

Land Use/Land Cover Analysis Using Remote Sensing and GIS: A Case Study of The Polytechnic Ibadan, Oyo State, Nigeria (2005, 2010 and 2015)

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Abstract
This study therefore examines the Land use/land cover analysis of The Polytechnic Ibadan using remote sensing and GIS. Landsat TM imagery of 2005, 2010 and 2015 was used to identify and classify the assessment spatial changes that have occurred in the institution between the year of the study. A GIS database of the study area and their location within the interval of 5years (2005-2010-2015) was generated and analyzed with the aid of GIS analytical functions. These includes: Land use/land cover classification using ArcGIS 10.2 Software and ILWIS 3.4. The result showed that the intensive rate of admitting students and insufficient administrative and academic offices has resulted in spatial changes in land cover land use between 2005_2010 and 2015. It also shows that population growth among student admitted as well as the need in more administrative and academic offices in the institution imposes a lot of pressure on the institution in providing a conducive environment. This research highlights the increasing rate of student admitted which leads to creation of additional infrastructural facilities by the institution and the need to apprehend the situation to ensure sustainable environmental development.
Keywords: Institution, Land Use/Cover Classification, infrastructural facilities, spatial changes

Introduction

Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitat:- such as arable fields, pastures, and managed woods. It also has been defined as “the arrangements, activities and inputs people undertake in certain land cover type to produce, change or maintain it” (FAO, 1997a; FAO/UNEP, 1999). Land use and Land cover change studies have become key components for managing natural resources and monitoring environmental changes Igbokwe (2008) opined that Land cover and Land use information should form part of the environmental data, which are kept in the form of inventories/infrastructures in many advanced and emerging economies. Most Land use change factors such as water flooding, air pollution, urban sprawl, soil erosion, deforestation, occur without clear and logical planning which results in serious environmental degradation with notable consequences globally. Lower resolution multispectral satellites like Landsat and NigeriaSat-1 are very effective at mapping LULC at the first two levels, by identifying the spectral signature of a particular type of feature, and broadly classifying areas that contain that spectral pattern With spatial resolutions of 15-30 m, Landsat can classify forests, grasslands and urban development’s using the different spectral reflectance of each type of land cover.

Land use change analysis is a particularly useful tool because it provides information on the wide societal forces leading to environmental change, land use change is a cause and of itself of land degradation and loss of biodiversity and provides information on the type and extent of environmental change (STAP 1999).

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh, 1989). Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest.

The spatial dimensions of land use and land cover need to be known at all times to enable policymakers and scientists to be sufficiently equipped to take informed decisions on land resources. Therefore, a wide range of scientists and practitioners, including earth systems scientists, land and water managers as well as urban planners seek information on the location, distribution, type and magnitude of land use and land cover change (Weng, 2002, Singh and Kumar 2012).The natural vegetation of the reserves has been destroyed and converted at a rapid rate from excessive logging, conversion to forest plantations (*Gmelina arborea*) and farming.

Mapping of land use/cover and its change provides in-valuable information for managing land resources and for projecting future trends of land productivity (Al-Bakri et al, 2013).

Land use and land cover change-detection and mapping are an important requirement for a range of environmental applications, including land use planning, landscape monitoring, natural resources management and habitat assessment (Brooks et al, 2000, Chen and Wang, 2010). These changes have impacts on the ecological stability of the forest regions and, thus identifying and investigating the status of a resource such as the forest cover which is a crucial part in resource management and monitoring at local or global perspectives (Marçal et al , 2005).

Remote sensing is used in the study of Land use and Land cover changes and analysis because of its ability to cover large are as in a single image scene (Singh, A, 1984). Over the past years, data from earth sensing satellites has become indispensable in mapping the earth's features, natural resources management and environmental change studies. Fischer (1999)

GIS allows users to manage and analyze spatially explicit data associated with the models. For example, GIS can aid modelers in building input variables for the models, identifying spatial heterogeneity or pattern in data (Openshaw & Clarke, 1996), quantifying observed and/or predicted temporal changes in spatial pattern (de Koning et al., 1999), and assessing factors that operate across a variety of scales (Qi & Wu, 1996). Most GIS-based models of land use change use data stored in the raster data structure (Clarke et al., 1997; Landis, 1994; Veldkamp & Fresco, 1996) because the structure simplifies the representation of space by breaking it into many units of equal size and shape. Further, remotely sensed data, which is inherently grid-based, is often used for model validation and calibration.

One of the foremost problems associated with industrialization and civilization is the urbanization and the consequent ills and fallouts This is because industrialization and civilization are pull factor for the rural-urban migrants as well as cross-national migrants In recent times most Nigerian cities especially Ibadan, Lagos and Kano have experienced tremendous planned and unplanned growth due to population explosion, which led to congestion, environmental degradation and urban socio-spatial upheavals. Planners and other urban gatekeepers manage urban space and residents for the purpose of efficient functioning and performance of urban systems (Wilkie and Finn 1998)

For this study, there are indications that population growth of students coupled with inadequate of some infrastructural facilities results in change in land use/land cover. Therefore, this study aimed at assessing spatial changes that have occurred between the three period of the study.

2.0 Study Area

The study area is the polytechnic Ibadan, Ibadan North Local Government Area Oyo state, Nigeria. The geographical location of the study area is approximately het longitude 07° 25' 36.61"N and 07° 27' 22.7"N and latitude 03° 52' 38.51"E and 03° 53' 45.81"E. The study area covers an estimated area of about 245 Hectares.

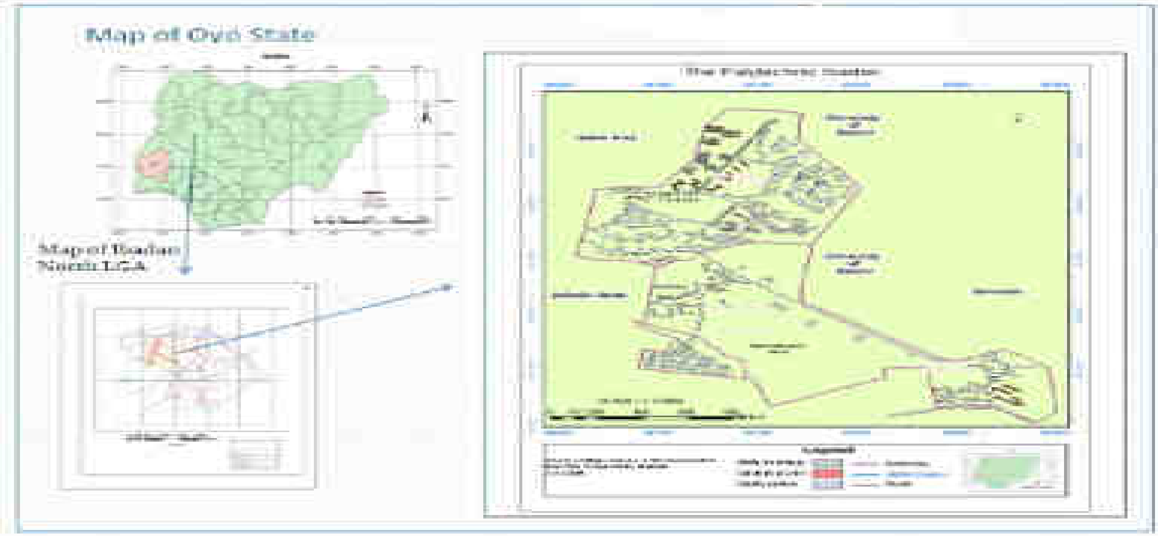


Figure 1: Map of The polytechnic Ibadan at Ibadan North LGA, Ibadan.

2.1 Climate

The Polytechnic Ibadan has an equatorial climate with dry and wet season and relatively high humidity. Dry season lasts from November to March while the wet season starts from April and ends in October.

2.2 Topography of the Study Area

The Topography is a gentle rolling low land in the rising to a plateau of about 40meters.

3.0 Material/Methods.

3.1 Equipment Used:

The materials used for the execution of the project task are:

3.1.1 Hardware

1. Differential Global Positioning System (ProMarkIII) and one rover and its accessories.
2. HP Pentium dual core Laptop with 300GB of HDD, 3GB of RAM 32-bit operating system

3. Flash drive
4. Printer (HP Series)
5. Field Book and Pen

3.1.2 Software

1. ArcGis 10.2
2. GNSS Solutions
3. WinZip Ilwis 3.4
4. Microsoft Word 2010, Notepad, Microsoft Excel
5. Downloaded imagery.

3.2 Method of Data Collection

This study covers sets of methods and fundamental principles implemented in the course of execution of the study. It entails various aspects of field exercise beginning from planning to data acquisition. The method and procedure employed in data acquisition will be fully discussed in this aspect. The field operations comprised of using GPS survey technique to track satellite code signals in order to determine the coordinates (X, Y and Z) between four stations. This part is very important and involves much planning, because the output of the entire process depends on the methods adopted, which are sources of data, sampling technique, system selection, database design, database creation field survey, data analysis. For this study, data were collected from primary and secondary data sources.

3.3 Test of Instruments

The Promark 3 GPS was used for this study was tested to confirm its working condition, Promark 3 with one rover, one with the master (reference) the other one was used as rover, both were configured in static mode, the master was set on a known point and the rover was also set on a known point and was allowed to track satellite for 30 minutes and the data were saved, downloaded and processed, so we discovered the one rover displayed correct approximate coordinates of the pillars they occupied, this shows that both receivers were working perfectly. The battery levels were examined and found to be fully charged and connection cables were checked to be in good order. These entire tests were performed before taking the instrument to site for field operation.

3.4 Data Acquisition

The data acquisition techniques used for this study was based on Geographic Information System (GIS) and remote sensing techniques. Data acquisition is one of the basic subsystems in any GIS analyses. The process carried out involved the collection of primary data through field observation using the Differential Global Positioning System (DGPS) equipment to acquired coordinates of control points used for geo-referencing Landsat satellite image used for this study.

3.4.1 Data Source

The data required for this study was obtained from both primary and secondary data. The primary data acquisition involved direct observation with Differential Global Positioning System (DGPS) while the secondary data was sourced from USGS satellite imagery Landsat TM 2005, 2010 and 2015 with resolution (1.0, 1.0 and 1.5)m respectively (figure 2) .

Figure 2: Downloaded imagery of year 2005, 2010 and 2015 before digitizing

The primary data source involved the collection of X and Y coordinates of the study area with the help of Differential Global Positioning System (DGPS) to determine the X and Y coordinates of four (4) identifiable points on the imageries for Geo-reference purpose as it shown in table 2 below. So also, the imagery used with resolution were shown in table 1

Table 1: imagery used and their resolution

No.	*Source*	*Data type*	*Years*	*Resolution*
1	*USGS Earth Explorer*	*Landsat image*	*2005*	*Medium (1.0)*
2	*USGS Earth Explorer*	*Landsat image*	*2010*	*Medium (1.0)*
3	*USGS Earth Explorer*	*Landsat image*	*2015*	*High (1.5)*

Table 2: Georeferenced Coordinates from Landsat TM imagery 2005, 2010 and 2015

No.	X coordinates	Y coordinates
1	598670.000	821108.000
2	597300.020	822364.080
3	597434.410	823020.230
4	597627.452	822166.917

3.4.2 GPS Field Observation

In practice, field procedures employed for GPS surveys depend on the capabilities of the receivers and the specification of the survey. Some of the procedures currently being used in GPS observation include the static, rapid static, Kinematic and real-time kinematic. All are based on carrier phase-shift measurements and employ a relative positioning technique; that is two receivers occupying two different stations and simultaneously making observation to several satellites. The field procedures employed in this study is the static mode of observation.

On the first day observation, (ProMark III) GPS was configured and a folder created for the study. A tribrach with an optical plummet set on tripod was used to center the GPS antenna on PBN 30327 control before the observation. In other to fixed a position of any point both horizontally and vertically, at least four satellite must be tracked hence an average of two hours was spent on each control point except on PBN 30327 and PBN 30328 where additional time of observation were added (i.e. 30min. and 1hr.) to check the effect of time spent on a station and the accuracy obtained. The master GPS receiver was set on PBN 30327 as base station and rover on GPS 01, GPS 02, GPS 03, GPS 04 and data were acquired.

3.5 Data Processing

The data processing for this study started from geo-referencing procedure up to digitizing stage. ArcGIS 10.2, ILWIS 3.4 software was used to generate the result of data analysis. During the geo-referencing the residual errors and Root Mean Square error was examined. The errors were associated with the amount of disagreement between the two control points for each link once the transformation is set (once you've added more than three links).

3.5.1 Ground Control Data Processing

The data were processed using ProMarkm III Geomatics office Software GNSS Solution. With GNSS Solution software, the coordinate of the control point were edited and then 'process and displayed. The result interface figure 1 shows the coordinates used for ground control (see figure 2). The residual errors for the year 2005 was 0.00 and Root Mean Square error was 0.00, the residual errors for the year 2010 was 0.00 and Root Mean Square error was 0.00 and the residual errors for the year 2015 was 0.0383692 and Root Mean Square error 0.0131755, 0.0406277, 0.0076993, 0.0632874 as shown in figure 3 below.

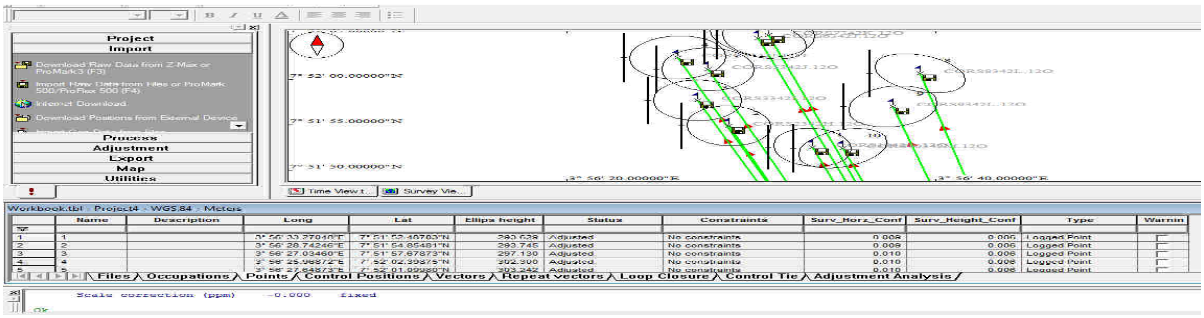


Figure 3: Overview of Processed Data using GNSS Solution

3.6 Sub-Map

The sub-map of raster map operation copies a rectangular part of a raster map into a new raster map. The user has to specify row and column numbers or X and Y coordinates of the input map that should be copied into the new map. This operation was carried out in ILWIS 3.4 environment to extract the study area (see table 3 below).

Table 3: Row and column numbers used for sub map

Total RMS Error: Forward:0

Link	X Source	Y Source	X Map	Y Map	Residual_x	Residual_y	Residual
1	3162.307160	-4810.558029	598670.000000	821108.000000	0	0	0
2	854.738572	-2738.849065	597300.020000	822364.080000	0	0	0
3	1022.988053	-1697.953550	597434.410000	823020.230000	0	0	0
4	1398.575409	-3069.502749	597627.452181	822166.916752	0	0	0

Total RMS Error: Forward:0

Link	X Source	Y Source	X Map	Y Map	Residual_x	Residual_y	Residual
1	3162.307160	-4810.558029	598670.000000	821108.000000	0	0	0
2	854.738572	-2738.849065	597300.020000	822364.080000	0	0	0
3	1022.988053	-1697.953550	597434.410000	823020.230000	0	0	0
4	1398.575409	-3069.502749	597627.452181	822166.916752	0	0	0

Total RMS Error: Forward:0.0383692

Link	X Source	Y Source	X Map	Y Map	Residual_x	Residual_y	Residual
1	2033.500087	-3055.499542	598670.000000	821108.000000	-0.0131755	0	0.0131755
2	757.500056	-1908.500000	597300.020000	822364.080000	-0.0374275	-0.0158047	0.0406277
3	850.499873	-1328.499897	597434.410000	823020.230000	-0.00769931	0	0.00769931
4	1058.139652	-2091.112022	597627.450000	822166.910000	0.0583023	0.0246197	0.0632874

	X	Y	Row	Col	Active	DRow	DCol
1	598670.620	821108.260	5731.17	3931.78	True	0.00	0.00
2	598648.350	821389.040	5288.51	3875.55	True	0.00	0.00
3	597629.280	822167.010	3993.68	2172.49	True	0.00	0.00

4165,4427 (599022.46, 822121.08)

3.6.1 Development of a Classification by Category

Based on the prior knowledge of the study area for over 10 years and a brief reconnaissance survey with additional information from previous research in the study area, a classification of twelve (12) categories scheme was developed for the study area (table 4).

Table 4: **Land Use And Land Cover Classification Of The Polytechnic Ibadan**

No	Category	Order	Condition	No	Category	Order	Condition
1	Residential	Staff Quarters	Fair	6	Sport	Sport Office	Fair
		Hostel	Good			Football Pitch	Fair
2	Commercial	Bank	Good			Lawn Tennis	Good
		Factory	Good			Basketball Court	Good
		Filling Station	Fair			Volley Ball	Good
3	Academics	Lecture Theater	Fair	7	Shop	Business Centre	Fair
		Staff Room	Fair			Food Canteen	Good
		Library	Fair			Barbing Saloon	Good
		Department	Fair			Retail	Fair
		Faculty	Fair	8	Power House	Generator House	Fair
		Administrative	Fair			Transformer	Fair
		ICT	Fair	9	Waterways	Stream	Fair
4	Road	Major Road	Good			Dam	fair
		Minor Road	Good	10	Medical	Health Centre	Fair
		Bus Stop	Good	11	Services	Restaurant	Good
5	Religion	Mosque	Fair	12	Vacant	vegetation	Low Land
		Church	Fair				

4.0 Results and Data Analysis.

The objective of this study form the basis of all the analysis carried out in this section. The results are presented inform of maps, charts and statistical tables. They include the cartographic map showing the perimeter boundary of the institution (see figure 4 and 6), static, change and projected land use land cover of each class. The land use/land cover distribution for each study year as derived from the maps is presented in the table 3 and figure 5 and 7 presents the exact land use/land cover for each year. Table 5-7 presents analysis of land use and land cover

Table 5: **Land use/Land covers Distribution between 2005, 2010 and 2015.**

Land Use/Cover Categories	Area (m^2) 2005	Area (m^2) 2010	Area (m^2) 2015	Area (%) 2005	Area (%) 2010	Area (%) 2015
Residential	649738.539	649738.539	612707.373	26.5	26.5	25
Commercial	8921.354	8921.354	14443.14	0.4	0.4	0.6
Academics	349415.612	349415.612	417478.226	14.2	14.2	17
Road	129881.089	129881.089	142591.655	5.3	5.3	5.8
Religion	10048.934	10048.934	21906.595	0.4	0.4	0.9
Sport	113046.539	113046.539	113046.539	4.6	4.6	4.6
Shop	16839.359	16839.359	17889.359	0.7	0.7	0.7
Power House	3086.667	3086.667	4043.419	0.1	0.1	0.2
Waterways	70789.865	70789.865	70789.865	2.9	2.9	2.9
Medical	12619.362	12619.362	21424.206	0.5	0.5	0.9
Services	13564.636	13564.636	42909.403	0.6	0.6	1.8
Vacant	1072048.044	1072048.044	970770.22	43.8	43.8	39.6
TOTAL	**2449999.999**	**2449999.999**	**2449999.999**	**100**	**100**	**100**

Table 6: Land use/Land covers Distribution between 2005 and 2010.

Land Use/Cover Categ	Area (m^2) 2005	Area (m^2) 2010	Diff. Area (m^2) 2005_2010	(%) Diff. 2005_2010
Residential	649738.539	649738.539	0.000	0.000
Commercial	8921.354	8921.354	0.000	0.000
Academics	349415.612	349415.612	0.000	0.000
Road	129881.089	129881.089	0.000	0.000
Religion	10048.934	10048.934	0.000	0.000
Sport	113046.539	113046.539	0.000	0.000
Shop	16839.359	16839.359	0.000	0.000
Power House	3086.667	3086.667	0.000	0.000
Waterways	70789.865	70789.865	0.000	0.000
Medical	12619.362	12619.362	0.000	0.000
Services	13564.636	13564.636	0.000	0.000
Vacant	1072048.044	1072048.044	0.000	0.000
TOTAL	**2449999.999**	**2449999.999**	**0.000**	**0.000**

Table 7: Land use/Land covers Distribution between 2005-2015

Land Use/Cover Categories	Area (m^2) 2005	Area (m^2) 2015	Diff. Area (m^2) 2005_2015	(%) Diff. 2005_2015	% Change 2005_2015
Residential	649738.539	612707.373	37031.166	1.5	13.400
Commercial	8921.354	14443.14	5521.786	0.2	2.000
Academics	349415.612	417478.226	68062.614	2.8	24.600
Road	129881.089	142591.655	12710.566	0.5	4.600
Religion	10048.934	21906.595	11857.631	0.5	4.300
Sport	113046.539	113046.539	0.000	0	0.000
Shop	16839.359	17889.359	1050.000	0	0.400
Power House	3086.667	4043.419	956.752	0.1	0.300
Waterways	70789.865	70789.865	0.000	0	0.000
Medical	12619.362	21424.206	8804.844	0.4	3.200
Services	13564.636	42909.403	29344.794	1.2	10.600
Vacant	1072048.044	970770.22	101277.824	4.2	36.600
TOTAL	**2449999.999**	**2449999.999**	**276617.977**	**11.4**	**100**

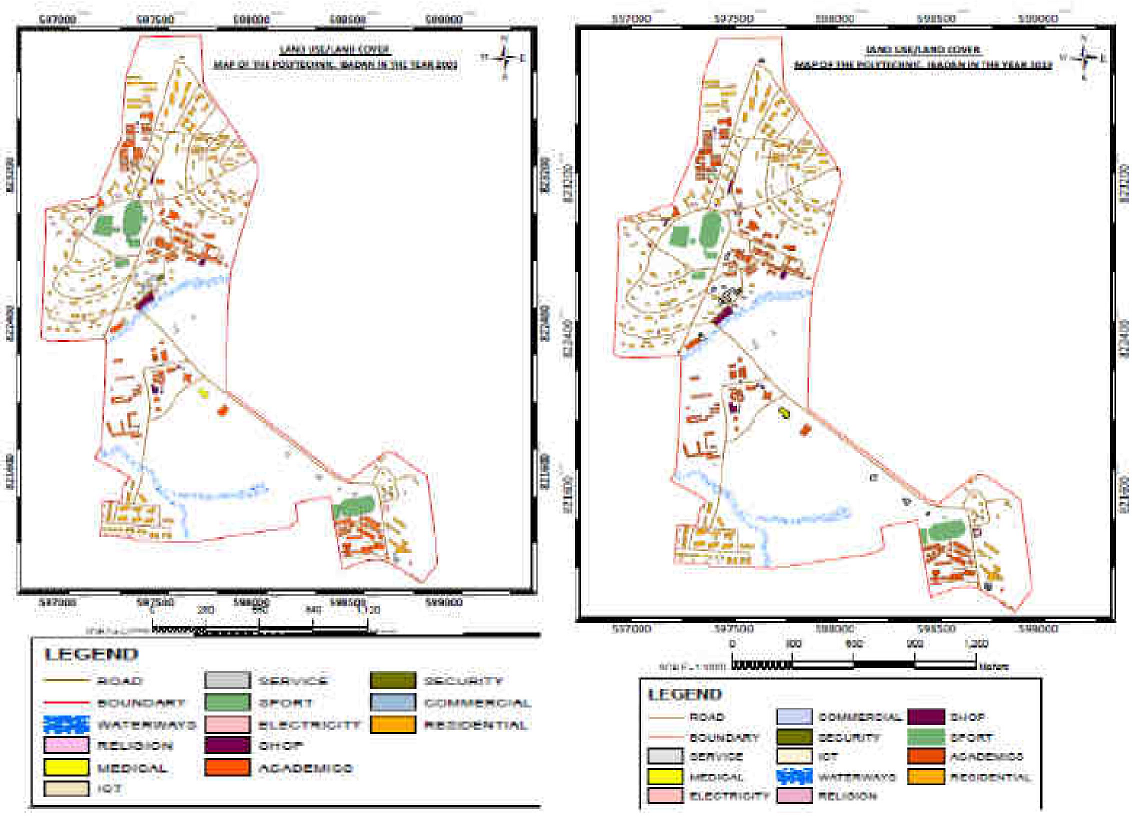


Figure 4: Cartographic detailed Map showing perimeter surveyof the Polytechnic Ibadan, 2005 and 2010

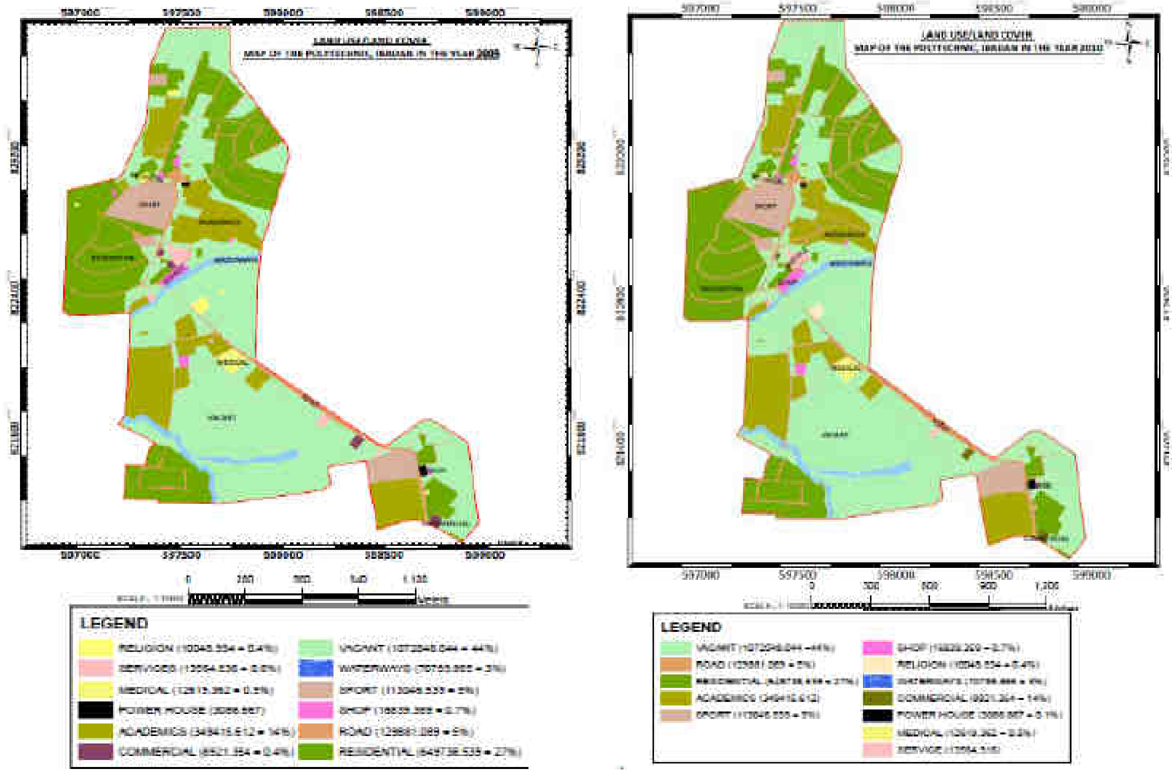


Figure 5: 2005and 2010 Land Use/Land Cover map of the Polytechnic Ibadan

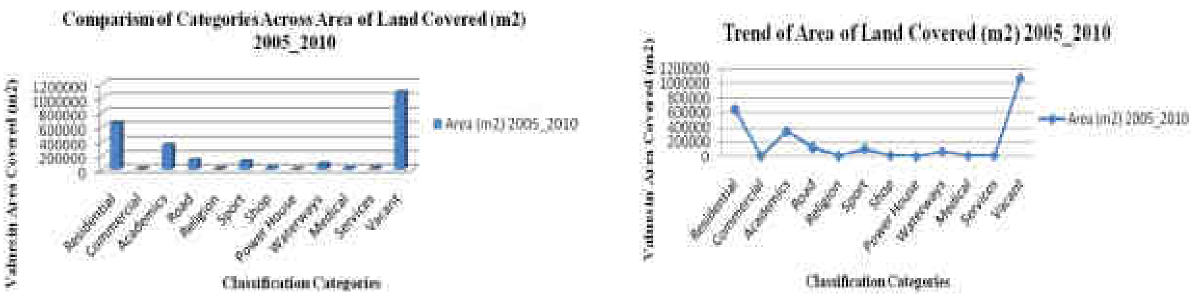


Chart 1: land use/cover categories and their trend of year 2005_2010 of the polytechnic, Ibadan.

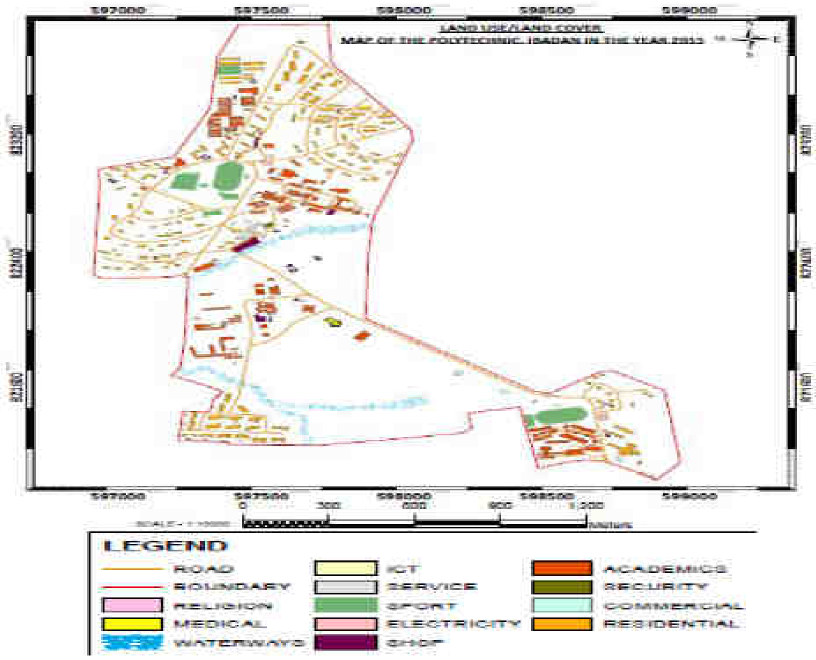


Figure 6: Cartographic detailed Map showing perimeter surveyof the Polytechnic Ibadan, 2015

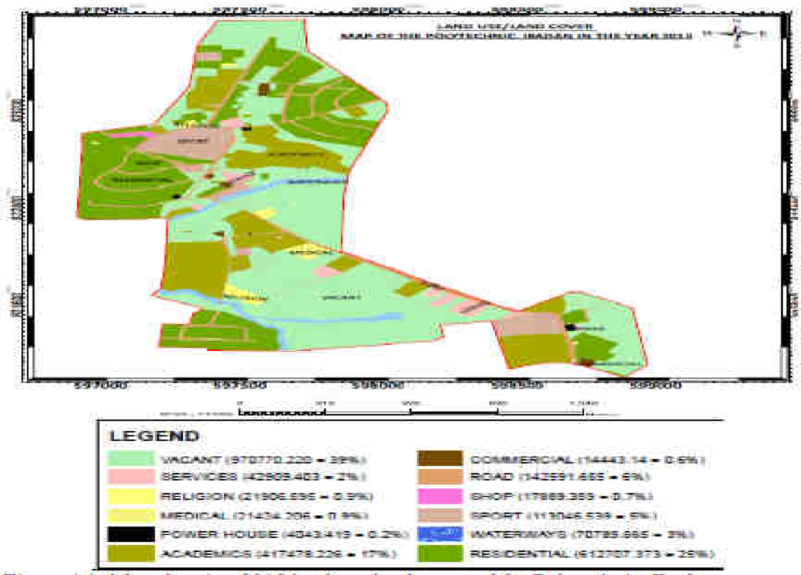


Figure 7: 2015 Land Use/Land Cover map of the Polytechnic Ibadan

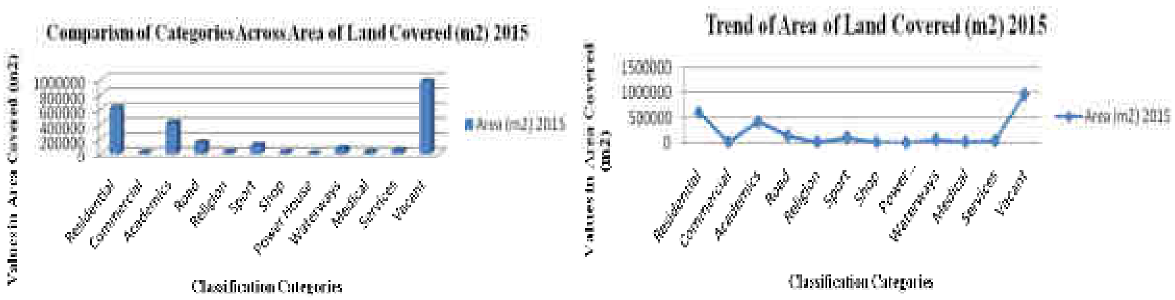


Chart 2: land use/land cover categories and their trend of year 2015 of the polytechnic, Ibadan.

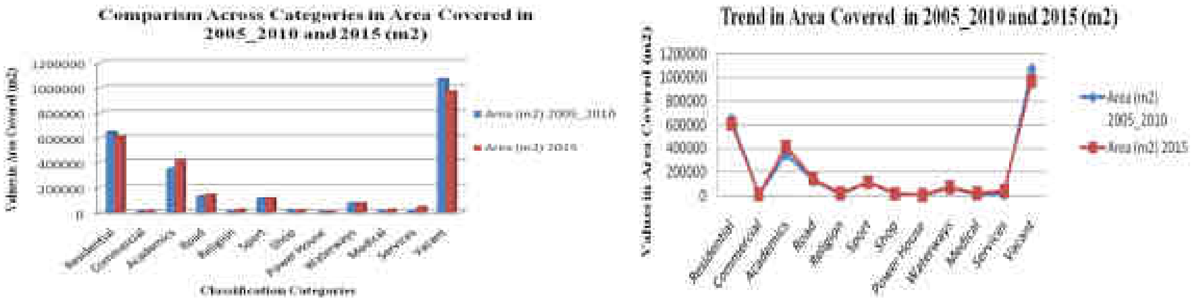


Chart 3: land use/land cover categories and their trend for year 2005_2010 and 2015

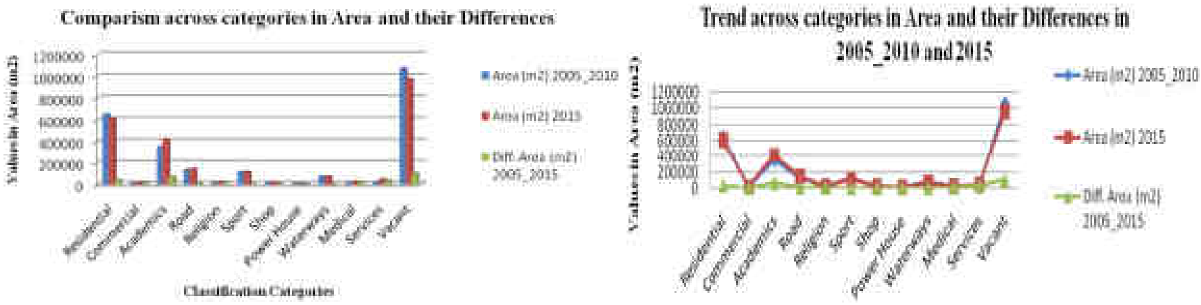
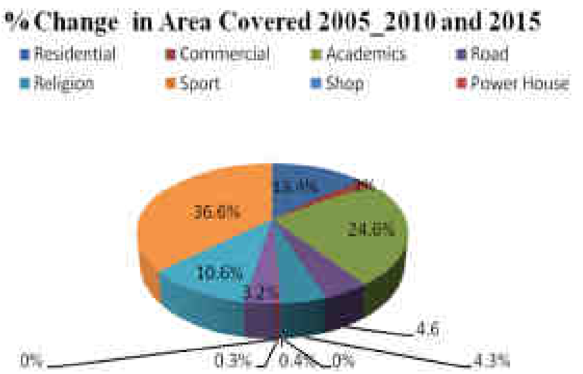
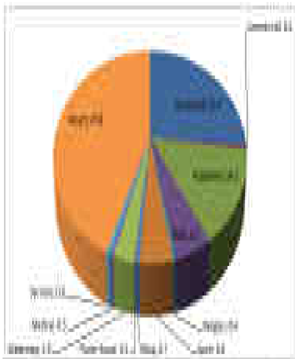


Chart.4: land use/land cover categories, differences and their trend for year 2005_2010 and 2015





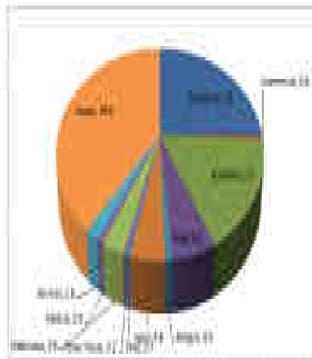


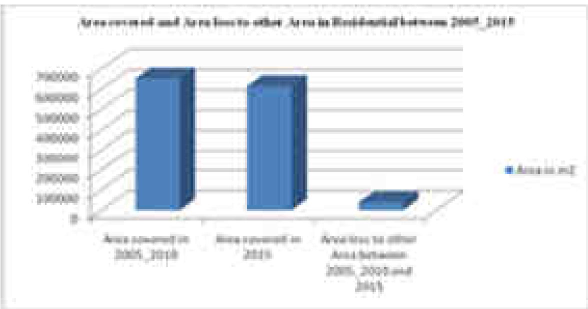
Chart 5: Percentage Change in 2005_2010 and 2015 Percentage Area 2005_2010 Percentage Area 2015

4.1 Discussion of results

From Table 5-7 above, it shows that there are some areas gained by other classes, areas loss to other classes and the area that no changes occurred at all between the periods of the study. The area lost and gained and area neither los nor gained was between 2005 and 2015 since there were no changes between year (2005-2010).

4.1.1 Area Loss To Other Classes

In the year 2005 Residential account for 649738.539 m^2 (26.5%) while in 2015 vegetation account for 612707.373m^2 (25%) as it is shown in (table 7 and chart 6) which shows large decrease (negative) in vegetation area by 37031.166 m^2 or (13.4%) of the total land cover within time period covered and this shows how the school environment has been degraded. Vacant Land account for 1072048.044 m^2 (43.8%) in 2005 and 970770.22m^2 (39.6%) in 2015 image as it is shown in (table 7 and chart 6) which shows change decrease (negative) by 101277.824 (36.6%) of the total land cover within time period covered. This shows that the intensive rate of more infrastructural facilities which has resulted in the loss of vacant area being converted to residential (Staff Quarters and Students Hostel) and as well as administrative and academic offices. It also shows that population increase in students admitted to the institution impose a lot of pressure on the institution management to build more classes and administrative as well as academic offices.



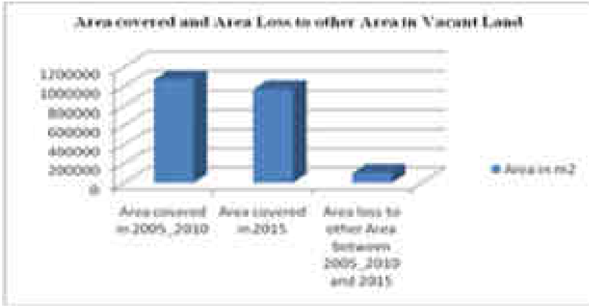
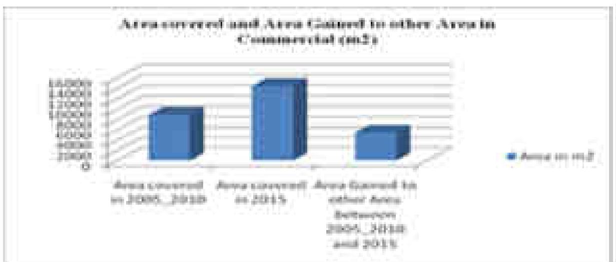
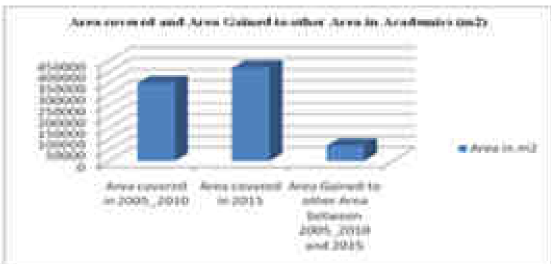


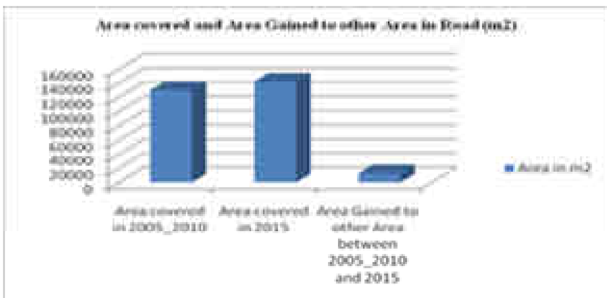
Chart 6:Trend of Area Covered and Area Loss to other Area

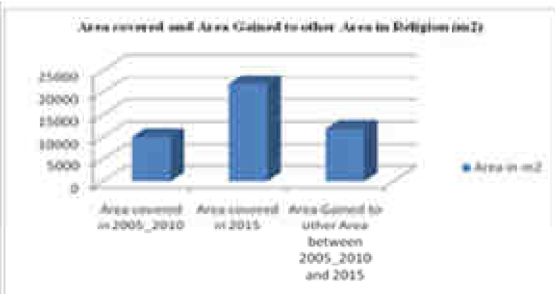
4.1.2 Area Gained By Other Classes

The study shows that Commercial account for 8921.354m^2 (0.4%) in 2005 image and 14443.14m^2 (0.6%) in 2015 image as it is shown in (table 7 and chart 7) which shows positive change increase (Positive) in commercial by 5521.786 m^2 or (2%) of the total land cover within time period covered. Academics account for 349415.612 m^2 (14.2%) in 2005 image and 417478.226m^2 (17%) in 2015 image as it is shown in (table 7 and chart 7) which show change increase (positive) in Academics by 68062.614 m^2 or (24.6%) of the total land cover within time period covered. Road account for 129881.089 m^2 (5.3%) in 2005 image and 142591.655m^2 (5.8%) in 2015 image as it is shown in (table 4 and chart 7) which shows change increase in road by 12710.566 m^2 or (4.6%) of the total land cover within time period covered. Religion account for 10048.934m^2 (0.4%) in 2005 image and 21906.595m^2 (0.9%) in 2015 image as it is shown in (table 7 and chart 7) which shows change increase in religion houses by 11857.631m^2 (4.3%) of the total land cover within time period covered. Shop account for 16839.359 m^2 (0.7%) in 2005 image and 17889.359m^2 (0.7%) in 2015 image as it is shown in (table 7 and chart 7) which shows change increase in Shop by 1050.000 m^2 (0.4%) of the total land cover within time period covered. Power House account for 3086.667 m^2 (0.1%) in 2005 image and 4043.419m^2 (0.2%) in 2015 image as it is shown in (table 7 and chart 7) which shows change increase in Power House by 956.752m^2 (0.3%) of the total land cover within time period covered. Medical account for 12619.362 m^2 (0.5%) in 2005 image and 21424.206m^2 (0.9%) in 2015 image as it is shown in chart 7 which shows change increase in medical by 8804.844 m^2 (3.2%) of the total land cover within time period covered. Services account for 13564.636 m^2 (0.6%) in 2005 image and 42909.403m^2 (1.8%) in 2015 image as it is shown in (table 7 and chart 7) which shows change increase in Services by 29344.794 m^2 (10.6%) of the total land cover within time period covered. All these classification categories of features were leading to degradation in the institutional natural biodiversity which can cause Global warming.









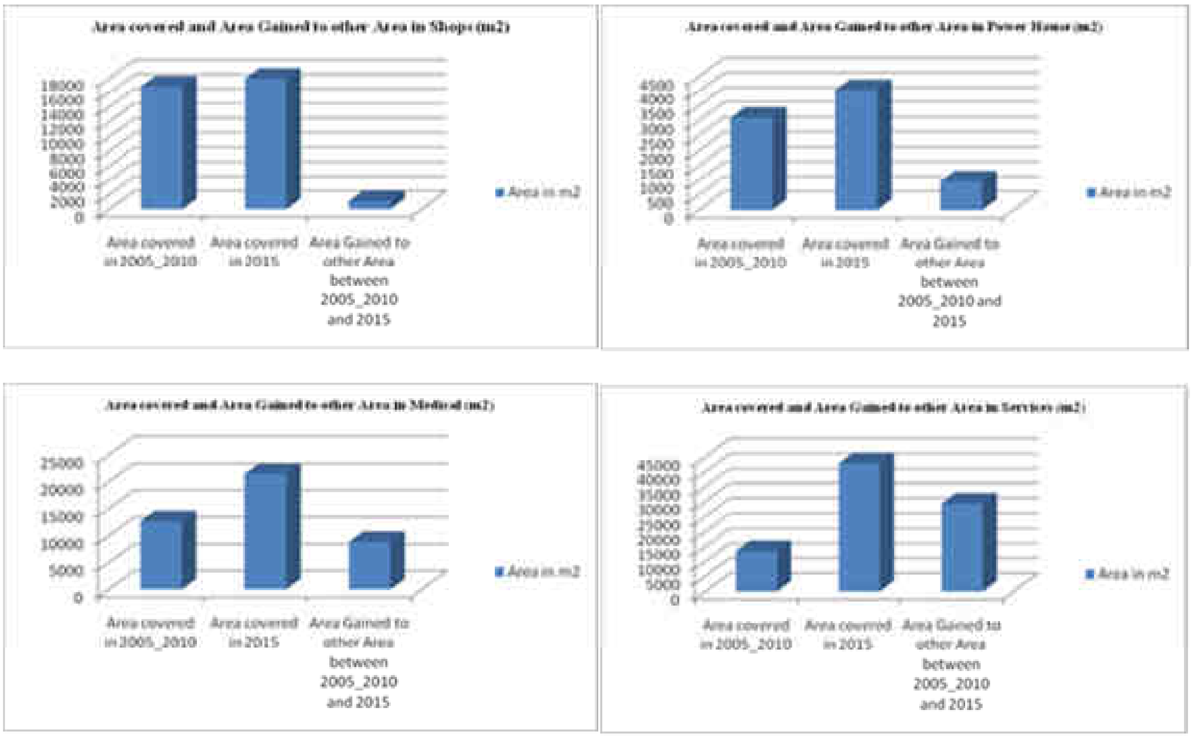


Chart 7:Trend of Area Covered and Area Loss to other Area

4.1.3 Area neither Gained nor Loss

Sport account for 113046.539 m^2 (5%) in 2005 and 113046.539 m^2 (5%) in 2015 which shows no increase or decrease in total area covered. The same to Waterways which account for 70789.865 m^2 (3%) in 2005 and 70789.865 m^2 (3%) in 2015 which also shows no increase or decrease of the total area covered (table 6 and chart 8).

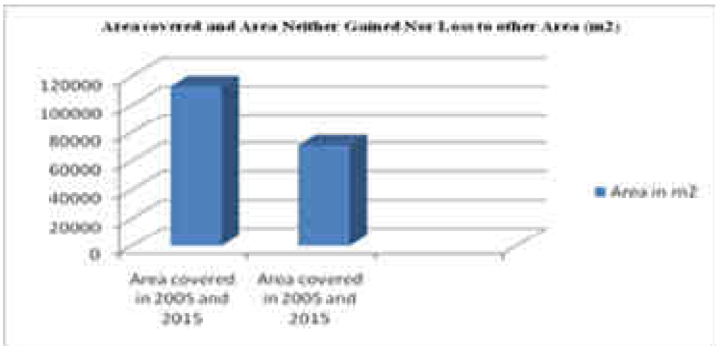


Chart 8:Trend of Area Covered and Area Loss to other Area

5.0 Conclusion

Landsat images TM 2005, 2010 and 2015 satellite remote sensing data were used to identify, classify, assess and interpret spatial changes that have occurred at the Polytechnic Ibadan, Ibadan North Local Government south western Nigeria. The GIS database of land use/ land cover categories and their changes within 10 years (2005, 2010 and 2015) was acquired and analyzed. Generally, the result showed the changes that occurred were due to several needs in terms of the administrative offices, academic offices medical rooms and more lecture room in the institution. The rates at which the reserve has been degraded have made the area a shadow of their former selves. The spatial changes will go a long way in building a conducive learning environment for the students as well as the staff of the institution. From this study, Landsat TM data are important sources of imagery data for mapping and monitoring the dynamics of land use/ land cover of the institution which will help in environmental sustainability.

Recommendation

The Authors wish to recommend that there should be adequate and constant monitoring of the environment within the institution which should be between five years interval so as to maintain constant monitoring of the environment. Finally, the technology of remote sensing and GIS should be employed in major studies for proper planning and data record, concerning national issues such as deforestation, desertification etc. GIS application should be introduced to all existing record section or department in the country.

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