area population of Ado-Ekiti in 2023 is 536,000, a 3.88% increase from 2022. The metro area population of Ado-Ekiti in 2022 was 516,000, a 3.82% increase from 2021. The metro area population of Ado-Ekiti in 2021 was 497,000, a 3.54% increase from 2020.

Nigeria has abundant oil, gas, hydro, and solar resources which can generate over 20 megawatts (MW) of electric power from existing plants, of which 10,142 MW is thermal and 2,380 MW is hydro, but on most days, it can only generate around 5,000 MW, which is insufficient for the country's over 200 million people. Nigeria's hydroelectric and thermal-producing units are unable to create enough electricity to meet the country's household, commercial, and industrial demands (Ibitoye et al., 2007). While hydroelectric power is largely recognized as ecologically favorable, fossil fuel and nuclear power have related environmental limits. This is due to the negative consequences of their by-products. (Omole et al., 2014). If the numerous renewable resources that abound in Nigeria can be fully harnessed, the electrical power to meet the demands of our rising population and economy will not be a source of concern. Exploiting and using renewable energy (RE) sources would not only assist Nigeria in meeting its energy demands but also ensure environmentally friendly energy availability. According to (Awogbemi et al. 2015), there is an unbreakable link between energy availability and sustainable development, as well as the problems associated with the exploitation and utilization of non-renewable energy sources, and that Nigeria's quest for energy sufficiency will be a mirage if REs are not given their rightful place in the country's energy mix, and that REs are the only solution out of power poverty in Ado-Ekiti metropolis according to Yusuf et al (2022).

LITERATURE REVIEW

Renewable energy sources

Renewable energy is energy that is the energy of nature which is constantly renewed. This comprises solar energy, geothermal energy, heat, wind, tides, and water. The most important aspect of renewable energy is its unlimited nature and abundant availability. Renewable energy sources are clean energy sources that are more environmentally friendly than traditional fossil energy technologies (Uchegbulum et al., 2014). The majority of renewable energy expenditures go into materials and staff to create and operate the facilities, rather than expensive energy imports. People are becoming more conscious of the disadvantages of using fossil fuels, therefore renewable energy is the energy necessity of the day. Solar energy, hydropower, wind energy, biomass, and biogas are examples of recognized renewable energy (RE) and are fully explored in the course of the study under review.

Biomass

Biomass is a biological matter that comes from recently extinct or active creatures. It often refers to plants or products derived from plants that are referred to as lingo-cellulosic biomass. Biomass may be utilized as an energy source directly by being burned to create heat or indirectly by being transformed into different types of biofuel. There are many ways to convert biomass into biofuel, which may be genetically categorized as thermal, chemical, and biological techniques. Wood is currently the most popular biomass energy source. Examples given by Fagbohun & Adebanji (2014) include forest leftovers (such as dead trees, branches, and tree stumps), garden clippings, wood chips, and even city solid waste. Industrial biomass can be produced from miscanthus,

switchgrass, hemp, maize, poplar, willow, sorghum, sugarcane, bamboo, and various tree species, including eucalyptus and oil palm (palm oil). It is possible to transform biomass into other useful energy sources, including methane gasoline or automobile fuels like ethanol and biodiesel (Nwuhu et al., 2011). Methane gas, also referred to as "landfill gas" or "biogas," is released by decomposing waste materials, including food scraps, animal and human waste, and trash. Crops like maize and sugar cane can be fermented to produce ethanol, a fuel for vehicles. Biodiesel, a fuel alternative generated from leftover food such as vegetable and animal fats, is another form of transportation fuel. Different types of biomass are used in each region to create energy. Direct burning is the most widely used technique for getting energy from biomass for the generation of both heat and power, according to (Fagbohun and Adebanji 2014). Anaerobic fermentation of agricultural, animal, and human waste to produce biogas for a variety of uses is another application area that has been recognized.

Hydropower (Large and Small Scale)

Water movement that generates energy that may be captured and transformed into power is known as hydropower or hydroelectric power. According to Fagbohun and Adebanji (2014), this is referred to as a clean, environmentally friendly method of producing electricity. Miniature hydropower: Small hydro is the small-scale production of hydroelectricity for a single industrial unit or small town. Although the term "small hydro project" has several distinct definitions, it is usually accepted that anything with a production capacity of up to 10 megawatts (MW) qualifies. Small hydro plants can be connected to current electrical distribution networks to provide low-cost renewable energy (Fagbohun & Adebanji, 2014). Small hydro projects may also be built in areas without a national energy distribution network or in distant areas where it would be unprofitable to supply electricity via a network. Since small hydro projects often involve fewer reservoirs and civil construction projects than large hydro projects, they are believed to have a reduced environmental impact. Small hydro is frequently created by utilizing already-built dams or by constructing new dams whose primary use is irrigation or river and lake level control. Due to the limited environmental and licensing requirements, the equipment's standardization and simplification, the small scale of the civil works construction, and the typical serial manufacturing of small hydro projects, small hydro projects may often be produced extremely quickly. Since the equipment is physically tiny, it is simpler to carry it to distant locations without reliable road or rail connectivity.

Solar energy

The use of photovoltaic (PV) or concentrated solar power (CSP) to directly or indirectly convert sunlight into electricity is known as solar energy. A vast swath of sunlight is focused into a small beam by concentrating solar power systems using lenses, mirrors, and tracking technology. According to Fagbohun and Adebanji (2014), photovoltaics use the photovoltaic effect to convert light into electric current. Small and medium-sized applications, ranging from an off-the-grid home powered by a photovoltaic array to a calculator powered by a single solar cell, have been and still are powered by photovoltaic technology (Lawal et al., 2020). Direct sunlight is utilized to warm the working fluid in each of these systems before it is used to produce electricity or store energy. Power generation is possible for up to 24 hours with efficient thermal storage. Solar photovoltaic technology was one of the first renewable energy technologies to be adopted

globally for supplying electricity for basic needs, especially in remote locations. Due to their continuous use in space, current cost, and performance, PV technologies will be appropriate for a variety of grid-isolated and even grid-linked applications in both developed and developing regions of the world. From the above Table 3, it is seen that solar energy stands out as the most utilized energy source with 15MW, which tells how efficient solar energy is a blessing for Nigeria as a nation and its citizens. Both direct current (DC) and alternating current (AC) forms of solar photovoltaic energy are employed for a variety of tasks, including powering electrical appliances. One of the most promising renewable energy sources in the world is photovoltaic solar electricity. Since solar energy is generated for free, has no moving parts to break down, requires little maintenance, and minimizes losses, it has many advantages over non-renewable sources like coal, nuclear gas, and oil. It is also a non-polluting energy, which lowers emissions because it has no negative effects on the environment.

Wind energy

According to Fagbohun and Adebanji (2014), the definition of wind power is the conversion of wind energy into a form of useful energy, such as using wind turbines to produce electricity, windmills to provide mechanical power, wind pumps to pump or drain water, or sails to propel ships. Even though there is a lot of variation across shorter periods, wind power is very consistent from year to year. Contrary to fuel-based producing facilities, the capacity factor is affected by some variables, including the site's local wind variability and the size of the generator relative to the turbine's swept area (Fagbohun & Adebanji, 2014). A small generator would be less expensive and have a higher capacity factor, but it would produce less energy (and hence less profit) during heavy gusts. On the other side, a large generator would cost more, provide less electricity, and, depending on the type, stall out at low wind speeds. Small-scale wind power systems are defined as those that can produce up to 50 kW of electrical power from the wind. In distant areas, wind turbines could take the place of diesel generators. For financial or environmental reasons, people may purchase these systems to reduce or eliminate their dependency on the electricity grid.

Geothermal energy

Geothermal energy is thermal energy produced and retained by the Earth. The energy that affects the temperature of matter is known as thermal energy. According to Fagbohun and Adebanji (2014), the Earth's crust derives 80% of its geothermal energy from the radioactive decay of minerals and 20% from the planet's initial genesis. The continuous movement of thermal energy in the form of heat from the planet's core to the surface is caused by the geothermal gradient, which is defined as the temperature difference between the planet's core and its surface. According to Fagbohun and Adebanji (2014), the internal heat of the Earth is thermal energy produced by radioactive decay and continuing heat loss from Earth's creation. Temperatures near the core-mantle interface may be higher than 4000 °C (7,200 °F). Because of the tremendous temperature and pressure in the Earth's center, some rock melts and the solid mantle behaves plastically, causing segments of the mantle to convert upward since it is lighter than the surrounding rock. In the crust, rock and water are heated to temperatures of up to 370 °C (700 °F).

MATERIALS AND METHOD

Several journals, local and worldwide conference papers, and other relevant web resources were utilized to gather renewable energy access,

consumption, and future forecasts for renewable energy evaluation in Nigeria.

RESULTS AND DISCUSSION

Renewable energy trend in Nigeria

Solar energy

According to Awogbemi et al. (2015), the sun emits about 3.8 x 1023 kW of energy per second, or 1.082 million tonnes of oil equivalent (mtoe) every day. Nigeria has a yearly incident solar energy of 1.8044.851 1012 kWh based on a geographical area of 924 x 103 km 2 and the global average. Nigeria's geographic location ensures that sun radiation is distributed equally throughout the country, as shown in Figure 1. Every day, the sun shines for 5.5 hours on average. The country's annual solar energy value exceeds 115,000 times the quantity of power produced and is almost 27 times greater than its whole fossil fuel supply. This means that just 3.7% of Nigeria's land area is required for solar energy to be captured to match the nation's traditional energy sources. Yusuf et al. (2022) and Awogbemi et al. (2015).

Biomass

The estimated 8 x 102 MJ of biomass resources in Nigeria (including fuel wood, agricultural waste, sawdust, and municipal solid waste) can be used as fuel, fermented into biogas, or turned into paper. According to Awogbemi et al. (2015), Nigeria utilizes 80 million m3 of fuel wood annually for cooking and other household uses. This fuel wood has a 6 × 109 MJ energy content.

Wind energy

Wind speeds in northernmost Nigeria range from 4.0 to 5.12 m/s, whereas they are between 1.4 and 3.0 m/s in southern Nigeria. According to information currently available, 22 locations distributed across seventeen states in Nigeria have the potential to generate 1680.50 kWh of wind energy each year at a height of 25 meters. A wind turbine might produce up to 197.68 kWh/year in Sokoto, 93.91 kWh/year, 49.78 kWh/year, 49.98 kWh/year, and 101.10 kWh/year in Enugu, Ibadan, Port Harcourt, and Maiduguri, respectively, according to estimations by Awogbemi et al. (2015) and Mohamed & Petinrin (2014).

Biogas

Even though biogas is not currently a component of Nigeria's energy mix, researchers have found commercially viable feedstock such as manure, water hyacinth, cassava peels, rice husk, water lettuce, sawdust, banana peels, sewage, wood shavings, and more (Awogbemi et al., 2015). Approximately 227,500 tonnes of new animal waste will be produced daily in Nigeria, and each capital will generate 20 kilograms of urban solid waste each year. 1 kg of fresh animal dung can yield 0.03 m3 of biogas, or 6.8 million m3 of biogas, per day in Nigeria.

Hydroelectric energy

Nigeria now only possesses about 20,000 MW of technically exploitable hydropower out of a potential 30,000 MW (Awogbemi et al., 2015). Small hydropower (SHP) in Nigeria has a potential capacity of 3,500 MW at about 277 sites scattered throughout 12 states and four river basin authorities, with just 30 MW currently being utilized, according to (Awogbemi et al., 2015; Mohamed & Petinrin, 2014).

Renewable energy master plans in Nigeria

The government established Nigeria's Renewable Energy Master Plan (REMP) in 2009 which offers the efficient RE implementation of Nigeria's goal of attaining sustainable energy developmental objectives via this pathway, as seen in (Awogbemi et al, 2015). By 2025, renewable energy will produce 18% of all electricity. 20% of the power generated in 2030 will come from renewable sources. 100 MW of small hydro capacity by 2015 and 760 MW by 2025; 300 MW of solar PV capacity by 2015 and 400 MW by

2025; 40 MW of wind capacity by 2025; and 5 MW of biomass-fired capacity by 2015. 300 MW of solar PV capacity by 2015, expanding to 400 MW by 2025; 40 MW of wind capacity by 2025; and 5 MW of biomass-fired capacity by 2015, rising to 30 MW by 2025. Table 2 shows that these aims are excessively low in Nigeria as compared to other African nations in terms of clear government objectivity.

CONCLUSIONS AND RECOMMENDATIONS

The only solution to the global power supply dilemma in Ado-Ekiti and all of Nigeria is renewable energy. In addition to halting our (Ado-Ekiti and Nigeria as a whole) epileptic power supply and reducing the negative environmental effects associated with non-renewable energy sources like coal, oil, and natural gas, the choice of renewable energy sources is meant to advance the economic growth and development of the nation. Choosing a renewable energy source will not only result in long-term costs but will also help preserve the environment from the threats of fossil fuel pollution. The National Grid will always receive additional electricity produced in other parts of the country for use in Ado-Ekiti and other parts of the country, thus this can be done by utilizing our RE differential. Additionally, electrical companies should gradually switch to using renewable resources, which are plentiful and will never run out, while the government should play a significant role and there should be a sound policy in place. The following suggestions would help Ado-Ekiti, Ekiti State, and other parts of the world have more reliable and enough power supplies.

i. The use of contemporary technology methods to add electricity generation to both the local and the national grids.
ii. Direct measurements and analysis are used to get data on renewable resources.
iii. Gathering renewable data from the Nigeria Metrological Agency for use in complicated regression and computational intelligence.
iv. Using statistical analysis to assess variable different renewable energy sources

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Table 1: Renewable Energy Resources and Estimated Reserves in Nigeria.

S/N	Renewable Energy Sources	Estimated Power supply
1	Hydropower(Large/Small Scale)	14,750 MW
2	Solar Radiation	3.5 - 7.0 kWh/m^2/day
3	Wind	2 - 4 m/s at 10 m height
4	Biomass	144 million tons/year
5	Wave and Tidal Energy	150,000 TJ/year

Source: Nwulu 2011

Table 2: RE targets in Africa.

Country	RE targets	Target year
Cameroon	50% /80%	2015/2020
Cape Verde	50%	2020
Ghana	10%	2020
Madagascar	75%	2020
Mauritius	65%	2028
Niger	10%	2020
Nigeria	7%	2025
Rwanda	90%	2012

Source: (Awogbemi, 2015)

Table 3: Energy source consumption as of 2017

S/N	Resource		Reserve	Utilization Level
1	Large hydro power		11,250MW	1,900MW
2	Small Hydro power		3,500MW	64.2MW
3	Solar Energy		4.0 kWh/m^2/day 6.5kWh/m^2/day	15MW solar PV stand-alone No solar thermal electricity
4	Wind		2-4m/s at 10m height	2x2.5KW electricity generator; 10MW wind farm in Katsina
5	Biomass	Fuel wood	11 million hectares of forest and woodlands	43.4 million tonnes of firewood/yr
		Municipal waste	- 18.3 million tonnes in 2005* & about 30 million tonnes/yr now	-
		Animal waste	- 243 million assorted animals in 2001	-
		Energy Crops and agric waste	- 72 million hectares of Agricultural land	28.2 million hectares of Arable land only 8.5% is cultivated

Source: Zarma, (2017)

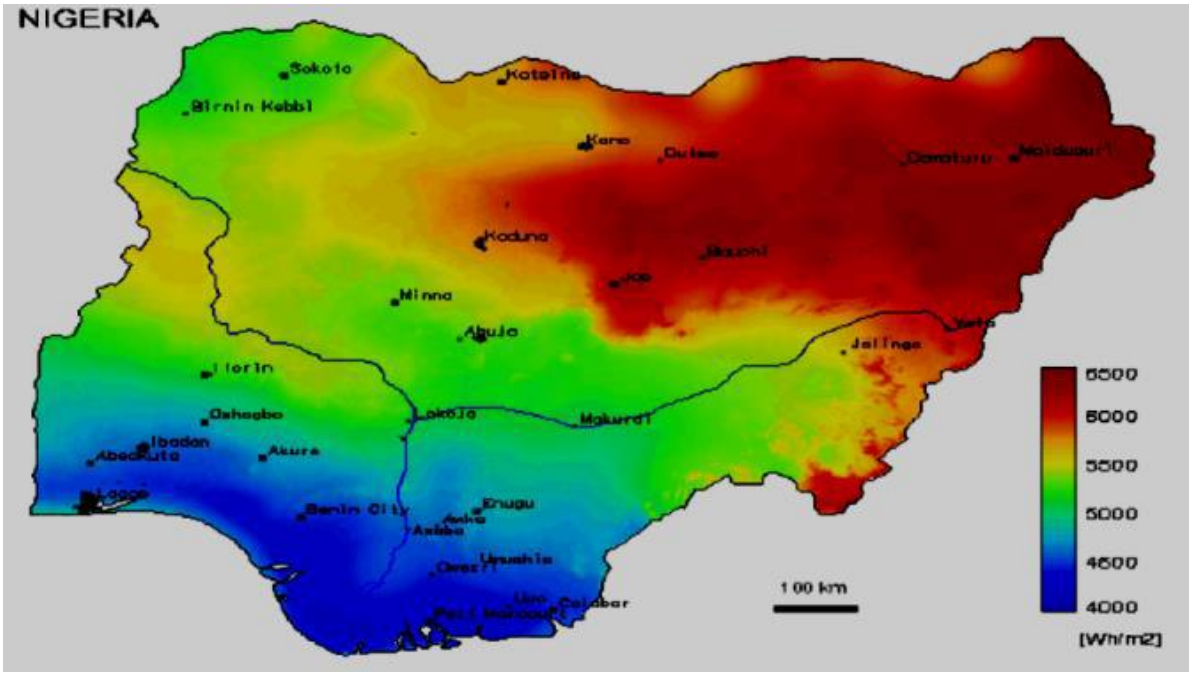

Figure 1: Solar radiation map of Nigeria.

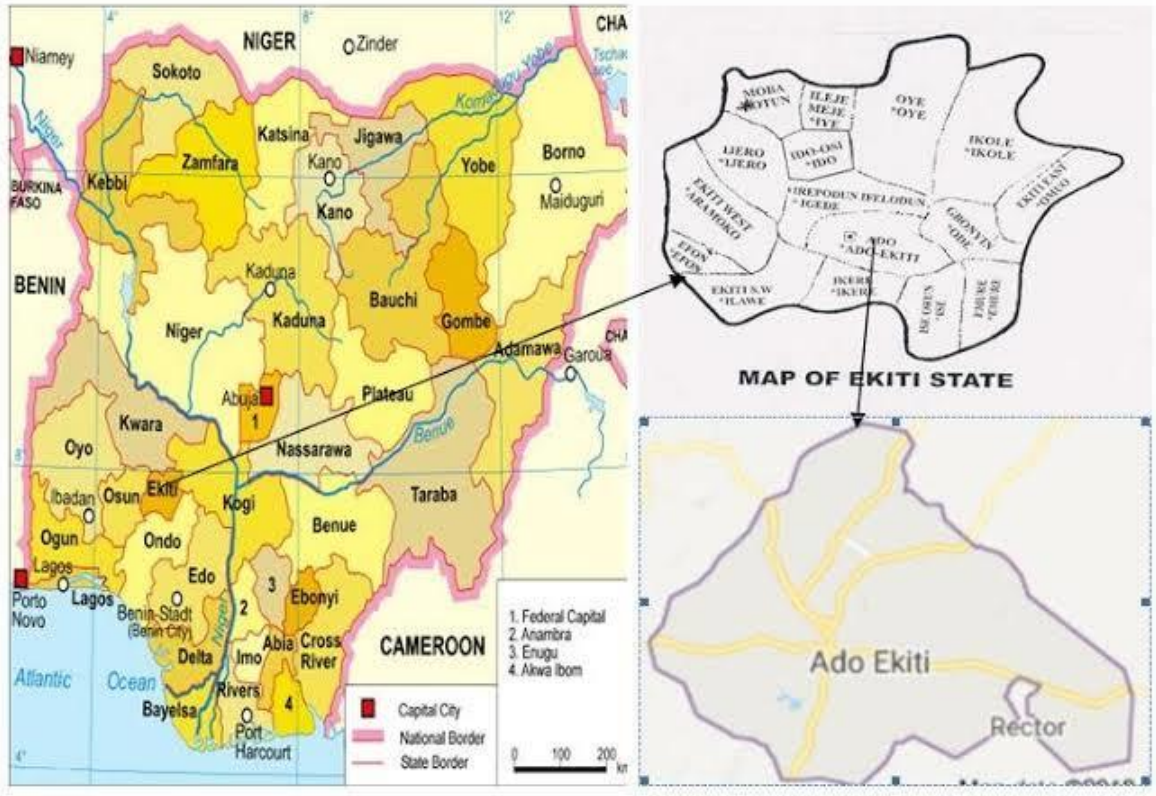

Figure 2: Map of Nigeria, Ekiti-State and Ado-Ekiti

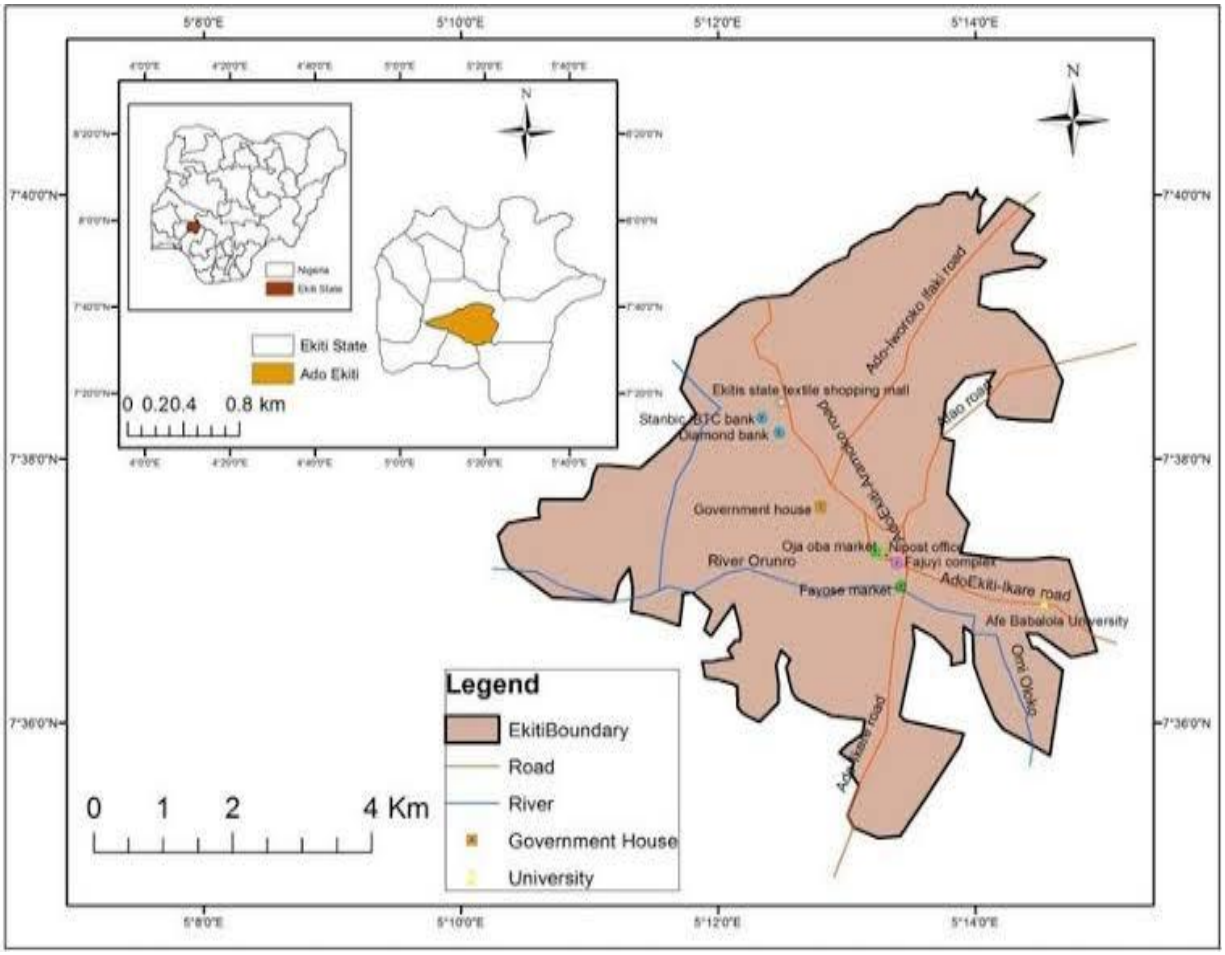

Figure 3: Administrative map of Ado-Ekiti with the road network.