Spatial Temporal Dynamics of Urban Wetlands Around Obio/Akpor and Its Environs: Implications for Sustainable Development Goals

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Abstract- Wetland's ecosystem can be attributed to the lands transition between terrene and marine eco-systems where the water table is usually near the surface or the land areas that are covered by shallow water. Wetlands are dynamic, both in space and time, and can easily shift from one ecological state to another as a result of annual and seasonal fluctuations in environmental conditions, such as variation in annual rainfall patterns. Furthermore, dynamic and fuzzy spectral boundaries between different wetland types and other land cover categories hamper long-term remote monitoring of wetlands. Therefore, this study attempts, to assess wetland dynamics with other landscape-related indicators of urbanization. The study used image interpretation for 20 epoch years in Obio-Akpor local government area (1999, 2009 and 2019) while applying remote sensing and GIS techniques for spatial and temporal analysis of the wetland's dynamics. The wetlands dynamism was analyzed using Landsat7 ETM images of 1999, 2009 and 2019. The ArcGIS10.6 software was used to analyze the remote sensed images covering the area. A total area of 259.64sq km was delineated as the study area. After processing the imagery, five LULC classes where developed in ArcGIS environment, such as wetland, built-up area, vegetation, water bodies and fallow land. The study shows that the urban land-use of Obio-Akpor LGA had altered intensely during the period of 20 years. Descriptive and Inferential statistics were employed in the study. The descriptive analysis involved the use of percentages and bar charts to describe proportion, magnitudes and trend of land cover dynamics within the study area. The study concluded that there is a need for the wise use of wetland resources and improvement of institutional arrangement so that wetland policies can be fully integrated into the planning process across all disciplines.

Indexed Terms- Ecosystem, GIS, Landuse change, Remote Sensing, SDGs, Wetlands,

I. INTRODUCTION

Wetlands can be attributed to the lands transition between terrene and marine eco-systems where the water table is usually near the surface or the land areas that are covered by shallow water (Orimoloye, *et al*., 2018). The important of wetlands internationally is gradually getting appropriate attention as they add to a healthy and adorable environment in various ways (Cohen *et a*l., 2016; Richardson *et al.,* 2016). Wetlands are recognized as the "kidneys of the earth" because of their vitalecological and hydrological features and element cycles, and they can also be considered as "biological supermarkets" because of their large food webs and rich biological diversity (Huang *et al.,* 2014; Guo*et al*., 2017; Tangao*et al*., 2018; Hu *et al.,* 2018).Wetlands have far-reaching influences on the urban environment, including on the hydrological cycle, flood control, shoreline protection, climatic regulation, landscape building, natural species protection, and ecosystem sservice functions (Dabrowska*et al.,* 2014; Reiss *et al*., 2014). However, as human activity has continuously increased over the past hundred years, many wetlands have been lost, and the remaining wetland areas have substantially decreased, which has caused a large loss of natural habitats (Eluiss*et al.,* 2014; Bouahim*et al*., 2015). Recently, due to the progress of society and the rapid development of modern industry, land reclamation, water pollution and excessive deforestation have become increasingly serious issues, especially for urban wetlands. With the acceleration of urbanization, a large number of wetlands have disappeared (Tana *et al.,* 2013). Monitoring urban wetlands and detecting their changes over specified time periods are necessary to ensure wetlands protection and optimal use (Zhou *et al.,* 2010).

Wetlands easily respond to changes in environmental condition around them within time and space by shifting from one ecological state to another (Mitsch*et al.,* 2015) such changes could be in the form of annual and seasonal fluctuations in environmental conditions, such as variation in annual rainfall patterns (Katja*et al.,* 2020). It is equally difficult to undertake long term monitoring of wetlands due to dynamic and fuzzy spectral boundaries between different wetland types and other land cover (Ozesmi*et al.,* 2002; Wang *et a*l., 2008; Katja*et al.,* 2020). Human activities have continued to cause the loss of wetlands or their degradation persistently. This has significantly eroded the very important benefits people derive form wetlands. The benefits, derived from wetland ecosystem services, are unique, varied and extend across many sectors, but their contribution and value is not always fully captured in wetland management decision-making. A better understanding of wetland benefits is required in order to make the case for halting further loss and degradation, and to support activities that assist in the recovery of their biodiversity and ecosystem functioning. Removing the stressors or pressures on the ecological character of wetlands is the best practice for preventing further loss and degradation; when this is not feasible, however, or when degradation has already occurred, wetland restoration must be considered as a potential response option (STRP, 2012; Wizor and Wali, 2020).

Urban wetlands make cities livable in many important ways. They reduce flooding, replenish drinking water, filter waste, provide urban green spaces, and are a source of livelihoods. These wetland benefits grow ever more crucial as the number of people living in cities has now passed the 4 billion mark and continues to rise. By 2050, 66% of humanity will live in cities, as people move into urban areas searching for better jobs. Unfortunately, most people are unaware of the value and importance of urban wetlands. In fast-growing cities, wetlands are often viewed as wasteland; places to dump rubbish, fill in or convert to other uses. Scientists estimate that at least 64% of the world's wetlands have disappeared since 1900, while in parallel, cities have exploded in growth (Global Wetland Outlook, 2018; Wizor and Wali, 2020).

Remote sensing and GIS has provided a considerable opportunity to monitor land use and land cover (LULC) and detect changes because of the rapid, synoptic and repetitive capabilities of remote sensing (Cozar*et al*.,2005; Hemba et al 2017; Tangao*et al*., 2018). The quality of the remotely-sensed data and the ability of classifiers affects the dynamicspatio-temporal analysis directly. A remote sensing image with a higher spatial resolution, or a classifier with higher accuracy, leads to a more reasonable analysis which fits the reality better. However, using data with higher spatial resolution brings increasing cost. Thus, many researchers have attempted to generate a more accurate spatio-temporal analysis of wetlands by enhancing the classification accuracy (Yi*et al*., 2018). Multi-source satellite images provide efficient information on the temporal trends and spatial distributions of urban areas that is needed to understand, model, and project land changes (Jiang *et al*., 2012). Specifically, moderate-resolution multispectral sensors (e.g., Landsat, SPOT, and ASTER) have been successfully used for studying the extent of flooding and affected land cover (Hui *et al*., 2008), detecting the presence and composition of wetlands in heterogeneous landscapes (Wright *et al*., 2007),and monitoring invasive plant species (Laba*et al*., 2010). Recently, object-based image analysis (OBIA) has been applied more frequently for image classification and change detection in wetland systems (Tangao*et al*., 2018). For the identification of water bodies and wetlands, many different remote sensing approaches have been proposed such as supervised(Gautam*et al*,.2015) and unsupervised classification (Wang *et al*., 2019), object-based image analysis (OBIA)(Wang *et al.*, 2008; Wang *et al*., 2019), machine learning algorithms (Acharya *et al*., 2019), and the spectral water index method (Feyisa*et al* ., 2014; Yao *et al.*,2015). The latter is widely used due to its relative high accuracy and its straightforward calculation procedure (Jiang *et al*., 2014). The combined use of the advanced classification techniques of multi-temporal imagery and of ancillary

information on soils, elevation data or image-derived (water) indices greatly improved wetland classification in recent decades (Ozesmi*et al*., 2002; Katja*et al.*, 2020). In particular, OBIA methods, which can incorporate spectral, spatial, textural, and contextual information into the classification process, yield greater accuracies for wetland mapping compared to traditional pixel-based approaches (Knight et al., 2015). They are also beneficial for urban contexts (Taubenböck*et al.*, 2009;Katja*et al.*, 2020).
Urban wetland systems have been extensively studied and mapped around the globe. They are Kolkata in India (Mondal*et al.*, 2017) and Colombo in Sri Lanka (Hettiarachchi*et al*., 2014). However, only a few studies have investigated the dynamics and changes in small urban wetlands and (lake) water bodies (Mui et al., 2015; Hu et al., 2018). Umeudujiet *al.*, 2018 investigated the perception of indigenous people to wetland conservation and protection in Rumuagholu community in Obio/Akpor, the study make uses of both experimental and survey research design in the study. The study also revealed that wetland within the period of the study lost 10.64% its original state moving from 11km2 to 6km2 and that Loss of biodiversity in the Rumuagholu Community is a major effect of wetland loss. In a likewise manner Wali*et al*., 2019e studied wetland changes overtime in Port-Harcourt metropolis using remote sensing techniques from 1984-2013.The study shows that total percentage of change and total rate of change for the entire trend after conversion are thus: Saltwater Wetland 23.44 %, to- 2.17, Freshwater Wetland -26.44%to- 11.49 Fallow land- 47.13%to- 5.41 Built-up Area 43.33% to 7.41Water bodies 43.36% to 3.06.The study recommended that activities shrinking wetlands size should be thoroughly put in check by the government and better efforts should be concentrated on those activities that encourage wetland conservation. Wizor and Wali , 2020 studied the geo-spatial analysis of urban wetlands loss in Obio/Akpor local government area using remote sensing and GIS techniques , the study concluded that there is need for wise use of wetland resources and improvement of institutional arrangement so that wetland policies can be fully integrated into the planning process across all disciplines. We theorized that, in contemporary times, urbanization processes and wetland dynamics were highest in the urban and peri-urban spaces around Obio-Akpor and its environs. Therefore, no broad long-term study exists on the multifaceted geospatial temporal dynamic of urban wetlands tied with the global sustainable development goals.
Therefore, these present study attempts, to assess wetland dynamics with other landscape-related indicators of urbanization and, on the other hand, places a specific focus on sustainable development goals as the UNs 2030 agenda for economic and developmental growth. Lastly, the study aimed at using image interpretation data for 20 epoch years in Obio-Akpor and its environ between 1999, 2009 and 2019, remote sensing and GIS techniques for spatial temporal analysis of the wetlands dynamics.

- Wetlands and Sustainable Development Goals (SDGs)

Around September 2015 the world's governments signed a historic agreement to eradicate poverty, improve the living standards and well-being of all people, promote peace and more inclusive societies and reverse the trend of environmental degradation. The 2030 Agenda for Sustainable Development commits to promoting development in a balanced way economically, socially and environmentally in all countries of the world, leaving no one behind and paying special attention to those people who are poorest or most excluded. It contains 17 Sustainable Development Goals (SDGs) with associated targets to assess progress (UN, 2015d; ILO, 2016b; World Bank group, 2016; UNDP, 2016f; Wali*et al.*, 2019a).

The 2030 Agenda builds on earlier commitments, more recently the aspirations set out in the Millennium Development Goals (MDGs) and Millennium Declaration. In much of the period leading up to and through the MDGs' target date, and in many parts of the world, progress in several areas that are also reflected in the SDGs has been strong. This is especially the case for income, poverty, access to education and health services, and improved sources of clean water. In other areas progress has been steady but less marked, including on gender equality, nutrition and access to sanitation facilities (UNDP, 2016f; Wali*et al.*, 2019a).

The SDGs are, however, universal, more ambitious and comprehensive. For example, the 2030 Agenda affirms explicitly with a dedicated goal that sustainable development requires building peaceful, just and inclusive societies. The SDGs aim at completing the unfinished business of the MDGs and also include targets on areas that have deteriorated or become more challenging since the turn of the century, including growing income disparities within countries, insecure and low-paid employment, climate change and environmental degradation (UN, 2015d ,ILO, 2016b;Wali*et al.,* 2019a). While the future is impossible to predict, as the global economic and financial crisis and many disasters in the MDG era acutely illustrate, this report assesses recent trends in six critical areas that are either reflected directly in the SDGs or are so important that they are likely to condition the prospects for achieving all of the goals. These six "mega-trends" relate to poverty and inequalities, demography, environmental degradation and climate change, shocks and crises, development cooperation and financing for development, and technological innovation (World Bank Group, 2016). Positive developments in these areas will radically enhance the prospects for achievements of the entire Agenda. These will be more likely with collaboration and cooperation between countries, in addition to natural competition and innovation in the private sector. Yet it is also possible that negative developments in some (or all) have the potential to derail the SDGs. Because we have no precise knowledge about what may happen, this points to the need for a sophisticated policy response of preparedness, investment and cooperation (UNDP, 2016f).

- Ways Wetlands Support Attainment of the Sustainable Development Goals (SDGs).

Of these, the Sustainable Development Goals (SDGs) specifically mentioned wetlands and water in relation to thirteen of its goals with its targets , then hence provide a policy context for the implementation of the Ramsar Convention and its new Strategic Plan, through to 2030 (Ramsar handbook,2016 ;Wali*et al.,* 2019a). The sustainable use of water and wetlands, by protecting the services they provide, is critical to enable society to achieve sustainable social and economic development, adapt to climate change and improve social cohesion and economic stability. The proposed United Nations Sustainable Development Goals (SDGs) offer a universal agenda that, for the first time, recognizes the need for restoration and management of water-related ecosystems, including wetlands, as a basis for addressing water scarcity and water risks. Wetlands are a solution for several key challenges around the world related to water, food and climate, and key to meeting the SDGs. Most of the proposed SDGs are relevant in some way or another to wetlands (World wetlands day, 2015; RCS, 2016;Ramsar Convention on Wetlands, 2018; RCS, 2018; Wali*et al.,* 2019a).

The overarching characteristics of the SDGs are their universality, the desire to include everyone in all countries in building a better life ("no one left behind"), and their focus on linking sustainability with economic growth and development in each of the goals. Building on experiences with the Millennium Development Goals (MDGs), which focused on developing countries, with environmental sustainability as just one of eight goals, the seventeen SDGs are more holistic, ambitious and visionary. The Ramsar Convention on Wetlands is uniquely equipped to respond to the challenge of the SDGs, because from its inception in 1971 it has worked on the conservation and the wise use of wetlands, with the third policy pillar of international cooperation (RCS, 2016; RCS, 2018). The concepts of conservation on one hand, and wise use on the other, address sustainability as well as the economic growth and development aspects of the SDGs (Ramsar handbook, 2016; RCS, 2018; The Nature Conservancy, 2018; Waliet *al.,* 2019a).

In the 4th Ramsar Strategic Plan 2016-2024, the aim is to be congruent both with the SDGs and with the Aichi Biodiversity Targets (many of which have in turn been incorporated into the SDGs). Unusually for the Ramsar Convention, this Strategic Plan therefore covers 9 years (3 triennia) rather than 6 years (2 triennia), enabling its timing to harmonize with both the SDGs and the Aichi Biodiversity Targets. The 5th Ramsar Strategic Plan will once again be a 6 year plan, covering the years 2025 to 2030, which is the final target date for the SDGs. Also important to note regarding timing, the midpoint review of this new 4th Strategic Plan will fall in 2020, when the Aichi Biodiversity Targets will be revised, to enable a realignment at that point towards the new biodiversity targets which will emerge to 2030(Ramsar handbook, 2016; The Nature Conservancy, 2018; RCS,2018;Wali *et al.,* 2019a).

The Ramsar Convention on Wetlands will work directly in support of the achievement of all the SDGs, since wetlands contribute towards a very broad range of the aspirations set out in the SDGs. Specifically, the Strategic Plan notes the reference to water and wetlands in the proposals for the Sustainable Development Goals, and also recalls (Resolution XII.2, paragraph 4) the Rio+20 outcome, that water is at the core of sustainable development. This is a key point to note. In SDG 6 which focuses on water and sanitation, for the first time in history the world has a coherent policy framework for water issues, ranging from drinking water supply and sanitation, to integrated water resources management, and the importance of water-related ecosystems. Wetlands are specifically mentioned under target 6.6, and the structure of the goal links wetlands directly with the increasingly urgent questions of water allocation, water risks and water scarcity, while opening the door to the other 16 SDGs (RCS, 2016; RCS, 2018; The Nature Conservancy, 2018; Wali*et al.*, 2019a).

Biodiversity issues arise within Goal 14 on oceans, seas and marine resources, and in Goal 15 on terrestrial ecosystems. Target 14.2 calls for the management and protection of coastal and marine ecosystems, while wetlands are once again specifically mentioned within target 15.1. Thus wetlands have a direct relevance to three of the SDGs, and indirect links to many more. The 4th Ramsar Strategic Plan was finalized just before the SDGs themselves were agreed; however, the broad shape of the SDGs was already visible. Hence the Ramsar Strategic Plan states in paragraph 15: "...all wetlands and the Ramsar Sites network will have a direct relevance for any Sustainable Development Goals which are related to water quality and supply, food and water security, adaptation to climate change, energy supply, healthy living, biodiversity and sustainable use of ecosystems, sustainable human settlements, poverty eradication, innovation and the development of appropriate infrastructure "(Ramsar handbook, 2016; The Nature Conservancy, 2018; RCS,2018;Wali*et al.*, 2019a).

The implementation of the 4th Ramsar Strategic Plan will therefore support the achievement of many of the Sustainable Development Goals. It will guide the actions and decisions of the Contracting Parties through until 2024, as well as reaching out to all stakeholders involved with wetland conservation and management, including the many new and concerned stakeholders in other sectors. The specific linkage of wetlands with the SDGs raises the profile of the Convention as never before, and will help to develop broad new coalitions of support for wetlands and sustainable development (Ramsar handbook, 2016; The Nature Conservancy, 2018; RCS, 2018; Wali*et al.*, 2019a).

II. MATERIALS AND METHODS

- The Study Area

Obio/Akpor LGA is a maritime state in the southern geopolitical region of the country; it is situated between latitudes 4º30'0"N and 5º30'0"N and longitude 6º30'0"E and 7º30'0"E (Figure 1) with inhabitants of 464,789 (NPC, 2006). Obio/Akpor LGA has its centre of operations at Rumuodumaya. The land mass is about 311.71km^2 and bordered by many LGAs and approachable through land, water and air (Wokocha and Omenihu, 2015). Obio/Akpor is majorly housed by Ikwerre ethnic nationality comprises of; Akpor, Apara, Evo and Rumueme Kingdoms. Due to its proximity to the states capital it is most times regarded as Port Harcourt.

Obio/Akpor appreciate tropical hot monsoon climate as a result of her latitudinal position. The daily tropical monsoon climate is characterized by heavy rainfall and high temperature all year round (Mmom, 2003). The study area experiences lengthy and heavy rainfall season and very short dry season. Rainfall in Obio/Akpor is heavy and more persistent as a result of the strong influence of the southwest trade wind. Obio/Akpor local government area and its adjoining neighbor rainfall is almost predictable and follows sequence of increase towards the month of July-August before decreasing in the month of November - February (Mmom, 2003; Wizor and Wali, 2019a). Rainfall is at its peak in July and September with a little dry season occurring in August, although the period of the break has been fluctuating in recent times. Obio/Akpor also experience a double maximum rainfall occurs between July and August. Although there might be rain during the months of December, January and February, most of the rains received are unreliable a spotty (Osuiwu and Ologunorisa, 1999;Wizor and Wali, 2019a ;). There is no year the length of rainy season is about 272 days. Rainfall in the study area occurs over a long duration of usually between 2-4 hours and it is high intensity (Osuiwu and Ologunorisa, 1999). Temperature on the other hand is high and fairly constant throughout the year in Choba. February is the warmest of all the months of the year with an average temperature of 32°C at noon, the month of July is the oldest.

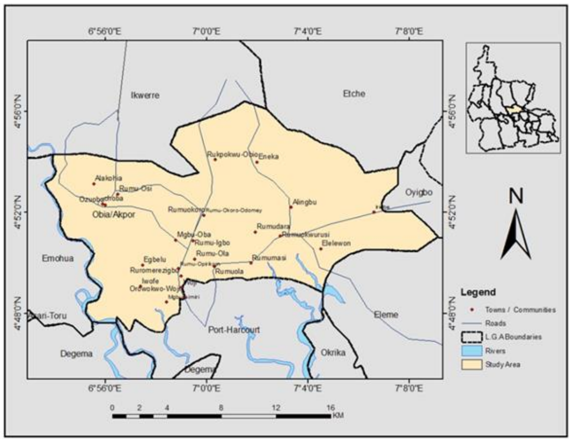

FIG. 1Obio-Akpor Local Government Area showing Communities.
Source: Department of Geography and Environmental Management Cartography Laboratory, University of Port Harcourt, 2020.

III. METHODOLOGY

The study aimed at using image interpretation for 20 epoch years in Obio-Akpor local government area between 1999, 2009 and 2019, remote sensing and GIS techniques for spatial and temporal analysis of the wetlands dynamics. The data were acquired using GPS to collect coordinates of the various wetlands points. The study analysis wetlands dynamism using Landsat7 ETM images of 1999, 2009 and 2019. The satellite images covering the area were analyzed using ArcGIS10.6. A total area of 259.64sq km was delineated in the study area. After processing the imagery, five LULC classes where developed in ArcGIS environment, such as wetland, built-up area, vegetation, water bodies and fallow land. The study shows that the urban land-use of Obio-Akpor LGA had altered intensely during the period of 20 years. Descriptive and Inferential statistics were employed in the study. The descriptive analysis involved the use of percentages and bar charts to describe proportion, magnitudes and trend of land cover dynamics within the study area.

IV. RESULTS AND DISCUSSION

- The Spatial and Temporal Dynamics of Urban Wetlands

It is evident that change is the landuse is inevitable as human population increases. This increase poses a threat to different landuse situated around the human population. The result of the analysis (Table 1) indicates that the study area experiences changes across all the classes of landuse (sq km). The trend shows that water body increases from 3.17% in 1999 to 4.81% in 2009 and to 4.83 in 2019. Similarly, built-up area increases from 12% in 1999 to 23% in 2009 and to 49% in 2019. Conversely, the vegetation decreases greatly from 50% in 1999 to 38% in 2009 and to 20%. Similarly, the wetland decreases from 11% in 1999 to 9% in 2019. The fallow land also decreases from 22% in 1999 to 17% in 2009 and to 15% in 2019.

Table 1. Proportion, magnitudes and Trendof Land CoverDynamics from 1999-2019.

CLASS NAME	1999 Image Area (sq km)	%	2009 Image Area (sq km)	%	2019 Image Area (sq km)	%
Water body	8.22	3.17	12.49	4.81	12.54	4.83
Wetland	30.55	11.77	41.53	16.00	25.37	9.77
Vegetation	130.71	50.34	100.86	38.85	52.45	20.20
Built Up Area	31.6	12.17	59.83	23.04	129.71	49.96
Fallow Land	58.56	22.55	44.93	17.30	39.57	15.24
TOTAL	259.64	100	259.64	100.0	259.64	100

Figure 2 contains three images showing landuse types in 1999, 2009 and 2019 as (a), (b) and (c) respectively.

It explained that wetlands, fallow land and vegetation occupied more space in 1999 and shrink in 2019. Conversely, built-up area occupies little space in 1999 but expands in 2019. In a nutshell, vegetation and built-up area are the two landuse classes that changed greatly over the study period. As vegetation decreases by about 30%, its built-up counterpart increases by about 37%. This shows that settlement expansion is the main cause of landuse dynamics in the area. It is believed that for any building construction to take place, the surrounding vegetation are cleared that causes the wetlands to dry off that subsequently affect the balance in ecosystem.

Figure 3 describes in detail landuse dynamics temporally, where it is evident that vegetation and built-up area are the two landuse that oppose each other. As the vegetation decreases on one hand, the built-up area increases at the other hand. The other landuse (fallow lands and wetlands) decrease a little. The class of water body is the only landuse that remain constant between 2009 and 2019. The SDG of the UN to preserve wetlands and natural habitat like vegetation that regulate atmospheric carbon are at the state of depleting. When there are no vegetation and wetland to sequester carbon in the environment, this will cause global warming and subsequently climate change. This affect the social and economic wellbeing of the people.

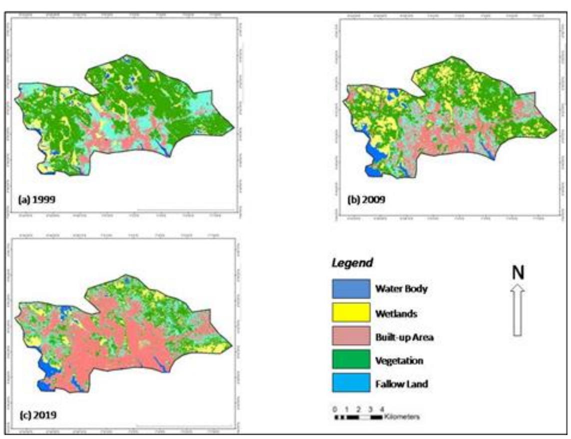

FIG. 2Landuse Change from 1999 to 2019

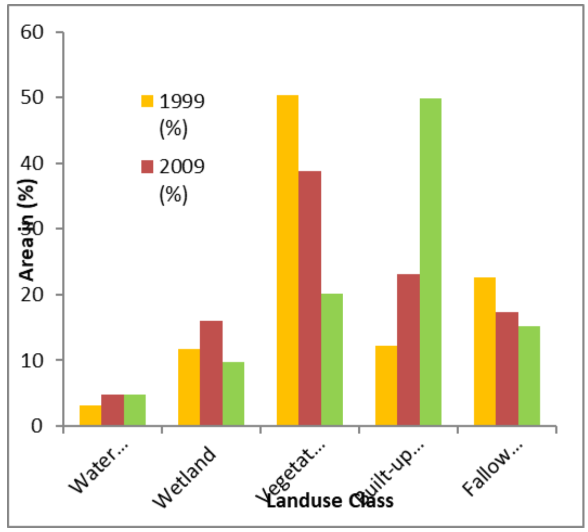

FIG. 3Landuse Dynamics from 1999 to 2019

CONCLUSION AND RECOMMENDATIONS

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