Space Technology for Monitoring & Managing Forest in Nigeria

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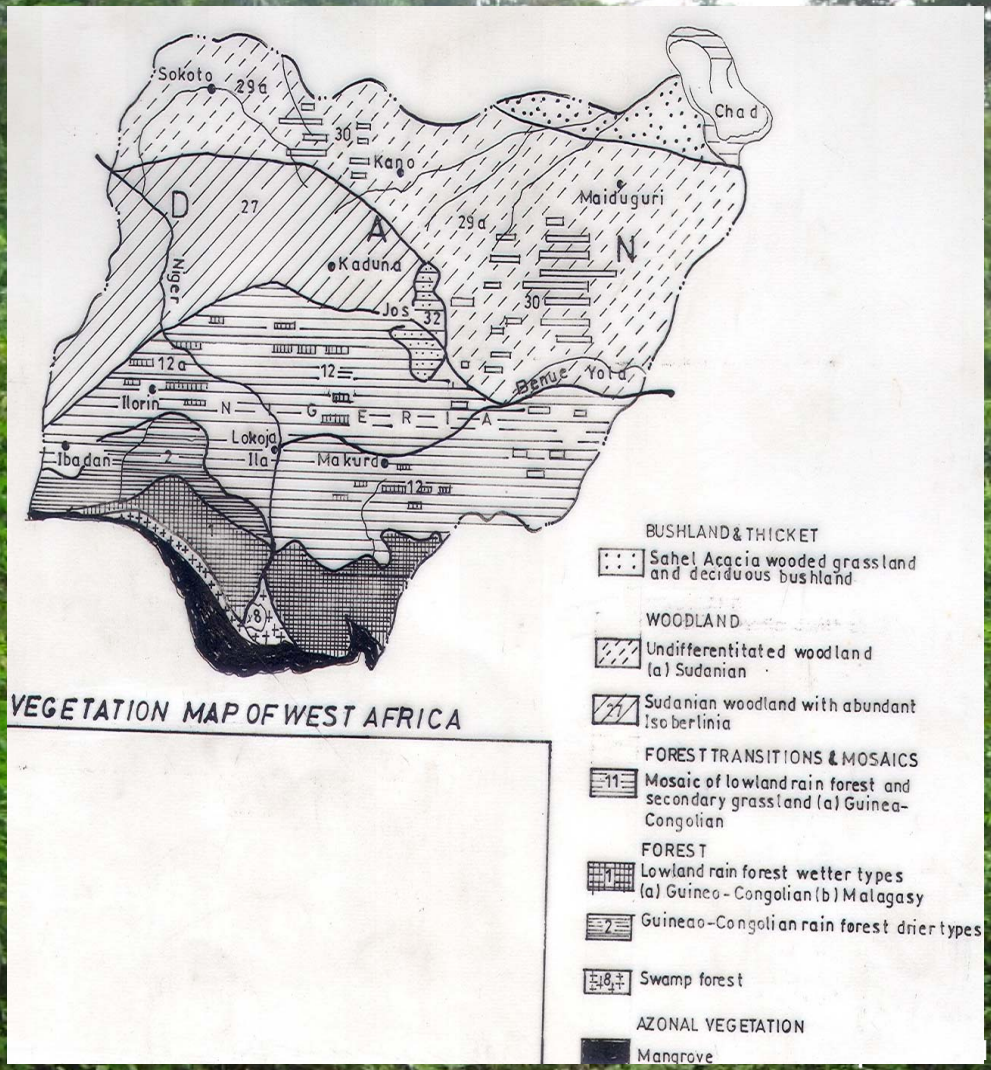
INTRODUCTION

- The growing decline in the area coverage of forest has been a source of concern to various governments in Sub-Saharan Africa

- Many of these countries have accepted, at least in principle, the need to address the problem

SITUATION IN NIGERIA



- The eco-climatic zones in Nigeria support a variety of vegetation; among which the most extensive vegetation zones are savannas in the north and forests in the south

- The tropical forests now cover less than 10% of Nigeria's landmass

SITUATION IN NIGERIA-CONTD.

- Unpublished surveys in the arid northern zones of the country show that farm tree densities have declined from 15 to 3 per hectare since 1950s
- Desert encroachment is advancing at an estimated rate of 0.6 km per year in the Northern Nigeria while uncontrolled logging and tree felling is the order of the day in the south

REMOTE SENSING AND FOREST MONITORING IN NIGERIA

- Despite the emergence of satellite products for environmental monitoring since 1970s, it has hitherto been very difficult to monitor the Nigerian forest estate using this means

- The Federal Government initiated the Nigerian Radar (NIRAD) project during 1976-1978 period. A similar initiative was coordinated by Forestry Monitoring and Evaluation Unit (FORMECU) between 1993 and 1995.

- These efforts could not be sustained due largely to the cost involved in procuring satellite images for regular assessment and monitoring.

REMOTE SENSING AND FOREST MONITORING IN NIGERIA – CONTD.

- Empirical evidence suggests that deforestation rates often quoted for Nigeria are at variance with local realities and can therefore not be used for predictive models
- But since NigeriaSat-1 was launched in September 2003 and the products are now available, it should now be much easier to obtain up-to-date information on most environmental parameters including the forests.
- The launching of NigeriaSat-1 has now opened up vista of utilization of earth observation satellites in national development on a sustainable basis

NIGERIASAT-1

NASRDA SPONSORED FOREST MONITORING PROJECT

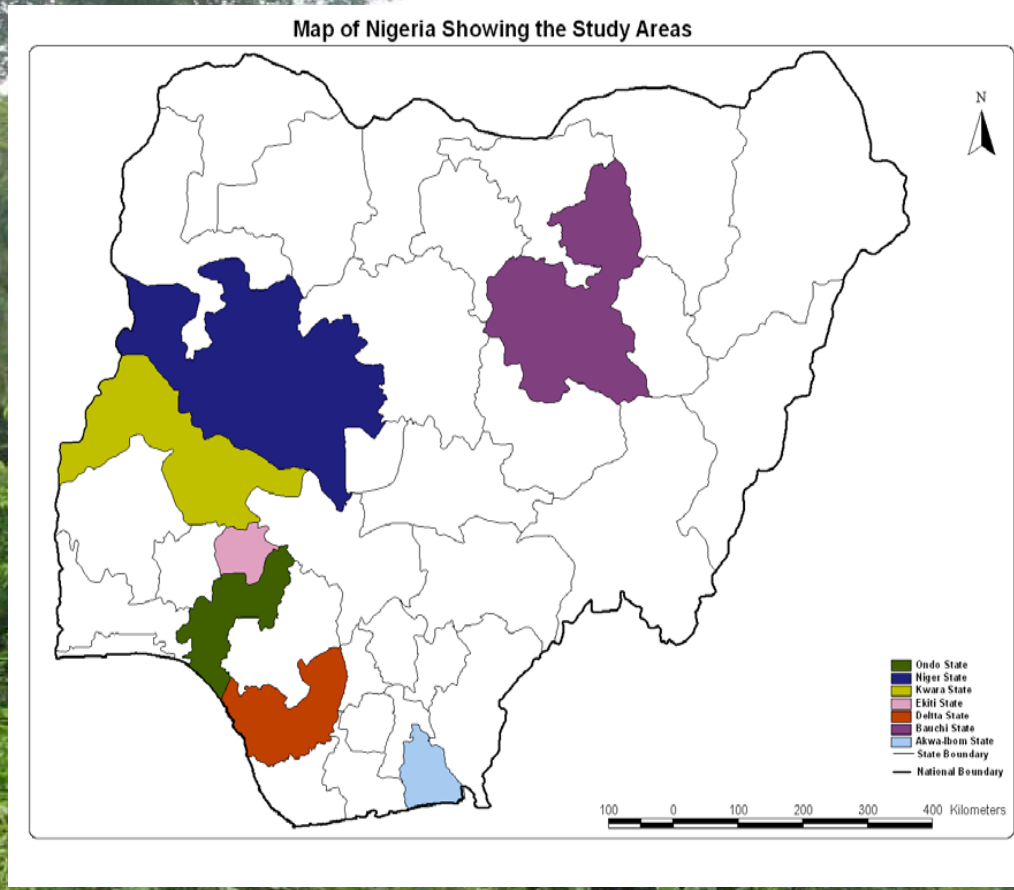
- The project was commissioned to assess the capability of NigeriaSat-1 for forest assessment and monitoring

It is a multidisciplinary study involving several institutions and scientists

STUDY SITES AND JUSTIFICATION

- The study was designed to have a national coverage with the field work covering 4 out of 6 geo-political zones in Nigeria; with 2 each in southern and northern parts of the country

- The study sites are located within South-South, South-West, North Central and North East geo-political zones



STUDY DESIGN

- In each of the selected site, attempt was made to inventory a protected area as well as the adjoining free area where *laissez faire* policy of land management operates
- The protected area was used as the control against which deforestation of the free area is measured
- The study provides a view of deforestation and biodiversity loss both within and outside the protected areas
- The study made use of ASTER, Landsat ETM and NigeriaSat-1

SOUTH-SOUTH ZONE

- A Landsat ETM+ image of January 8, 2001, an ASTER image of January 12, 2002, a NigeriaSat-1 image of December 2003 were used for this site

- The images were georeferenced to Universal Transverse Mercator (WGS84- Zone 32N) and a common window covering the same geographical coordinates was then extracted from each of the images

- Supervised classification was carried out based on the Maximum Likelihood algorithm.

SOUTH-SOUTH ZONE

- The classified image was then re-classified. This involved the masking out of other cover types to produce the main mangrove zonation types in the area.

- The re-classified map for each image thus extracted the area of mangrove coverage in the study area and delineated the boundaries between these mangrove types. The product is therefore the vegetation cover of the wetland in the study area.

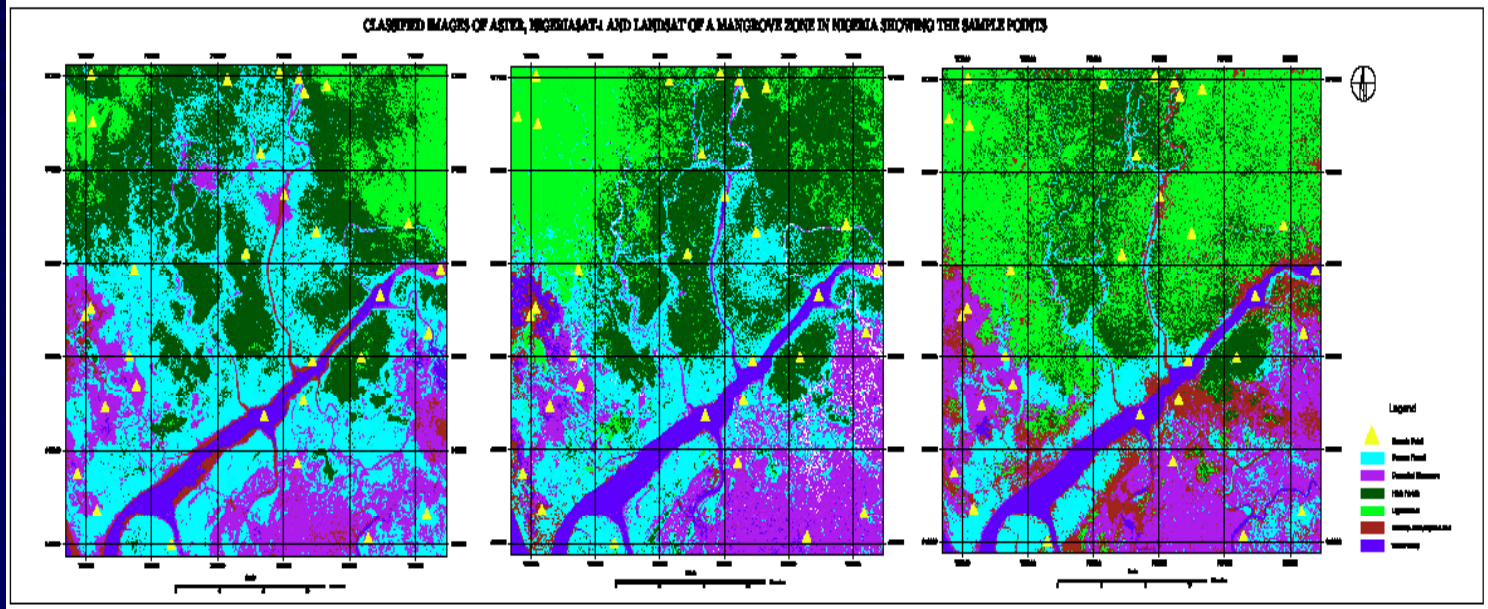
Results

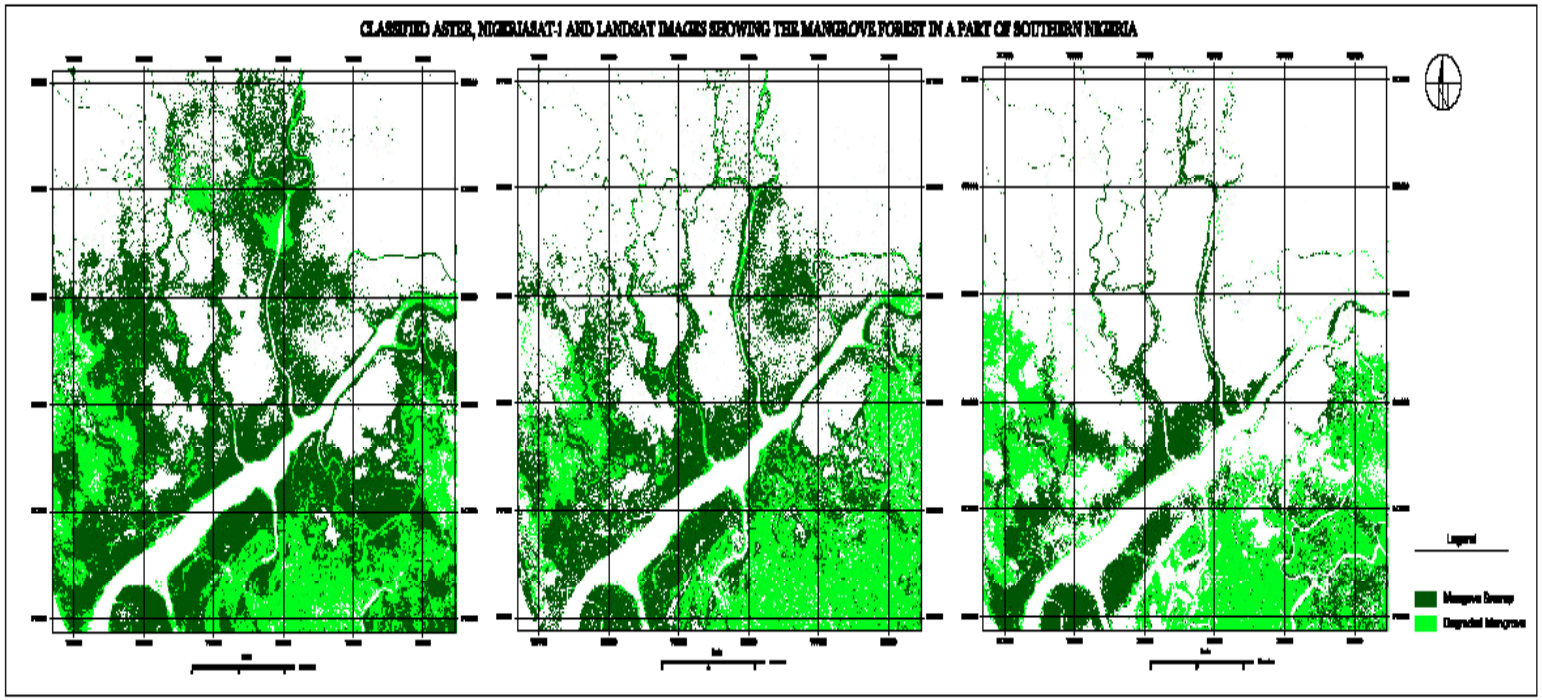
Table 1: Cover types in the area

Class	ASTER % Cover	NIGERIASAT-1 % Cover	LANDSAT ETM+ % Cover
Wetland			
Mangrove Swamp	37.04	33.22	13.57
Degraded Mangrove	17.18	17.85	16.54
Dryland			
High Forest	30.80	22.41	19.56
Light Forest	8.65	16.45	32.62
Others			
Mudflat/Bare	2.56	2.04	12.75
Surface Water	3.61	6.60	4.89
Unclassified	0.16	1.43	0.07
Total	100	100	100

Table 2: Classification accuracy

Class name	ASTER		NIGERIASAT-1		LANDSAT ETM+		No of points used for classification	No of points used for accuracy assessment
	Producer Accuracy (%)	User Accuracy (%)	Producer Accuracy (%)	User Accuracy (%)	Producer Accuracy (%)	User Accuracy (%)		
Wetland								
Mangrove Swamp	81.82	81.2	80.00	80.80	75.00	75.50	9	15
Degraded Mangrove	85.71	75.00	83.33	71.43	66.65	100.00	7	14
Dryland								
High Forest	75.00	60.00	100.00	71.43	100.00	80.00	4	10
Light Forest	60.00	75.00	57.14	66.67	83.33	66.50	5	10
Others								
Mudflat	100.00	100.00	66.60	100.00	100.00	66.69	4	08
Bare surface	50.00	66.67	50.15	100.00	60.00	100.00	3	08
Overall accuracy	75%		71.88%		78.13%		32	65


CLASSIFIED IMAGES OF ASTER, NIGERIASAT-1 AND LANDSAT OF A MANGROVE ZONE IN NIGERIA SHOWING THE SAMPLE POINTS
Legend


CLASSIFIED ASTER, NIGERIASAT-1 AND LANDSAT IMAGES SHOWING THE MANGROVE FOREST IN A PART OF SOUTHERN NIGERIA
Legend
Mangrove Swamp
Degraded Mangrove

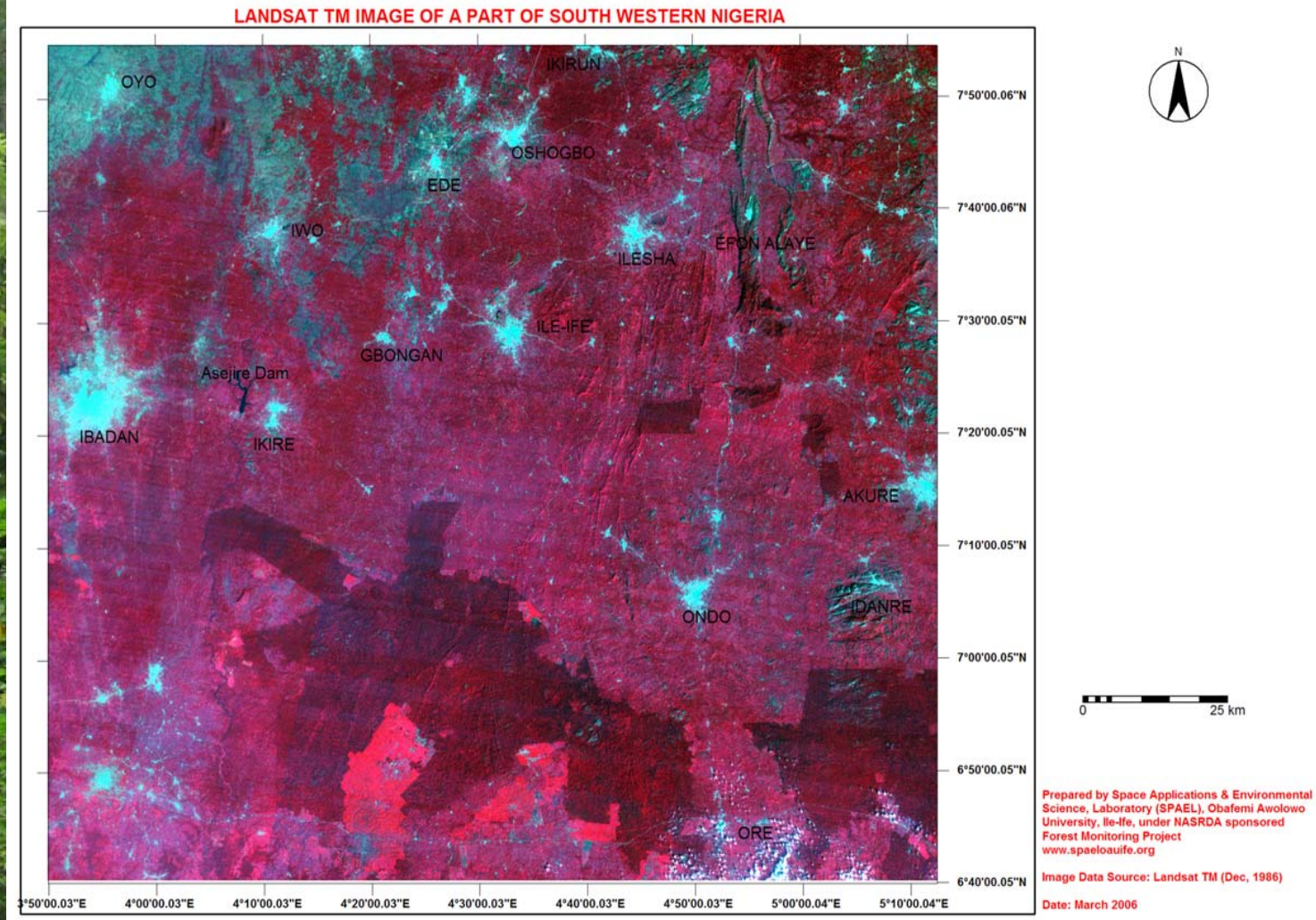
RESULTS Contd.

- An overall accuracy of 78% was obtained for LandSat 75% for ASTER and 71% for NigeriaSat-1

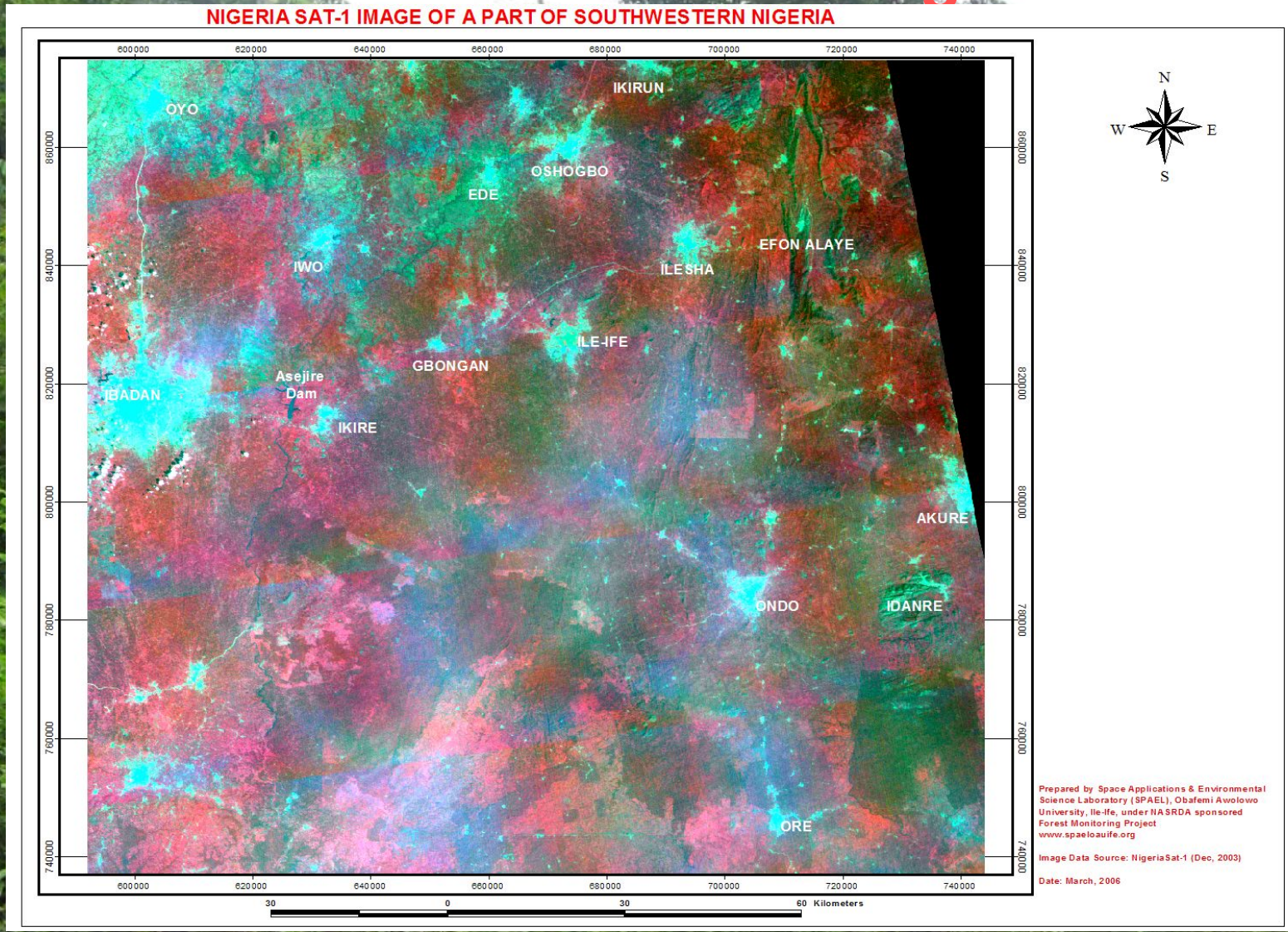
SOUTH-WEST

- Landsat TM of 1986 and NigeriaSat-1 images of 2004 were used for this site

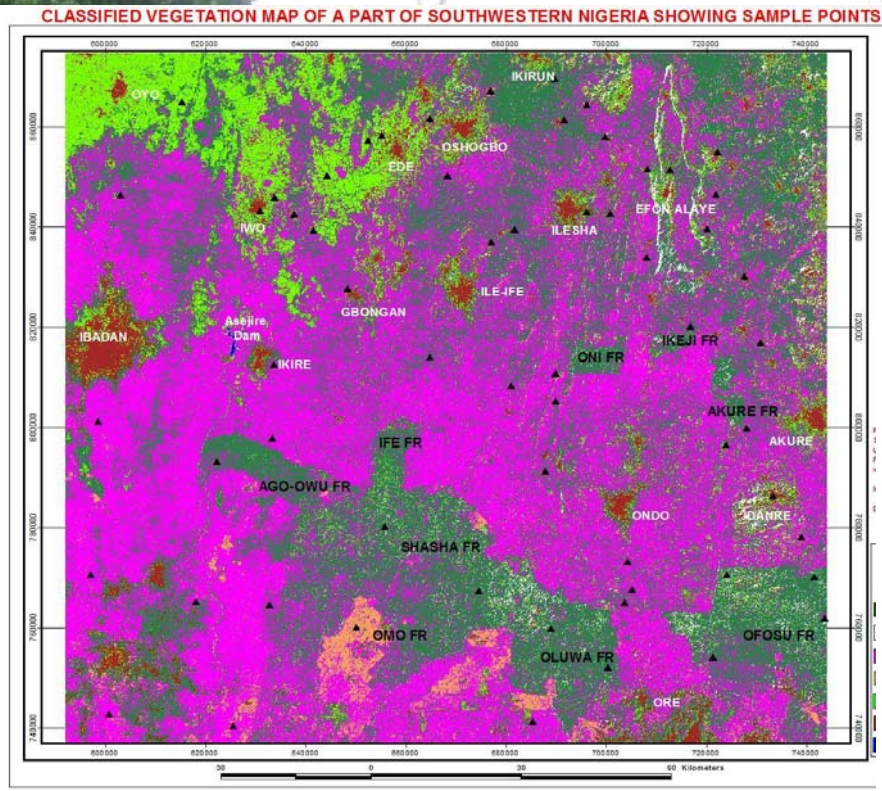
Landsat TM of a part of southwestern Nigeria



NigeriaSat-1 Image of a Part of Southwestern Nigeria



Vegetation maps of a part of southwestern (1986-2004)



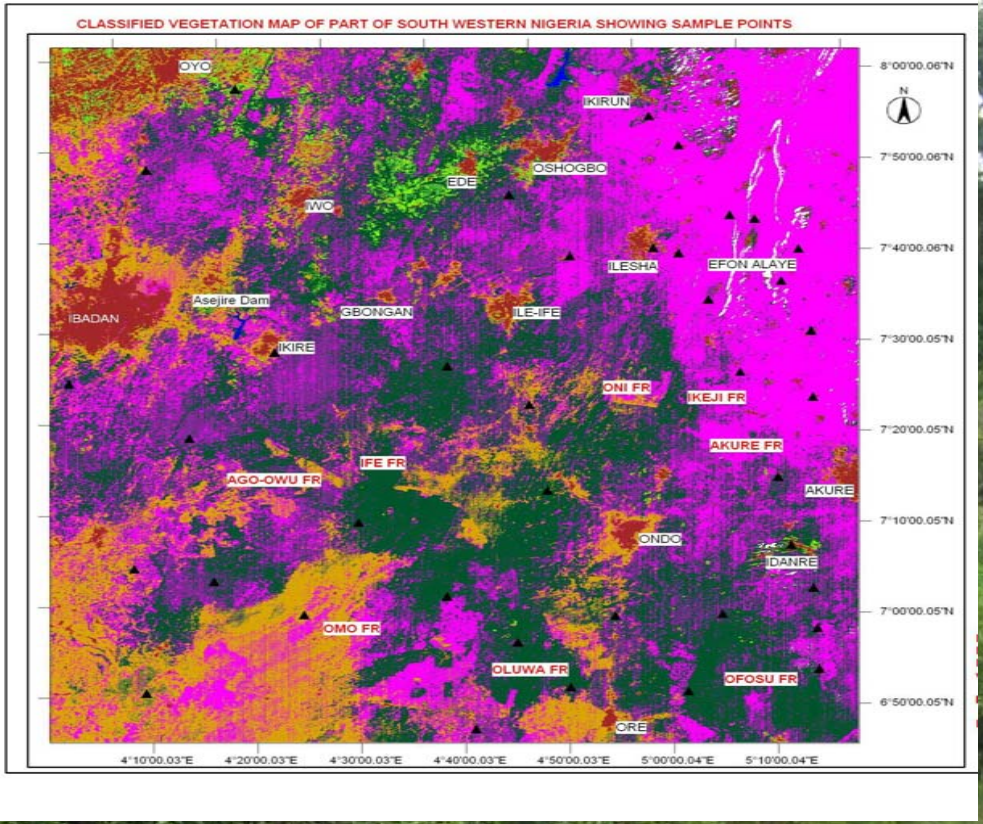
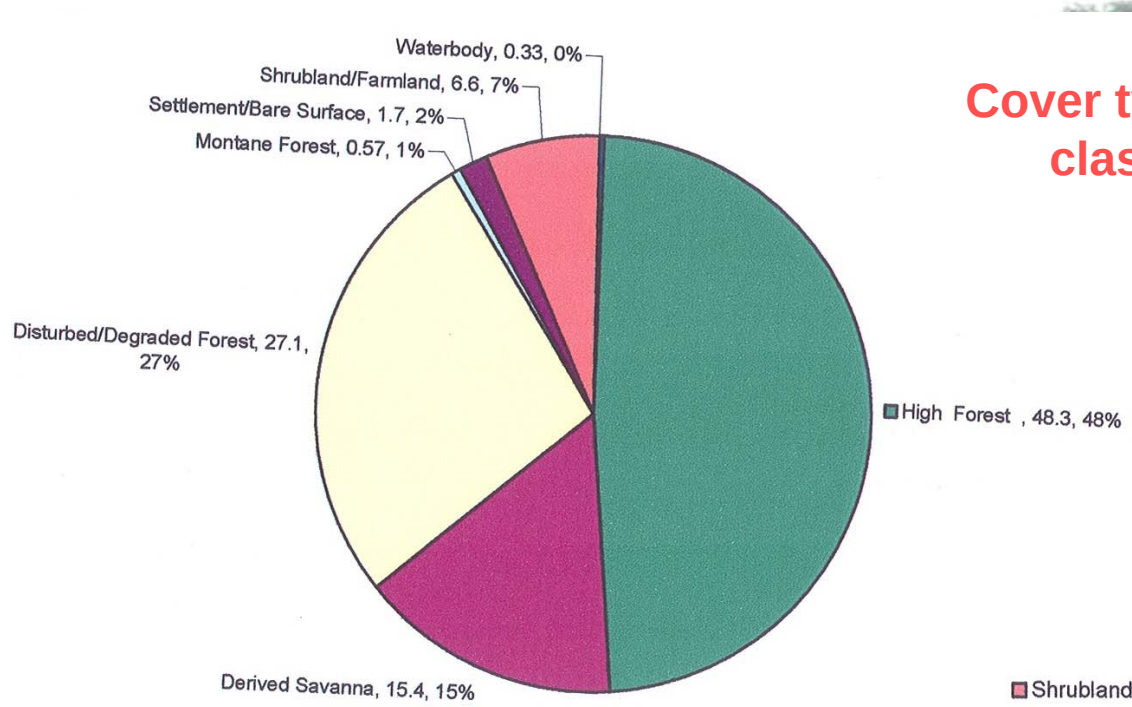


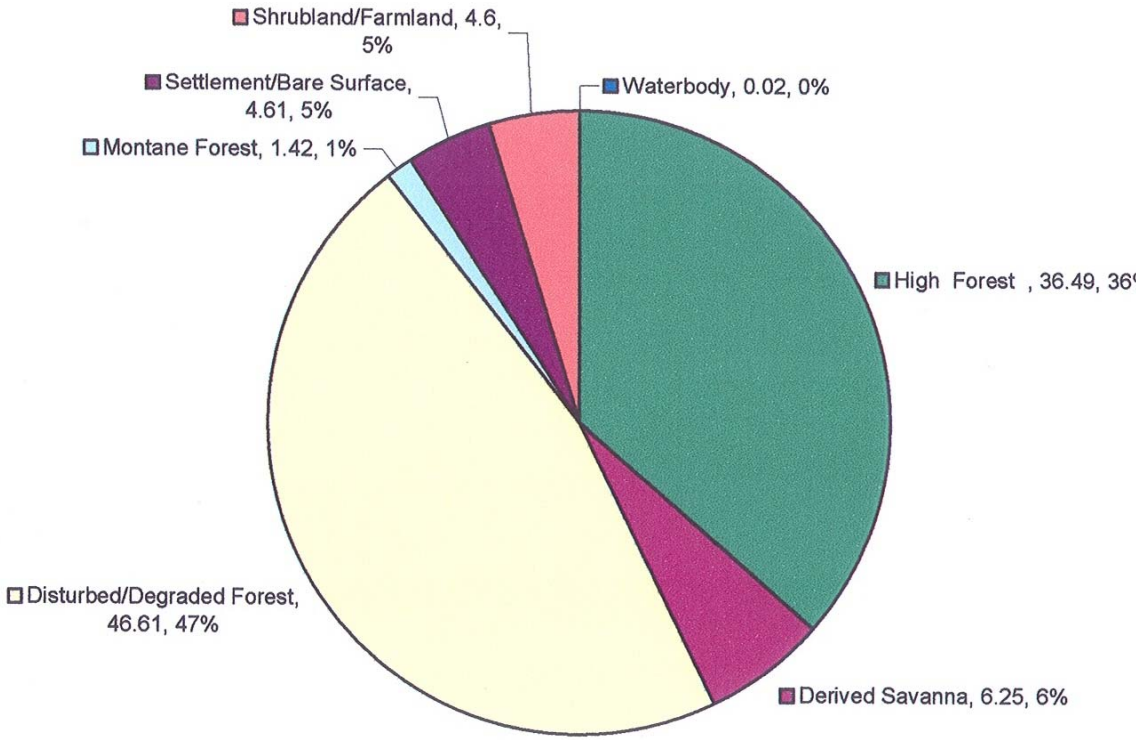
TABLE 3: AREAL OF COVER TYPES IN SOUTH WESTERN NIGERIA (1986-2004)

Cover Types	Landsat TM 1986		Landsat ETM 2001		NigeriaSat-1 2004	
	Area (in km^2)	% cover Area	Area (in km^2)	% cover	Area (in km^2)	% cover
High Forest	10108.82	48.3	8313.15	39.72	7637.08	36.49
Derived savanna	3223.1	15.4	1858.45	8.87	1308.07	6.25
Disturbed/ Degraded forest	5671.82	27.1	9045.64	43.24	9755.12	46.61
Montane Forest	119.29	0.57	319.03	1.52	297.19	1.42
Settlement/Bare Surface	355.79	1.7	834.45	3.99	964.75	4.61
Shrub land/Farmland	1381.13	6.6	549.45	2.63	962.75	4.6
Water body	69.06	0.33	5.2	0.03	4.18	0.02
TOTAL	20929.01	100	20929.25	100	20929.22	100



Cover types in south western Nigeria as classified from LandSat TM 1986

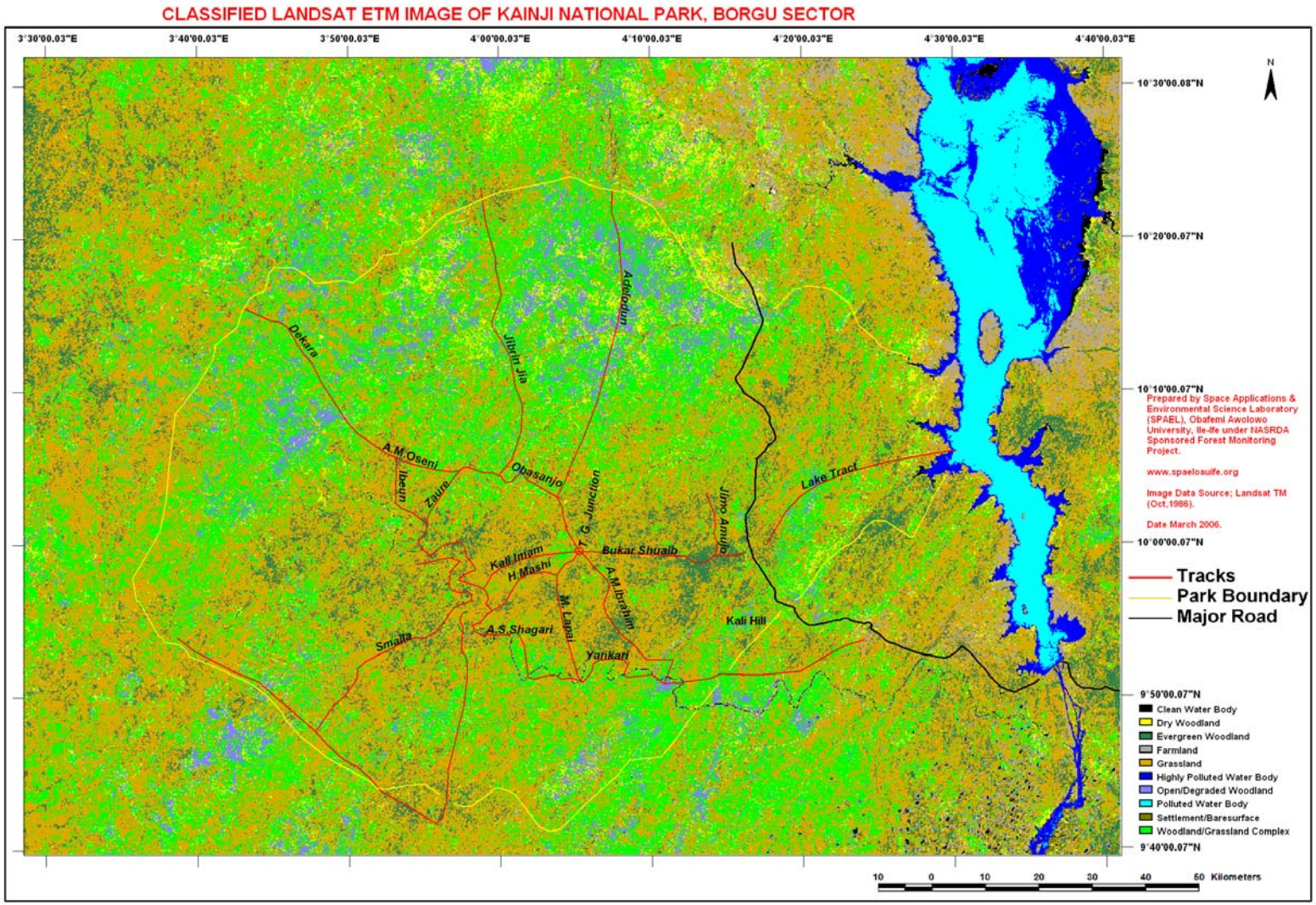
Cover types in south western Nigeria as classified from NigeriaSat-1 2004



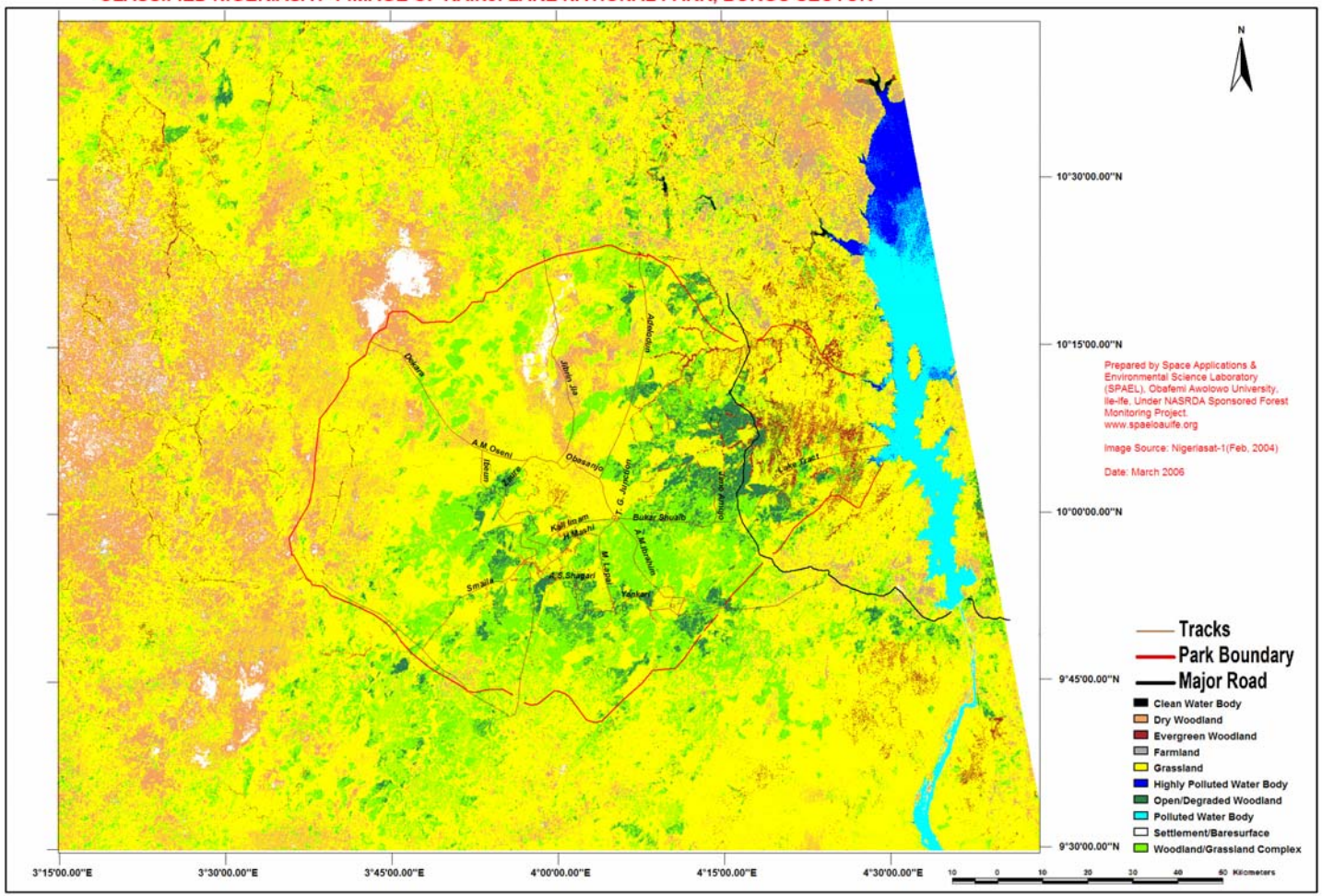
NORTH-CENTRAL ZONE

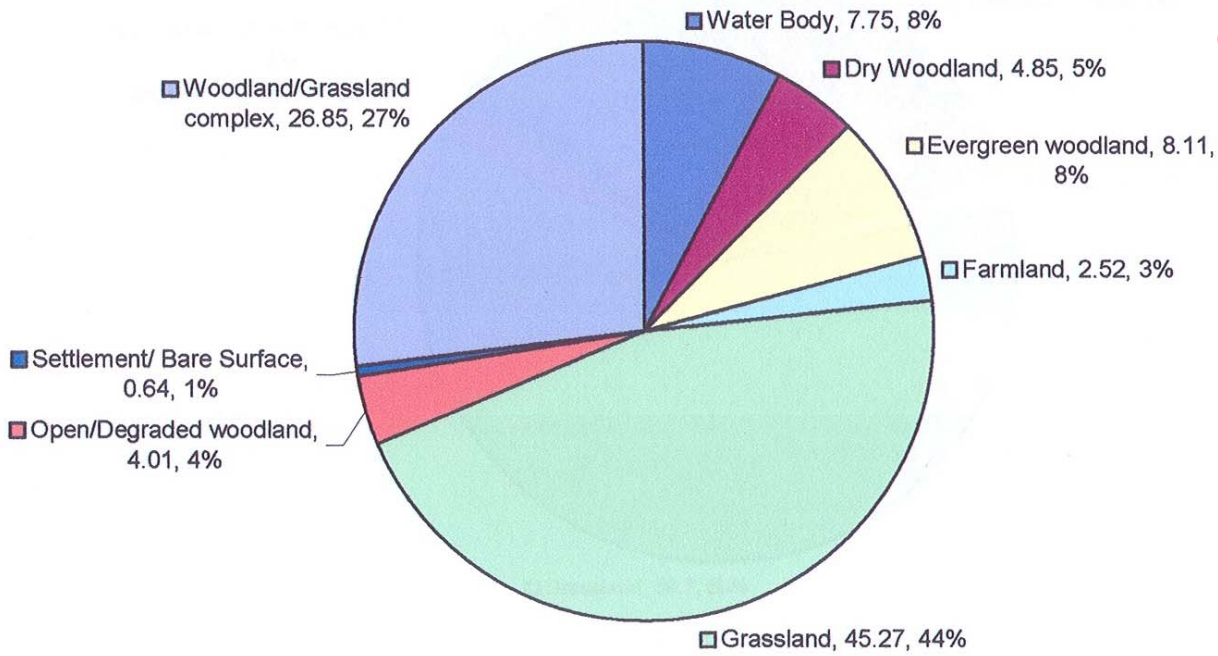
- Landsat TM (1986) and NigeriaSat-1 (2004) were processed and classified for this area

NORTH-CENTRAL ZONE



CLASSIFIED NIGERIASAT-1 IMAGE OF KAINJI LAKE NATIONAL PARK, BORGU SECTOR





% cover types within & around Kainji Lake National Park from Landsat TM (1986)

% cover types within & around Kainji Lake National Park from NigeriaSat-1 2004

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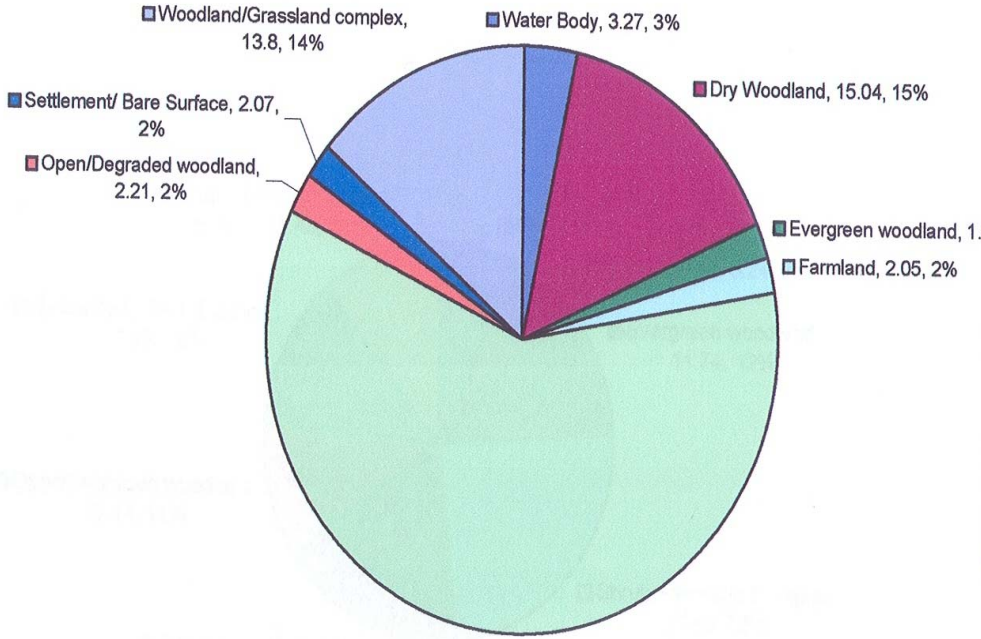


TABLE 4: CHANGES IN COVER TYPES WITHIN AND AROUND BORGU (KNLP) 1986-2004				
	Landsat TM 1986		NigeriaSat-1 2004	
Cover Types	Area (in km^2)	% cover Area	Area (in km^2)	% cover Area
Water Body	988.26	7.75	417.21	3.27
Dry Woodland	619.15	4.85	918.89	15.04
Evergreen woodland	1035.11	8.11	237.31	1.86
Farmland	320.93	2.52	261.55	2.05
Grassland	5775.67	45.27	7616.89	59.7
Open/Degraded woodland	511.42	4.01	281.97	2.21
Settlement/ Bare Surface	81.07	0.64	264.11	2.07
Woodland/Grassland complex	3427.01	26.85	760.69	13.8
Total	12758.62	100	12758.62	100

NORTH-EAST ZONE

- For this zone, Landsat and NigeriaSat-1 were used
- The trend was obtained for the period between 1990 and 2004

Figure 9: Landsat Image of Yankari National Park (FCC)

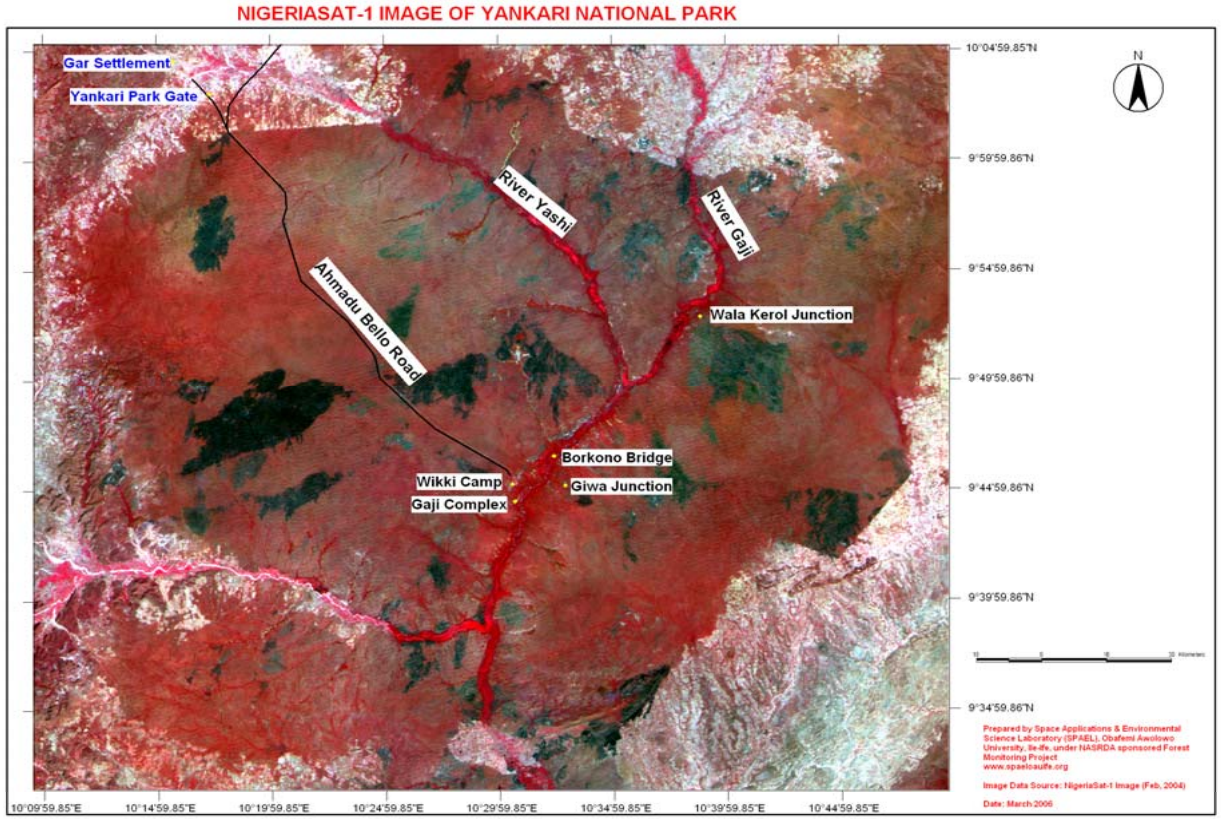
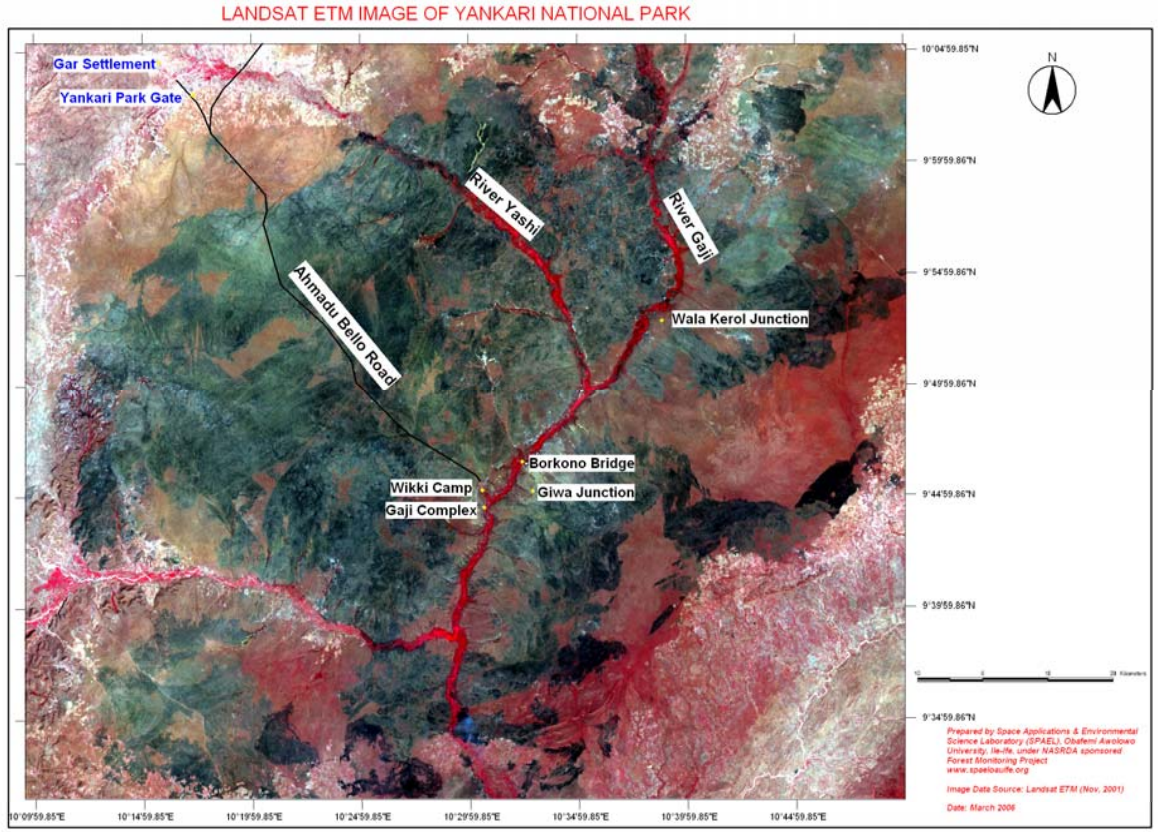
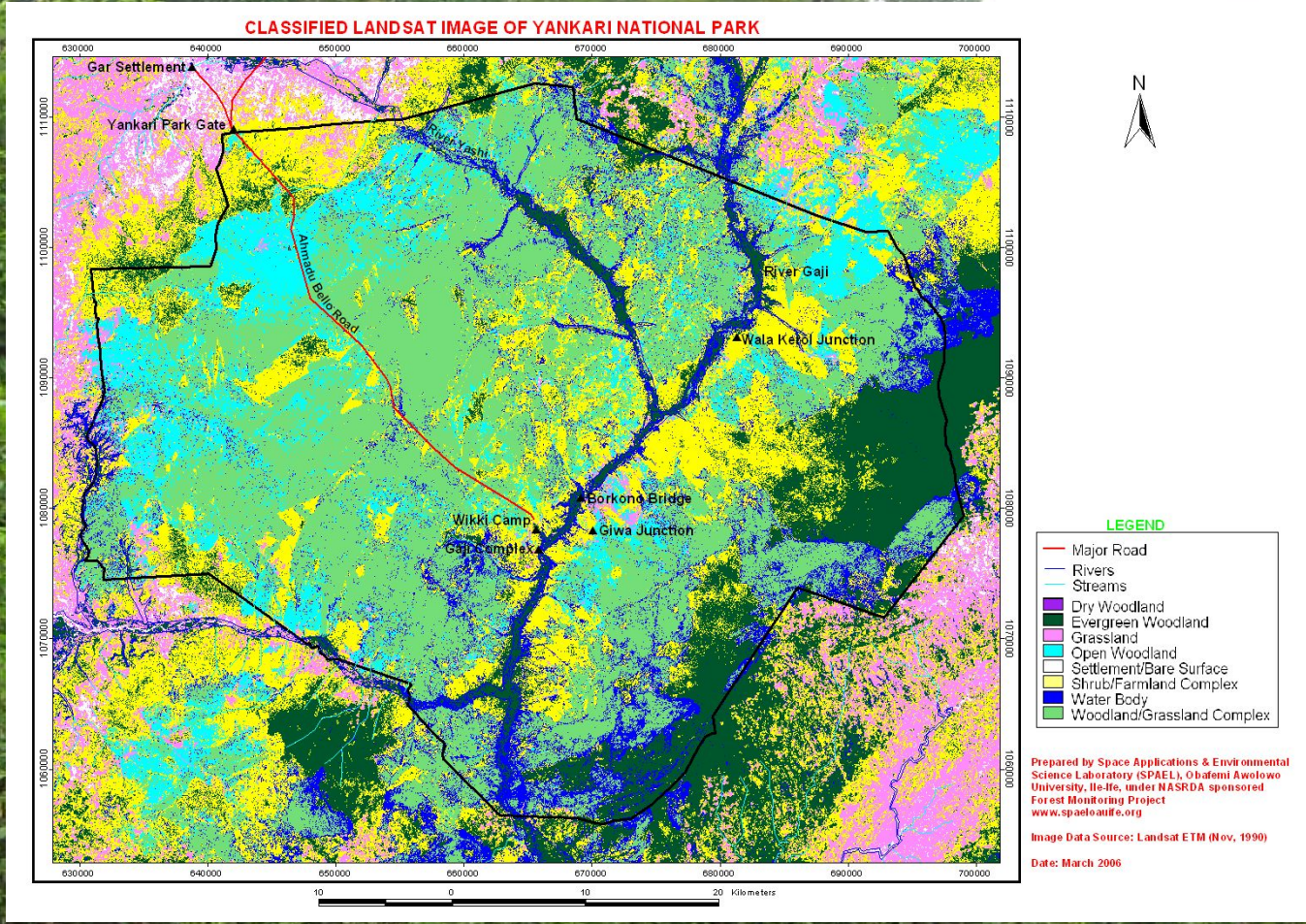


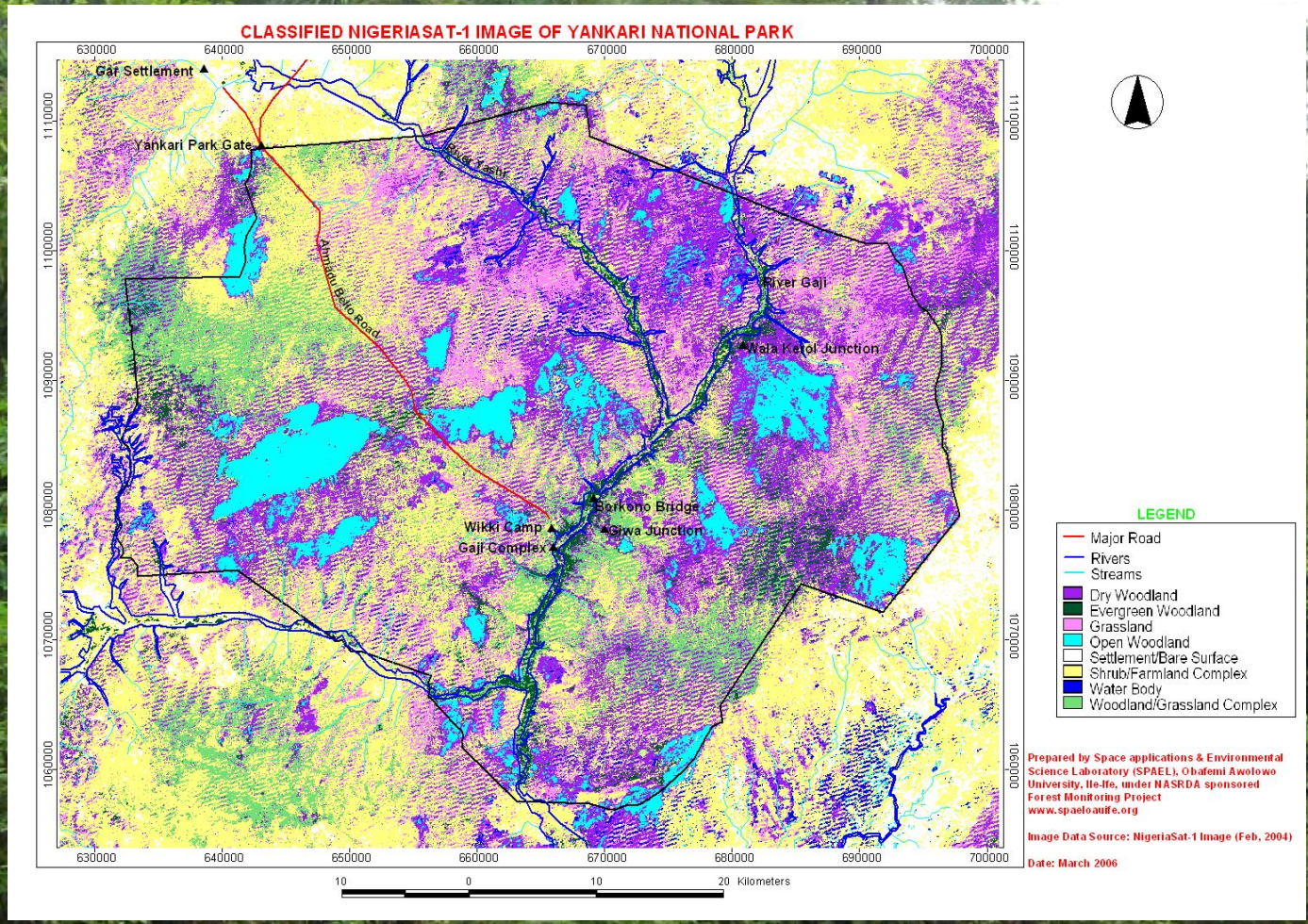
Figure 8: NigeriaSat-1 image of Yankari National Park (FCC)

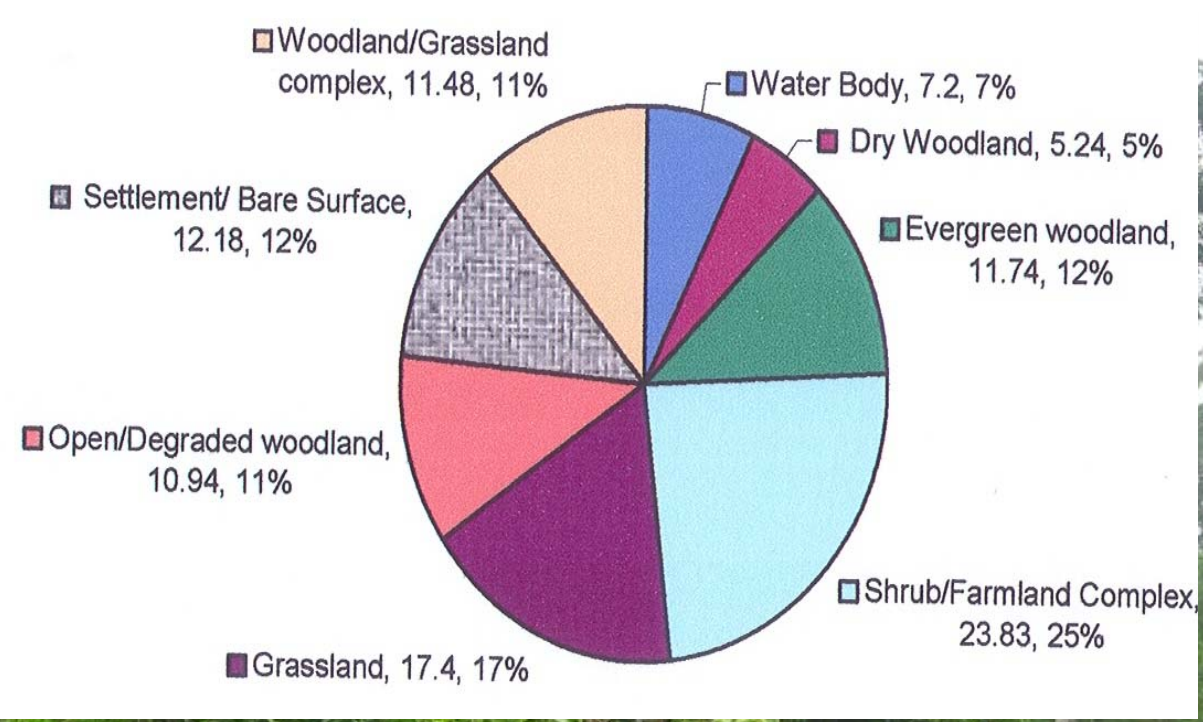


Classified LandSat Image of Yankari National Park

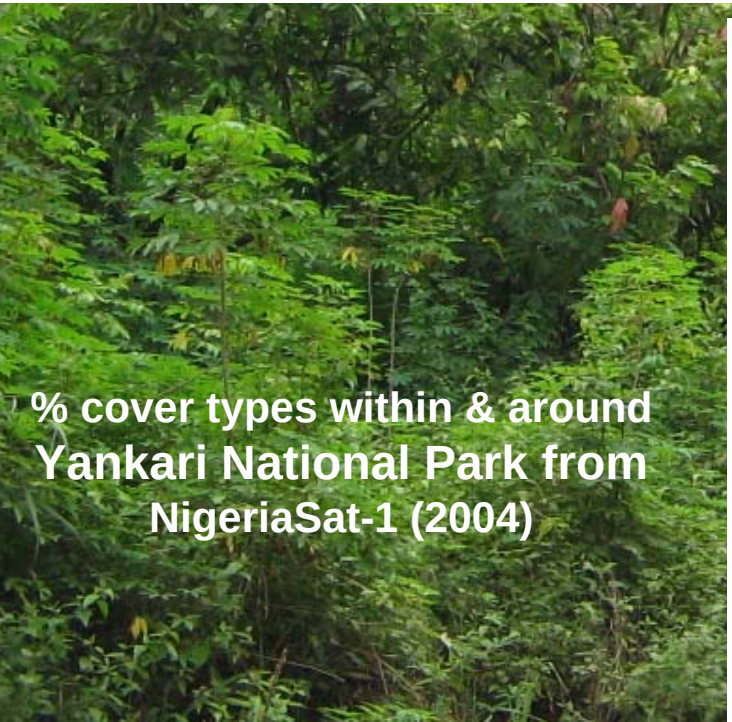


Classified NigeriaSat-1 Image of Yankari National Park




Woodland/Grassland complex, 11.48, 11%
Water Body, 7.2, 7%
Dry Woodland, 5.24, 5%
Settlement/ Bare Surface, 12.18, 12%
Evergreen woodland, 11.74, 12%
Open/Degraded woodland, 10.94, 11%
Shrub/Farmland Complex, 23.83, 25%
Grassland, 17.4, 17%


% cover types within & around Yankari National Park from Landsat TM (1990)


% cover types within & around Yankari National Park from NigeriaSat-1 (2004)

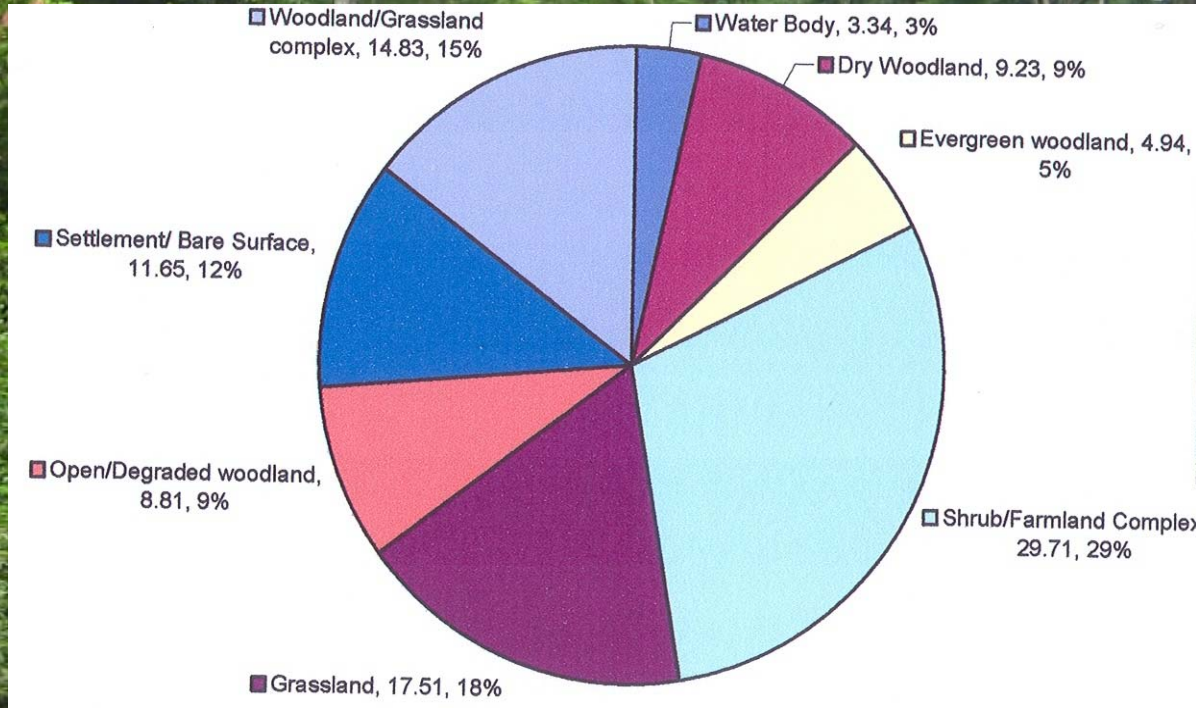

Woodland/Grassland complex, 14.83, 15%
Water Body, 3.34, 3%
Dry Woodland, 9.23, 9%
Evergreen woodland, 4.94, 5%
Settlement/ Bare Surface, 11.65, 12%
Open/Degraded woodland, 8.81, 9%
Shrub/Farmland Complex 29.71, 29%
Grassland, 17.51, 18%

TABLE 5: CHANGES IN COVER TYPES WITHIN AND AROUND YANKARI NATIONAL PARK, NIGERIA (1990-2004)

Cover Types	Landsat TM 1986		Landsat ETM+ 2001		NigeriaSat-1 2004	
	Area (in km^2)	% cover Area	Area (in km^2)	% cover	Area (in km^2)	% cover
Water body	207.81	7.20	157.39	5.47	96.48	3.34
Dry woodland	151.11	5.24	221.76	7.70	266.44	9.23
Evergreen woodland	338.40	11.74	138.63	4.81	142.15	4.94
Shrub/farmland complex	687.30	23.83	767.93	26.67	857.68	29.71
Grassland	501.80	17.40	586.57	20.37	505.44	17.51
Open/degraded woodland	315.44	10.94	255.67	8.87	254.35	8.81
Settlement/bare surface	351.61	12.18	329.08	11.43	336.18	11.65
Woodland/ grassland complex	331.20	11.48	422.80	14.68	428.01	14.83
TOTAL	2884.67	100	2879.83	100	2886.73	100

SUMMARY

- Forest degradation has continued to attract the attention of researchers, probably because of its far reaching environmental implications, such as its potential influence on surface albedo; reduction of timber and fuel wood as well as declining genetic diversity

SUMMARY – CONTD.

- It has been noted that reduction in freshwater supply over sub-Saharan Africa is partly man-made in the context of massive deforestation currently going on in the region

SUMMARY – CONTD.

- In the South West zone which epitomizes the tropical rainforest in Nigeria, it was found that deforestation is progressing at the rate of 1.36% per annum.

- This is higher than the rate of 0.76% quoted for the country by FAO and lower than the estimated rate of 3.5% currently being used by the Federal Department of Forestry, but falls within the rate of 1.0-1.5% given for the developing countries by World Bank.

SUMMARY – CONTD.

- The results obtained from Guinea savanna and Sahel savanna ecological zones revealed a similar pattern. The *Evergreen Woodland* is declining at a rate of 4.3% per annum in the North Central zone while it is 4.1% in the North Eastern zone.

SUMMARY – CONTD.

- The analysis also shows that the available volume of water is receding at a rate of 3.2% in the North Central zone while it is 3.8% in the North Eastern zone.

- The results of this project can therefore be related to the climate change issues in Nigeria.

SUMMARY – CONTD.

The findings suggest that the declining water volume in the Northern Nigeria may be associated with progressive increase in the area coverage of *Dry woodland* and continuous decrease in the coverage of *Evergreen woodland*.

SUMMARY – CONTD.

- When the outputs of this study are compared with the country-wide exercise conducted by FORMECU in 1976/78 and 1993/95, it is evident that this project provides an improved mapping scheme, as well as finer and better details that could be used for planning purposes by the relevant authorities

SUMMARY – CONTD.

- It is evident from this pilot project that with the advent of low cost satellites (like NigeriaSat-1) and their potentials for environmental management, the country is now in a better position to monitor the trend of deforestation on a sustainable basis

SUMMARY – CONTD.

- Attention is now being focused on the establishment of a remote sensing-based framework for database development, regular monitoring and sustainable management regime of this critical ecological habitat.

- A GIS-based forest monitoring system will make it easy for the country to embark on forest certification programme, which is the new international initiative for combating unsustainable exploitation of the world forests

CONCLUSION

- **The development of DMC heralds a novel north-south mutualistic (rather than parasitic) co-operation in space applications for environmental monitoring.**

CONCLUSION – CONTD.

- With the advent of the low cost satellites (like NigeriaSat-1) and their potentials for environmental management, African countries are now in a better position to monitor the trend of deforestation over the continent

- This could be done through South-South collaboration involving the owner countries within the continent (i.e. Nigeria and Algeria) and other countries through a framework provided by New Partnership for Africa's Development (NEPAD)

CONCLUSION – CONTD.

- This is to ensure that Africa's environmental management initiatives reap the maximum benefits from the advent low cost earth observation satellites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