Time Series Determination of Property Revenue for Mubi Metropolis using Remote Sensing and GIS

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Abstract

In the recent years, the need for Internal Generated Revenue (IGR) for infrastructures in Federal, State and Local Government for financial prowess for programs like Capital Grant, Livelihood Empowerment against Poverty and school feeding programs. The State and Local Government solemnly depends on funds allocated from the Central Government for their expenditures but all could not avail. It is on this ground that this research tends to investigate the Time Series Analysis (TSA) of the (IGR) from properties (Land Taxation) using Remote Sensing and GIS. The Color Composite image generated was then classified into four (4) different classes (Built Up areas, Bare land, Rocks and Vegetation) as identified using Maximum Likelihood; the post classification tool was used to determine the area cover statistics summary for each class and the classes was rasterized and the area cover in meter square was divided by 600 and then multiplied by the amount charged pa year for commercial and residential respectively which in turn resulted to the total sum of Internal Generate Revenue (IGR) for the year 1999 and the sum for the year 2018 respectively. It is therefore important that the payment of tax or revenue should be enacted as a law so as to boost the IGR o the local government authority to enable the payment of salaries for civil servants and for infrastructural developments such as Capital Grant, livelihood empowerment against poverty and school feeding programs.

Keywords - *Internal Generated Revenue, Property, Remote Sensing, GIS, Time Series Analysis*

I. INTRODUCTION

One of the most important sources of revenue generation in the world is property taxation; an effective property tax system has power to generate revenues to keep the government of any nation financial prowess for social programs like Capital Grant, livelihood empowerment against poverty and school feeding programs (Mantey & Tagoe, 2012).

State and Local government relies solemnly on funds allocated to them by the Central Government for their expenditures but all of these couldn't cater for the demands of the state and local authority for infrastructural development. The cry for Local government autonomy in Nigeria for the past eight (8) years has not yielded any positive result due to some political interest; however, it is important for individual states and local government to look inward for revenue generation from the resources within its local environment (Keith 1993).

Property tax has been historically associated with local government in nations of the world as source of revenue, because real properties are immovable and the revenue generated from properties are used to finance local services and to promote public decisions like good schools, better access roads; all taxes used for these purposes are capitalized into values like some country's tax land, buildings, farmland, business places etc.

Due to the political and technical exercise behind the implementation of revenue generation, the system is founding it difficult to implement and for this revenue/tax generation to be effective, there are some components that needs to be in place for consideration. One of the structures required is an existence of strong tax/revenue administration and a process of property identification, assessment, collection and enforcement (Richard & Enid 2002).

The successful implementation of property tax is supported by the tax payers and this can be achieved when the tax payer identifies, feels that they are receiving adequate services for the tax been paid by them and the process of taxing properties is fair, accountable and transparent. But in some system today, transparency and accountability is out of place (Richard & Enid 2002).

Corruption and the misuse of public fund for private gain is the menace in many developing countries like Nigeria, corruption in a system of government that deals with tax and revenue collection is dangerous because it reduces the revenue collection, public confidence in government and ultimately destroys government legitimacy. The credibility, efficiency, transparency and legitimacy of government politically will ensure tax compliance. Corruption can penetrate Land Property Tax (LPT) system in many ways; a property may be left out of fiscal cadaster, values of properties can be falsified, a property can be misclassified deliberately to beat tax rates and the mode of tax collection in compensation exchange.

Land property tax (LPT) can be maintained in four (4) ways:

A. Transparency

All procedure for revenue generation or tax collection must be open to general public; also the cadaster should be available for public inspection and observation. The method used to calculate the tax value should be understood by the tax payer to enable clarity of process and property tax bill should be available for comparism with similar properties (Walters, Reiny & Haile 2002).

B. Limited discretion

Tax officials should be limited in discretion application and the system should be standardized such that individuals can access the system by automated means and to reduce tax rates to the minima (Walters, Reiny & Haile 2002).

C. Oversight

Multiple agencies should be given the responsibility of administering the LPT system, while another is in charge of tax collection, and agency collecting the revenue is subject to audit at the end of every remittance by an office to oversee the system (Walters, Reiny & Haile 2002).

D. Accountability

The officials in charge of administration of LPT should be held responsible to account for accurate procedures and outcome of the process (Walters, Reiny & Haile 2002).

In this research, the LandSAT Image of 1999 and 2018 was used to determine the LPT revenue estimate for the two consecutive years, it is also observed that after the insurgency in October 2014, the town in turn blew up with large numbers of migrants from the rural area of the environs into the metropolis of Mubi thereby increasing the revenue generation.

According to an anonymous respondent from an oral interview states that the sum of five thousand naira (**#5,000:00**) is charged for 600m^2 annually for commercial, and one thousand naira (**#1,000:00**) for Residential or Noncommercial purposes; Mubi town known to be a commercial center and the biggest local government in Adamawa State.

The index, or land use budget, identifies the proportional use of land. Land uses are conventionally broken down into residential, commercial, industrial, public facilities, public amenities and movement. Appropriate proportions of land uses, particularly commercial, industrial and public amenity uses, are context specific. However, as a rule of thumb, at the local area layout scale, residential, commercial and industrial uses should take up approximately 55% of land, public facilities and amenities approximately 25%, and movement less than 20%.

These tools of evaluation may be used to assess the benefit of the use of various block designs in a proposed subdivision layout. It should, however, be cautioned that these indicators should only be used as a guide. The context of the site which is to be subdivided, as well as both the physical and cultural context of the site, may result in one form of subdivision being preferable to another. This is despite the land efficiency index indicating that an alternative subdivision is preferable from a technical efficiency perspective.

II. STUDY AREA

Martins & Gadiga (2015) stated that Mubi lies in the Mandara hills, close to the Camerouns border. Mubi Local Government Area is situated between latitude 10º11‟N and 10º16‟N of the equator and longitude 13º20‟ E and 13º35‟ East of Greenwich Meridian in Adamawa State, Nigeria It has had a chequered history since it first grew up as a settlement of the Ilega‟en Fulani in the eighteen century. These people coming as pastoralist developed a symbiotic relationship with local tribes, exchanging their produce with that of the cultivators of crops. Sometime this lead to the Fulani settling more permanently themselves, cultivate the land and intermarrying with the local families. Each settlement was under the Ardo (or headman) who owed allegiance to a Lamido (chief) but it was not until the Jihado 1804-10 that the Fulani usurped power and claim suzerainty over local tribes. In this area their sovereignty was frequently challenged by the continued independence of spirit of the hill people which continue to-day. Mubi was never an emirate and after the jihad came under the Lamido of Adamawa who added it to his kingdom with the approval of the Sarkin Musulmi. The area seems to have been troubled by the second emir, Hamman, warring against the Fali of Mubi. In 1959 a plebiscite was held to decide on their future; as this was indecisive a further plebiscite was held in 1961 when a majority vote decides on incorporation into Nigeria. But instead of returning this land to Adamawa, a new province of sardauna was created to administer the erstwhile trust territorie, and Mubi became the capital of the province. The mainstays of Mubi economy are trade, agriculture and its position as an administrative, service and institutional centre, there is a large central market held one day a week on Wednesday. Many of the market traders will move round from village market to village market during the rest of the week and Mubi relief and drainage comprised of predominantly upland and lowland with maximum and minimum height of 1036m and 523m above sea level, respectively with some few outcrops of hills around Vimtim in Mubi and Michika.

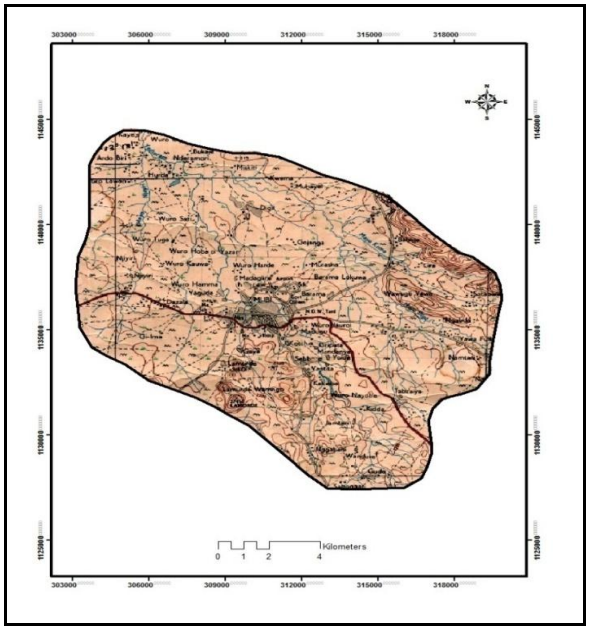

Figure 1: Map of Mubi Local Government Area

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III. MATERIALS AND METHODS

The LandSAT 7, LandSat 8 TM image of 1999 and 2018 was acquired and clipped to outlined the study area, the False Color Composite (FCC) of the image was generated by the band combination of 4,3,2; and 5,3,2 respectively. The image was then classified by the use of the spectral reflectance of colors into four (4) classes (Urban, Bare land, Rock Outcrop, Vegetation), the post classification tool was used to generate the statistics summary and the confusion matrix. The Confusion Matrices of the classified imageries were generated using the classes and Ground truthing method, this is to identify the level of accuracies in the classified imageries and the percentage area cover of classes in meter square; the meter square of the area covered was calculated using the post classification tools and the area cover in meter square for each land use is multiplied by the annual charges to give the total sum of tax generated for each year.

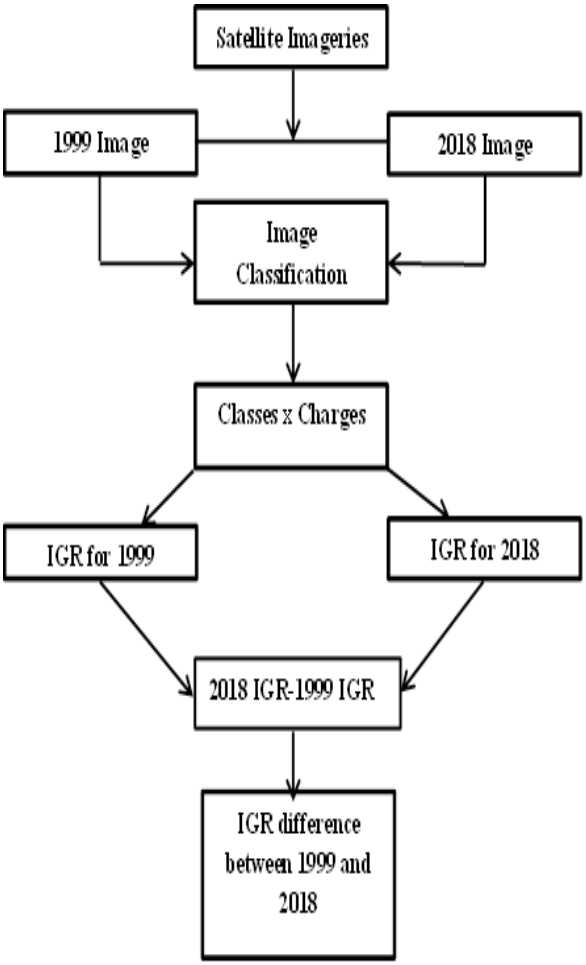

Figure 2: Work flow chart of the research

The classification summary in tables 1 shows in detail the percentage area cover of classes for 1999 and 2018 classified image, it is observed that the image classification of built-up area for the year 1999 covered 12.725 % of the total area with 8,219,157.7500 m^2, Bareland covers 16,054,121.2500 m^2 with 24.851% area cover, Rock Outcrop covers 2,424,566.2500 m^2 and vegetation area covers 37,903,646.2500 m^2.

Table 1: Class Distribution Summary for the year 1999 image

Classes	Pixels/Points	Land Cover %	Area Cover (m^2)
Built_Up Area	3552 : 10,119	12.723	8,219,157.7500
Bareland	842 : 19,765	24.851	16,054,121.2500
Rocks	544 : 2,985	3.753	2,424,566.2500
Vegetation	3227 : 46,665	58.673	37,903,646.2500

Table 2: Class Distribution Summary for the year 2018 image

Classes	Pixels/Points	Land Cover %	Area Cover (m^2)
Built_Up Area	4620 : 17,846	24.923	16,061,400.0000
Bareland	2573 : 5,733	8.007	5,159,700.0000
Rocks	183 : 2,150	3.003	1,935,000.0000
Vegetation	7116 : 45,875	64.068	41,287,500.0000

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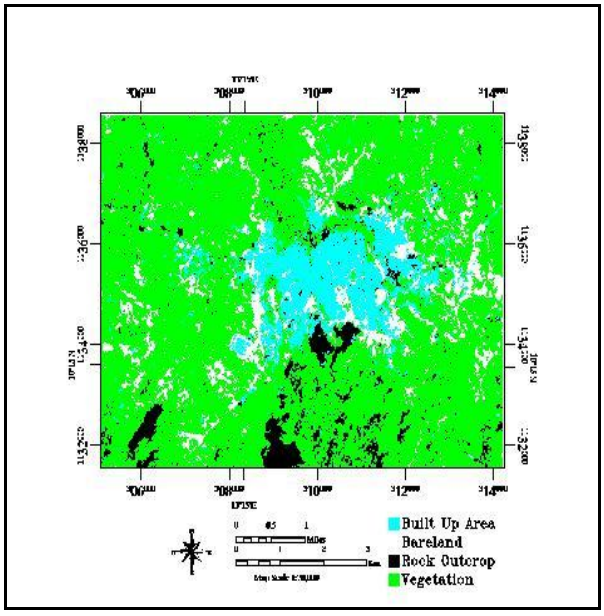

Fig.3: Classified image of 1999

In the year 2018, the area covered for built-up has doubled from 8,219,157.7500 m^2 to 16,061,400.0000 m^2 meaning more building has been erected having reduced the land cover for bareland giving way for the development while the bareland and the rock outcrop also give way for agricultural farming by increasing from 37,903,646.2500 m^2 to 41,287,500.0000m^2.

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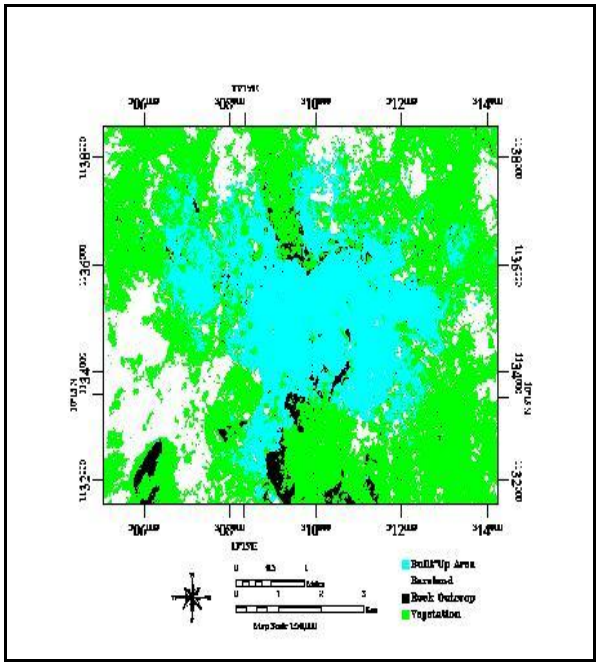

Figure .4: Classified image of 2018

A. Confusion Matrix

The confusion matrix of the subsequent years depicted below can be a bit difficult to understand because of lots of information therein, the very top of each matrix table gives couples of overall measures of accuracy. The Overall Accuracy measures are the most simple; it is a basic percentage of the total numbers of pixels contained within the ground truthing regions of interest that has been correctly classified.

The Kappa coefficient takes the agreement in the classified image and the ground truthing data, the close the coefficient is to 1 will determine the high level of accuracy. A Kappa Coefficient of 0 indicate no more agreement than would be expected by chance, less than 0 indicates less agreement expected by chance (Landis and Koch 1977).

Confusion Matrix: C:\A\Mubi Image 1999\Class_1999.tif

Overall Accuracy = (73552/79534) 92.4787%
Kappa Coefficient = 0.8723

Ground Truth (Pixels)

Class	Biult_UpG [	CyBarelandG [	WhRocksG [	BlackVegetationG [	Total
Built_Up Area	9834	0	98	187	10119
Bareland [Whi	397	17292	0	2076	19765
Rocks [Black]	0	0	2985	0	2985
Vegetation [G	143	72	3009	43441	46665
Total	10374	17364	6092	45704	79534

Ground Truth (Percent)

Class	Biult_UpG [	CyBarelandG [	WhRocksG [	BlackVegetationG [	Total
Built_Up Area	94.79	0.00	1.61	0.41	12.72
Bareland [Whi	3.83	99.59	0.00	4.54	24.85
Rocks [Black]	0.00	0.00	49.00	0.00	3.75
Vegetation [G	1.38	0.41	49.39	95.05	58.67
Total	100.00	100.00	100.00	100.00	100.00

Class	Commission (Percent)	Omission (Percent)	Commission (Pixels)	Omission (Pixels)
Built_Up Area	2.82	5.21	285/10119	540/10374
Bareland [Whi	12.51	0.41	2473/19765	72/17364
Rocks [Black]	0.00	51.00	0/2985	3107/6092
Vegetation [G	6.91	4.95	3224/46665	2263/45704

Class	Prod. Acc. (Percent)	User Acc. (Percent)	Prod. Acc. (Pixels)	User Acc. (Pixels)
Built Up Area	94.79	97.18	9834/10374	9834/10119
Bare land [Whi	99.59	87.49	17292/17364	17292/19765
Rocks [Black]	49.00	100.00	2985/6092	2985/2985
Vegetation [G	95.05	93.09	43441/45704	43441/46665

The Kappa coefficient takes the agreement in the classified image and the ground truthing data, the close the coefficient is to 1 will determine the high level of accuracy. A Kappa Coefficient of 0 indicate no more agreement than would be expected by chance, less than 0 indicates less agreement expected by chance (Landis and Koch 1977).

Confusion Matrix: C:\A\MUBI LANDSAT 8 IMAGERIES\Class_2018.tif

Overall Accuracy = (60926/71604) 85.0874%
Kappa Coefficient = 0.7472

Ground Truth (Pixels)

Class	Built_UpG [	CyBarelandG [	WhRocksG [	BlackVegetationG [	Total
Built_Up Area	17710	136	0	1381	19227
Bareland [Whi	0	5459	0	8467	13926
Rock Outcrop	122	0	1765	35	1922
Vegetation [G	14	138	385	35992	36529
Total	17846	5733	2150	45875	71604

Ground Truth (Percent)

Class	Built_UpG [	CyBarelandG [	WhRocksG [	BlackVegetationG [	Total
Built_Up Area	99.24	2.37	0.00	3.01	26.85
Bareland [Whi	0.00	95.22	0.00	18.46	19.45
Rock Outcrop	0.68	0.00	82.09	0.08	2.68

Vegetation [G	0.08	2.41	17.91	78.46	51.02
Total	100.00	100.00	100.00	100.00	100.00

Class	Commission (Percent)	Omission (Percent)	Commission (Pixels)	Omission (Pixels)
Built_Up Area	7.89	0.76	1517/19227	136/17846
Bareland [Whi	60.80	4.78	8467/13926	274/5733
Rock Outcrop	8.17	17.91	157/1922	385/2150
Vegetation [G	1.47	21.54	537/36529	9883/45875

Class	Prod. Acc. (Percent)	User Acc. (Percent)	Prod. Acc. (Pixels)	User Acc. (Pixels)
Built_Up Area	99.24	92.11	17710/17846	17710/19227
Bareland [Whi	95.22	39.20	5459/5733	5459/13926
Rock Outcrop	82.09	91.83	1765/2150	1765/1922
Vegetation [G	78.46	98.53	35992/45875	35992/36529

B. Mathematical Concept for Revenue Derivation

With the classified image as shown in Figure 2 and Figure 3, the area cover for each class, Built up area, Bare land, Rock Outcrop and Vegetation were calculated and analyzed to generate the total Land Property Tax (LPT) for the year 1999 and 2018. To actualize the income generated, the mathematical concept used in calculating the (IGR) of the year 1999 and 2018 is multiplying the classes in meter square by the amount charged per year to sum into the total revenue generated as depicted below;

Table 5: Analysis of IGR in the year 1999

S/No	Classes	Area Cover (m^2)/600	Amount pa year	Total IGR 1999
1.	Built up Area	8,219,157.7500	#5,000:00	#68,492,981.25
2.	Bareland	16,054,121.2500	#1,000:00	#2,675,685.41
3.	Rock Outcrop	2,424,566.2500	#1,000:00	#4,040,943.75
4.	Vegetation	37,903,646.2500	#1,000:00	#63,172,020.75
Total				**₦138,381,631.523**

Table 6: Analysis of IGR in the year 2018

S/No	Classes	Area Cover (m^2)/600	Amount pa year	Total IGR 2018
1.	Built up Area	16,061,400.0000	#5,000:00	#133,845,000.00
2.	Bareland	5,159,700.0000	#1,000:00	#8,599,500:00
3.	Rock Outcrop	1,935,000.0000	#1,000:00	#3,225,000:00
4.	Vegetation	41,287,500.0000	#1,000:00	#68,812,500:00
Total				**₦ 214,122,000:00**

From the analysis in the above table, it is observed that the revenue for built up area in 1999 is doubled in the year 2018. This is as a result of migrations of the people from insurgence affected areas into the metropolis for greener pasture and to reside. It is on these bases that we recommend that the Local Government Authority to implement the full enforcement of tax remittance to boost the execution of Capital Grant, Livelihood Empowerment against Poverty and school feeding programs. In coming years, it is believed that the revenue to be generated will increase with time.

IV. CONCLUSION

This research focused on Time series assessment to determined property revenue generation for the year 1999 and 2018 respectively using remote Sensing and GIS', in time past, it is only the budget office that has the capacity to prepare, predict and announce the budget of every year. In this view, Remote Sensing and GIS is an advent tool for policy makers in all field of study to annex with quick response to our daily need than ever before.

It is therefore important that the payment of tax or revenue should be enacted as a law so as to boost the IGR o the local government authority to enable the payment of salaries for civil servants and for infrastructural developments such as Capital Grant, livelihood empowerment against poverty and school feeding programs.

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