SPATIAL PATTERN OF PROTECTED AREA DESIGNATION IN SUB-SAHARAN AFRICA

by

KIKOMBO ILUNGA

A RESEARCH PAPER

submitted to

THE GEOSCIENCES DEPARTMENT

in partial fulfillment of the
requirements for the
degree of

MASTER OF SCIENCE

GEOGRAPHY PROGRAM

January 1992

Directed by
Dr. G.E. MATZKE

Acknowledgements

My experience in the Geography Program as a Masters Degree student has been very challenging mainly because of adjustments to a new culture and educational environment. This research paper is an achievement. I am very thankful to all Geography Program faculty member for everything they have done to help me achieve one of my goals. I am especially very grateful to my Academic Advisor, Dr. Gordon E. Matzke, whose helpful advice was not only academic but also personal. I'd like also to thank the graduate students and Geosciences personnel for their support. Thanks to everybody who has, in one way or another, helped me during this difficult period.

Table of Contents

Page

Introduction 1

Literature Review 2

Objectives 4

I. Data and Methods 6

II. Results 7

A: Vegetation Analysis 7

1. Ivory Coast 7

a. Background discussion 8

b. Analysis 8

2. Zaire 12

a. Background discussion 12

b. Analysis 12

3. Kenya 18

a. Background discussion 18

b. Analysis 18

4. Nigeria 21

a. Background discussion 21

b. Analysis 23

B. Historical Analysis 28

1. Ivory Coast 28

2. Zaire 30

3. Kenya 35

C. Analysis of all countries combined 39
III. Conclusion 42
IV. Observations 45
V. References cited 48

List of Figures

Page

Fig. 1 National Park and game reserve distribution in Africa 5

Fig. 2 Vegetation type and protected area distribution in Ivory Coast 9

Fig. 3 Vegetation type and protected area distribution in Zaire 13

Fig. 4 Vegetation type and protected area distribution in Kenya 19

Fig. 5 Vegetation type and protected area distribution in Nigeria 24

List of Tables

Page

Tab. 1 Ivory Coast: Size of the country, protected areas and vegetation types 10

Tab. 2 Ivory Coast: Expected versus actual protected area designations by vegetation type 11

Tab. 3 Zaire: Size of the country, protected areas, and vegetation types 15

Tab. 4 Zaire: Expected versus actual protected area designations by vegetation type 16

Tab. 5 Kenya: Size of the country, protected areas, and vegetation types 20

Tab. 6 Kenya: Expected versus actual protected area designations by vegetation type 22

Tab. 7 Nigeria: Size of the country, protected areas, and vegetation type 25

Tab. 8 Nigeria: Expected versus actual protected area designations by vegetation type 27

Tab. 9 Ivory Coast--Historical analysis: size of the country, protected areas, and vegetation types 29

Tab. 10 Ivory Coast: Expected versus pre and post independence protected area designations by vegetation type . . . 31

Tab. 11 Zaire--Historical analysis: size of the country, protected areas, and vegetation types 33

Tab. 12 Zaire: Expected versus pre and post independence protected area designations by vegetation type . . . 34

Tab. 13 Kenya--Historical analysis: size of the country, protected areas, and vegetation types 36
Tab. 14 Kenya: Expected versus pre and post independence protected area designations by vegetation type . . . 38
Tab. 15 Vegetation types, protected areas, and size of four countries combined 40
Tab. 16 Expected versus actual protected areas by vegetation types and rainfall in Ivory Coast, Zaire, Kenya, and Nigeria 41
Tab. 17 Variation of indexes before and after independence by vegetation types and rainfall in Ivory Coast, Zaire, and Kenya 43

SPATIAL PATTERN OF PROTECTED AREA DESIGNATION IN SUB-SAHARAN AFRICA

ABSTRACT. This research was designed to search for regularities in the spatial pattern resulting from government designation of protected areas for conservation purposes on the African continent. Four countries were used to test for a relationship between protected areas and vegetation types and also whether colonial background had an impact on post-independence protected area policy. It was found that protected areas were more likely to be implemented in savanna vegetation types. Colonial background did not influence post-colonial preservation policy. In fact, one country (Nigeria) of the four did not have a long colonial conservation policy but has established several protected areas in the post-colonial period. Two other countries (Ivory Coast and Zaire) have implemented protected areas in vegetation types different from those of the colonial era. It was also found that other vegetation types still remain unprotected. Finally, it has been suggested that one single factor does not explain protected area distribution.

Introduction:

The second half of the 20th century has brought an increased interest in both wildlife and habitat protection awareness. One expression of this interest is the rapidly growing list of areas formally set aside for the protection of wildlife resources. This growth has been confirmed by several studies and led to an estimated 2% of the earth's continental land mass being designated as protected area by 1982.(Eidsvik, 1980; Kenton, 1982).

The reasons for, and policies concerning, protected area designation are likely to be country specific, but are generally affected by cultural, political, socio-economic, and natural

conditions in each country (Butler and Burnett 1982; Lusigi 1981; Kenton 1982).

Nevertheless, it is reasonable to assume that the collective result of the myriad protected area designations is not accidental. Since some aspects of nature are more prominent in the awareness and concern of people, those places which include the favored features should most easily garner support for protection. This study is designed to examine this idea in the African context.

On the eve of Africa's independence, most European conservationists questioned the capabilities of free African countries to perpetuate the conservation legacy inherited from colonization (Barnett and Conover 1989). Despite some failures in management processes, Curry-Lindahl (1974) noticed a large improvement since 1960, approximately when most African countries achieved freedom. From 1967 to 1972, 55 new national parks were created in tropical Africa (Pullman 1988). Since independence, 10 national parks were added in Cameroon, nine in Tanzania, and eight in Zambia (Burnett and Conover 1989). By 1985, 216 protected areas existed in Africa, covering 253,995 square miles (Burnett and Conover 1989). Prior to 1960, there were 772,500 hectares of protected area, while 7,872,900 hectares were set aside after most countries became free (Pullman, 1988). Neither in Africa, nor worldwide, have spatial patterns and the process of protected area establishment been clearly identified.

Literature Review:

Wilkinson (1978) considered 26 variables in constructing a model describing which countries create protected areas. Data were collected from 127 countries, 90 of them having protected areas in conformity with International Union for the Conservation of Nature and Natural Resources (IUCN) criteria for national parks or equivalent reserves ([1]). Statistical methods were also used to identify relationships among them. Then stepwise multiple regressions were computed to predict two important variables, percent of area in parkland and area of parkland per capita. Despite his model's success, Wilkinson recognized the difficulty of a worldwide interpretation of his equations.

Burnett and Butler (1987) restricted their analyses to 102 third world countries. Stepwise multiple discriminant analysis was used to identify any socio-economic and/or physical pattern which would explain protected area distribution. Their results showed that ecological conditions were more likely to encourage a country to establish a protected area, while socio-economic conditions encouraged intensification of the program.

---

[1] A national park is an area of national territory for which the general government authority has ordered the following requirements to be fulfilled:

-status of general protection;
-size in excess of a certain minimum; and
-protected status adequately maintained.

Equivalent reserve covers areas which meet the above requirements, but which may be either strict nature reserves in which tourism is not permitted or reserves with protection deriving from other than the central government authority.

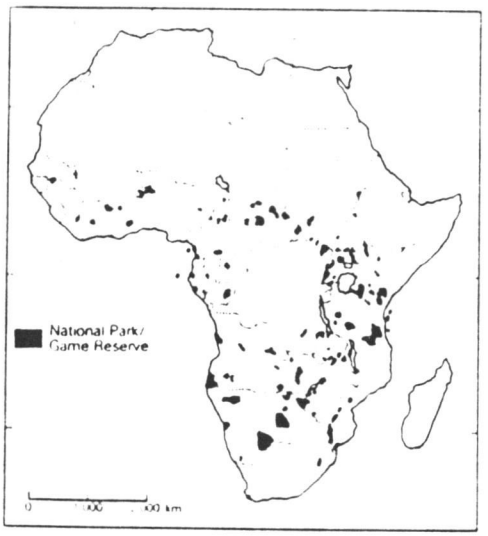
Butler and Burnett (1982), dealt with Sub-Saharan Africa in a more limited study. They used Wilkinson's methods with the same number of variables and applied them to 33 Sub-Sahara African countries. Their findings suggested a predominance of national parks in countries where grassland and savanna dominated. Pritchard's map (Figure 1) shows a similar pattern with the predominance of national park designation in a broad band sandwiched between the rain forest and deserts of Africa. Butler and Burnett also suggested that history had an impact on protected area establishment. The longer a country has experienced protected area management, the more likely it will be to implement others.

Objectives:

The purpose of this paper is to provide an alternative test to Butler and Burnett's finding with regard to ecological pattern. This study will examine data for four African countries to determine whether the particular cases (Ivory Coast, Kenya, Nigeria, and Zaire) support the general case developed by Butler and Burnett. The questions to be answered are as follows:

1. Does the pattern of protected area designation suggest a preference for protection of particular types of environments?
2. Has the pattern of protected area designations changed since independence?

Figure 1 National park and game reserve distribution in Africa.



Source: Pritchard (1979)

I. Data and Methods

Four countries were chosen for the purpose of this study, Ivory Coast, Kenya, Nigeria, and Zaire. Three reasons led to their selection. Each of them has at least four major vegetation types and 10 protected areas meeting the 1987 IUCN criteria (IUCN/UNEP 1987); collectively they include most Sub-Sahara African vegetation types. They also included a range of histories. Two of the study countries, Kenya and Nigeria, were former English colonies, Ivory Coast is a former French colony, and Zaire a former Belgian colony. Other colonial regimes were not included in this study due mainly to the paucity of data sources.

Data concerning protected area distribution were taken from the IUCN/UNEP (1987) publication. Additional information, especially that dealing with more accurate spatial delineation of areas at a larger scale, came from Laclavère (1979), 1:800,000 maps of Ivory Coast, and 1:1,100,000 maps of Kenya. Vegetation type areas were obtained from White (1987).

A geographic information system (GIS) was used for both mapping and data analysis. A base map of each country was entered at a scale of 1:5,000,000. Subsequently, it was overlain with data

layers representing protected areas ([2]), and vegetation types. The GIS was used to calculate both sizes of protected areas and vegetation types. It was also used to evaluate the proportion of each vegetation type being protected and the proportion of protected areas covered by the vegetation types. These data are reported in Tables 1-4.

The GIS was also used to identify areas designated before and after independence. The technique used in area measurements in was similar to that previously described and the results are shown in Tables 5-7([3]). A comparison between these two periods of data helped to detect post independence shifts in protected area designation policy. This paper is principally a descriptive analysis of the proportion of each protected vegetation compared to the total protected vegetation and to the corresponding vegetation type.

II. Result:

A. Vegetation Analysis.

1. Ivory Coast

---

[2] For these purposes, only designated lands where the policy is to preserve vegetation and wildlife were considered as protected areas.

[3] The assumption made in this study is that distribution and size of vegetation types and protected areas did not change during all the protected area designation process.

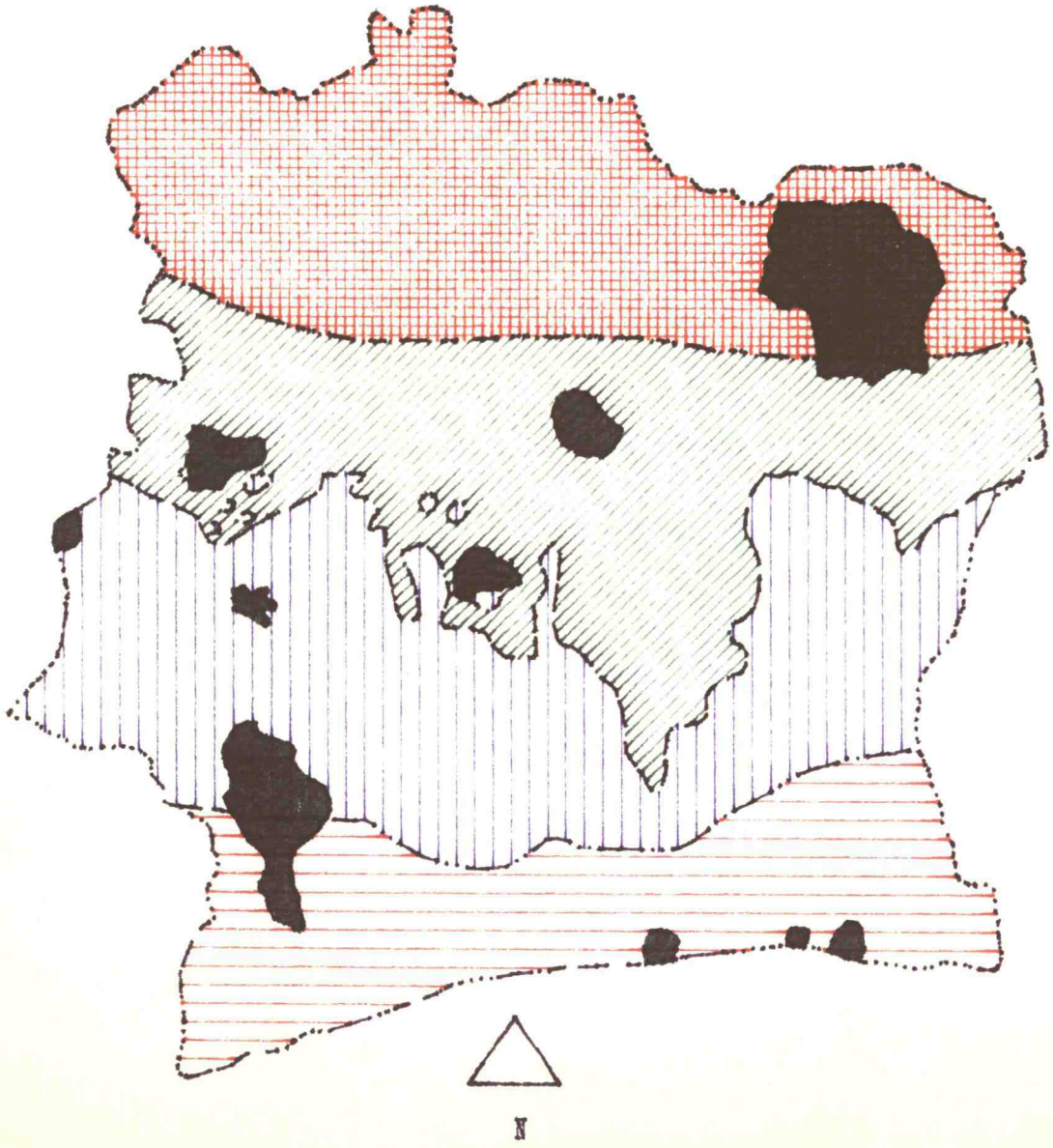
a. Background Discussion

The Ivory Coast is a West African country with a very wet coast and increasingly dry conditions along a latitudinal gradient toward the north. The four vegetation types shown in Figure 2 clearly follow latitudinal variations in rainfall as tree density decreases from south to north (IUCN/UNEP 1987). Preservation policy in Ivory Coast started in 1926 with the establishment of two protected areas, Tai and Azagny. The last area established was Mount Sangbe National Park in 1975 (IUCN/UNEP 1987). Over 50 years, the 11 protected areas shown in Figure two, and covering about 6.5% of the country, were created and include at least one designated area in every vegetation type.

b. Analysis

Table 1 shows the calculated areas covered by each vegetation type. They range in size from the drier Guineo-Congolian which is the largest vegetation type (almost 30% of the country) to the smallest lowland rainforest type covering 17.34% of the entire nation. It also shows the size of protected areas. From these data, Table 2 was derived and includes an index of variation which shows clearly that Sudanian Woodland is overrepresented. All other types are underrepresented. Earlier findings (Pullman 1988; Butler and

Fig.2 VEGETATION TYPE AND PROTECTED AREA DISTRIBUTION IN IVORY COAST



LEGEND

- Guinea-Congolian Lowland Rain Forest
- Guinea-Congolian Rain Forest Drier Type
- Guinea-Congolian Mosaic of Lowland Rain Forest
- Sudanian Woodland
- Protected Area

Scale: 1/4700000

Source: White, 1983; IUCN/UNEP, 1987

Table 1. Ivory Coast: Size of country, Protected areas, and Vegetation types

Vegetation Type	Total Area in Vegetation type		Total Area in Protected designation	
	Sq. Km (a)	Percentage (b)	Sq. Km (c)	Percentage (d)
Sudanian Woodland	79691.878	25.93	8777.946	46.04
Guineo-Congolian Mosaic of Lowland Rain forest	83484.041	27.17	3701.835	19.42
Guineo-Congolian Lowland Rain Forest	53280.616	17.34	2632.416	13.81
Guineo-Congolian Rain Forest Drier type	90860.29	29.57	3951.85	20.73
Total	307316.825	99.91	19064.047	100

Source: Geographic Information System

Table 2

Ivory Coast: Expected Vs Actual Protected Area Designations by Vegetation Type

	(1)	(2)	
Vegetation Type	% of Area Expected *	Actual % of Protected areas **	Index of Variation 1=random***
Sudanian Woodland	25.93	46.04	1.78
Guineo-Congolian Mosaic of Lowland Rainforest	27.17	19.42	.71
Guineo-Congolian Lowland Rainforest	17.34	13.81	.80
Guineo-Congolian Rainforest Drier Type	29.57	20.73	.70

* Expected if areas were designated randomly with reference to vegetation type. This figure is equal to the percentage of the country covered by each vegetation type.(Table 1. Column a)
** From Table 1. Column d)
*** Column 2 divided by Column 1

Burnett 1982) relating protected area to savanna vegetation types are, therefore, confirmed in the Ivory Coast case. White (1987) characterizes Sudanian Woodland vegetation as a grass predominant type resulting from human disturbance since the late 19th century.

2. Zaire

a. Background discussion.

The first national park to be created in Africa was Albert National Park.(Coolidge 1972). Created in 1925, it was designated as a strict natural reserve (Monod 1962) and later changed to allow scientific studies (Curry-Lindahl 1972). From 1925 until 1970, 10 protected areas were established in Zaire (IUCN/UNEP 1987) at an annual average rate of one every five years. The protected areas are scattered all over the country: two in the south, two in the north, three on the eastern border, one on the western side, and two in the central area (see Figure 3).

b. Analysis

Fifteen different vegetation types have been identified.(see Figure 3). According to White's main vegetation classification, the Guineo-Congolia is a vegetation form,

Fig.3 VEGETATION TYPE AND PROTECTED AREA DISTRIBUTION IN ZAIRE

N

LEGEND

- Guineo-Congolian Lowland Rain Forest
- Guineo-Congolian Rain Forest Drier Type
- Transitional Rain Forest
- Swamp Forest
- Mosiac of Swamp Forest and Rain Forest*
- Mosaic of Lowland Rain Forest and Sec. Grassla
- Undifferentiated Montane Vegetation
- Wetter Zambezian Miombo Woodland
- Sudanian Undifferentiated Woodland
- Mosaic of Wetter Zambezian Woodland
- Secondary Wooded Grassland
- Mosaic of East African Evergreen Bushland
- Edaphic and Secondary Grassland on Kalahari Sar
- Mangrove
- Swamp
- Lake
- Protected Area

Scale: 1/14150000

Source: White, 1983; IUCN/UNEP, 1987

dominated by Guineo-Congolian lowland rain forest. It covers 52.79% of the total area of the country. A mosaic of lowland rain forest and secondary grassland, a transition zone between rain forest and savanna, covers 24.08%. The wetter Zambezian Miombo woodland, a savanna related vegetation type, represents 14.25% of the country.(see Table 3)

The total surface under protection measures 116,834.4 square kilometers, representing 5.57% of the area of the country. Nearly 31% of all protected areas are located in the mosaic of lowland rain forest and secondary grassland. Another 25% is in Guineo-Congolian lowland rain forest(see Table 3).

An index of protected and expected area variation (see Table 4) shows a lack of randomness in protected area designation. Eight of the vegetation types are overrepresented (Index higher than 1). Two types are the most protected: Mosaic of East African evergreen bushland and swamp. Mosaic of East African evergreen bushland represents a landscape of lightly wooded grassland with some small patches of forest (White, 1983). This vegetation type is mainly located in the northeastern section of Zaire. The swamp area, different from swamp forest, is characterized by herbaceous vegetation (Vossia cuspridata) and aquatic vegetation (Cyprus papyrus) (White 1983). This vegetation is endemic to depressions associated with lakes. In the Zaire case, it is largely

Table 3. Zaire: Size of the country, Protected areas, and Vegetation types

Vegetation Type	Total Area in Vegetation type		Total Area in Protected designation	
	Sq. Km (a)	Percentage (b)	Sq. Km (c)	Percentage (d)
Mosaic of Lowland R.F. and Sec. Grassland	505430.324	24.08	36207.011	30.99
Guineo-congolian Rain forest Drier Type	271525.968	12.94	8956.989	7.67
Mosaic of East African Evergreen Bushland	5658.404	0.27	2953.403	2.53
Undifferentiated Montane Vegetation	53533.857	2.55	4992.235	4.27
Guineo-congolian Lowland Rain forest	519045.657	24.73	28901.734	24.74
Transitional Rain Forest	18878.552	0.9	4006.692	3.43
Mosaic of Swamp Forest and Rain Forest	164574.39	7.84	11166.799	9.56
Wetter Zambezian Miombo Woodland	299166.336	14.25	9134.419	7.82
Mosaic of Wetter Zambezian Woodland	64023.196	3.05	2535.636	2.17
Mangrove	1464.604	0.7	0	0
Edaphic and Sec. Grassland on Kalahari	47643.181	2.27	3851.844	3.4
Secondary Wooded Grassland	11166.799	0.53	1442.022	1.23
Swamp	2300.138	0.11	1035.546	0.89
Swamp Forest	132662.798	6.32	1650.099	1.41
Sudanian Undifferentiated Woodland	1990.442	0.95	0	0
Total	2099064.646	99.99	116834.429	100

Source: Geographic Information System

Table 4

Zaire: Expected Vs Actual Protected Area Designations by Vegetation Type

Vegetation Type	(1) % of Area Expected *	(2) Actual % of Protected areas **	Index of Variation 1=random ***
Mosaic of Lowland Rainforest and Secondary Grassland	24.08	30.99	1.29
Guineo-Congolian Rainforest Drier Type	12.94	7.67	.59
Mosaic of East African Evergreen Bushland	.27	2.53	9.37
Undifferentiated Montane Vegetation	2.55	4.27	1.67
Guineo-Congolian Lowland Rainforest	24.73	24.74	1.00
Transitional Rainforest	.90	3.43	3.81
Mosaic of Swamp Forest and Rainforest	7.84	9.56	1.22
Wetter Zambezian Miombo Woodland	14.25	7.82	.55
Mosaic of Wetter Zambezian Woodland	3.05	2.17	.71
Mangrove	.70	0.00	0.00
Edaphic and Secondary Grassland on Kalahari	2.27	3.40	1.50
Secondary Wooded Grassland	.53	1.23	2.32
Swamp	.11	.89	8.09
Swamp Forest	6.32	1.41	.22
Sudanian Undifferentiated Woodland	.95	0.00	0.00

* Expected if areas were designated randomly with reference to vegetation type. This figure is equal to the percentage of the country covered by each vegetation type. (Table 3. Column a)
** From Table 3. Column d
*** Column 2 divided by Column 1

located in the southern part of the country, along the Zaire River.

Among the remaining, transitional rainforest and secondary wooded grassland are also far beyond protection expectations. Some areas, on the other side, are not well protected. Their indexes are less than one. Six vegetation types have been detected and two of them, mangrove and Sudanian undifferentiated woodland, are not protected at all. It appears that in Zaire, the main attention is focused on transitional and savanna related vegetation.

In 1962, Verschuren concluded that savannas and secondary growths are almost exclusively the aim of protection as a result of the attention given to big game. A general view of Zairian vegetation type and protected area distribution (see Figure 3) shows a peripheral location of most protected areas. In fact, vegetation types in the extreme north, east, and southeast are more grass dominated than the rest of the country which is more woody. The trend is toward preservation of areas dominated by large animals, leading to the same conclusion as was drawn in the Ivory Coast case. Zaire adds the additional twist of localized fresh water wetland by demonstrating that location may also receive special attention for protection.

3. Kenya

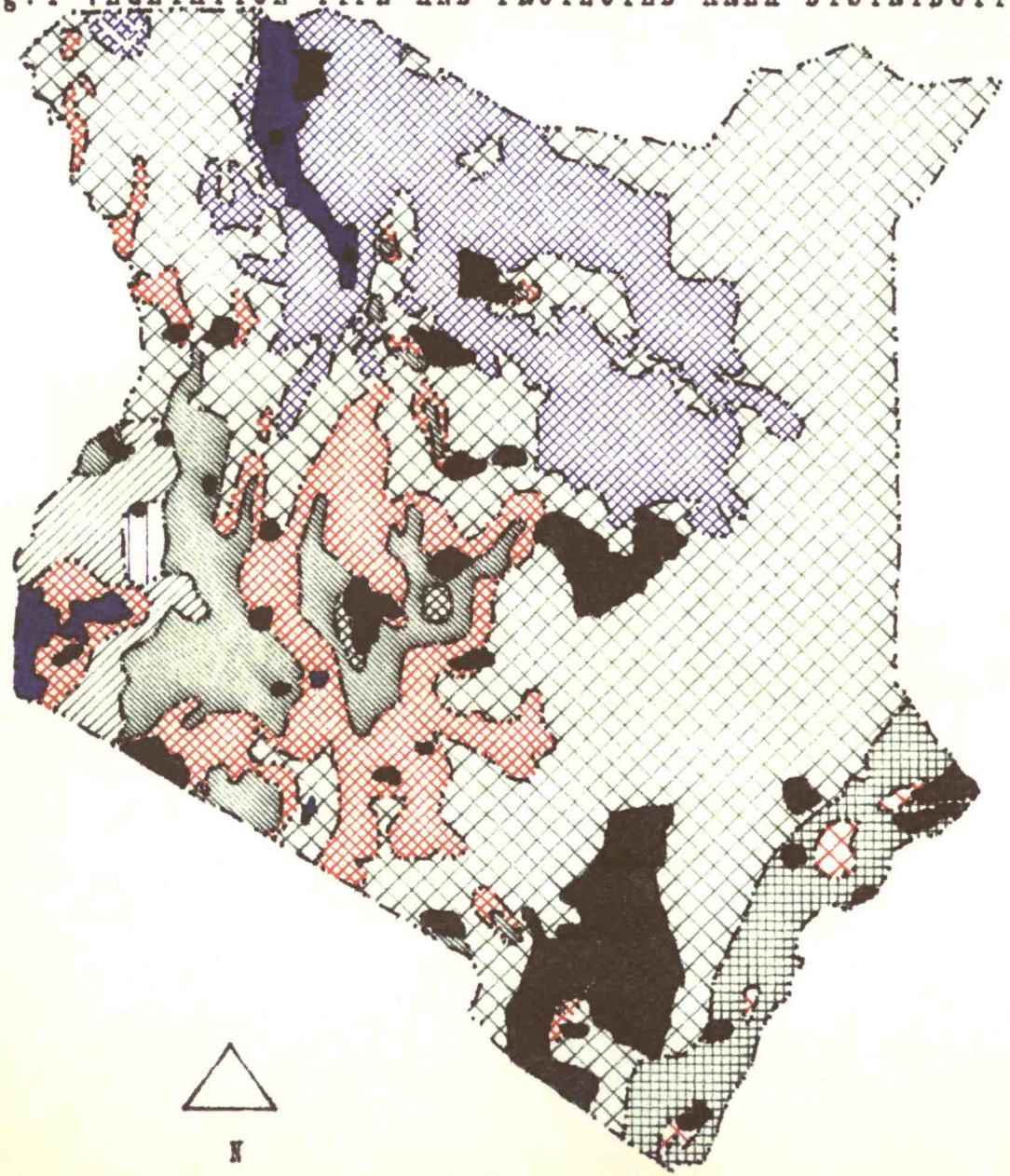
a. Background discussion.

According to Olindo (1974), Kenya's protected area policy was implemented to cover most of the representative geographical zones. Since the demarcation of the first protected area in 1943, more than 40 have been established (IUCN/UNEP 1987). Their sizes vary, the smallest being approximately 41 square kilometers and the largest being 2,400 square kilometers. In terms of distribution, however, northeastern and eastern Kenya are unprotected (see Figure 4).

b. Analysis.

Vegetation types are very diversified in Kenya, reflecting considerable variation in both altitude and rainfall. Ten were identified, varying from semi-desert grassland to Guineo-Congolian rain forest. The dominant vegetation type is Somalia-Masai acacia-commiphora at 54.33% (see Table 5). Others are also well represented. Semi-desert grassland and shrubland covers 16.85% and Mosaic of East African evergreen bushland 11.92%. As an overall view the Somalia- Masai regional center of endemism represents more than 80% of all vegetation types.

Fig.4 VEGETATION TYPE AND PROTECTED AREA DISTRIDUTION IN KENYA



LEGEND

- Guinea-Congolian Rain Forest Drier Type
- Mosaic of Lowland Rain Forest and Sec. Grassler
- East African Coastal Mosaic Zanzibar-Inhambane
- East African Coastal Mosaic Forest Patches
- Undifferentiated Montane Vegetation
- Somalia-Masai Acacia-Commiphora
- Mosaic of East African Evergreen Bushland
- Semi-Desert Grassland and Shrubland
- Altimontane Vegetation
- Swamp
- Lake
- Protected Area

Scale: 1/8141500

Source: White, 1983; IUCN/UNEP, 1987

Table 5. Kenya: Size of the country, Protected areas, and Vegetation types

Vegetation Type	Total Area in Vegetation type		Total Area in Protected designation	
	Sq. Km (a)	Percentage (b)	Sq. Km (c)	Percentage (d)
Somalia-masai Acacia-Commiphora	300479.318	54.33	44202.652	80.39
Semi-Desert Grassland and Shrubland	93092.682	16.83	2242.07	4.08
Swamp	1753.331	0.32	0	0
Mosaic of East African Evergreen Bushland	65932.988	11.92	3613.12	6.57
Undifferentiated Montane Vegetation	41220.215	7.45	1914.631	3.48
Mosaic of Lowland R.F. and Sec Grassland	15431.571	2.79	196.786	0.36
Guineo-Congolian R.F. Drier type	2335.624	0.42	80.65	0.15
Altimontane Vegetation	1604.935	0.29	83.876	0.15
East African Coastal Mosaic Zanzibar Inhamban	28098.46	5.08	2451.76	4.46
East African Coastal Mosaic Forest Patches	3113.09	0.56	196.786	0.36
Total	553062.214	99.99	54982.331	100

Source: Geographic Information System

Analysis of the relationship between protected area and vegetation type distribution conforms with Olindo's (1974) statement in that almost every vegetation type, nine of 10, is protected. The degree of protection depends upon vegetation types. In fact, 80.39% of all protected areas are allocated to the protection of the largest vegetation type-- Somalia-Masai acacia-commiphora. Table 6 shows once again Somalia-Masai acacia-commiphora being overrepresented. Its index is 1.48. Nine types are less protected.

It appears that Kenyan conservation policy tends to avoid protecting woody or dry areas in favor of grassy land. Kenya's policy seems to be in agreement with the policies of both Ivory Coast and Zaire in that all three countries prefer grass dominated vegetation types, but in the Kenya case these types have tremendous human pressure. (Lusigi, 1982)

4. Nigeria

a. Background discussion.

Nigeria's climatic distribution is similar to Ivory Coast. Coastal zones are wetter. The climate becomes drier when moving toward the north. Before 1950, only two forest reserves were established (Ola-Adams and Iyamabo 1977). The

Table 6

Kenya: Expected Vs Actual Protected Area Designations by Vegetation Type

	(1)	(2)	
Vegetation Type	% of Area Expected *	Actual % of Protected areas **	Index of Variation 1=random***
Somalia-masai Acacia-commiphora	54.33	80.39	1.48
Semi-desert Grassland and Shrubland	16.83	4.08	.24
Swamp	.32	0.00	0.00
Mosaic of East African Evergreen Bushland	11.92	6.57	.55
Unddifferentiated Montane Vegetation	7.45	3.48	.47
Mosaic of Lowland Rainforest and Secondary Grassland	2.79	.36	.13
Guineo-congolian Rainforest Drier Type	.42	.15	.36
Altimontane Vegetation	.29	.15	.52
East African Coastal Mosaic Zanzibar Inhambane	5.08	4.46	.88
East African Coastal Mosaic Forest Patches	.56	.36	.64

* Expected if areas were designated randomly with reference to vegetation type. This figure is equal to the percentage of the country covered by each vegetation type.(Table 5. Column a)
** From Table 5. Column d)
*** Column 2 divided by Column 1

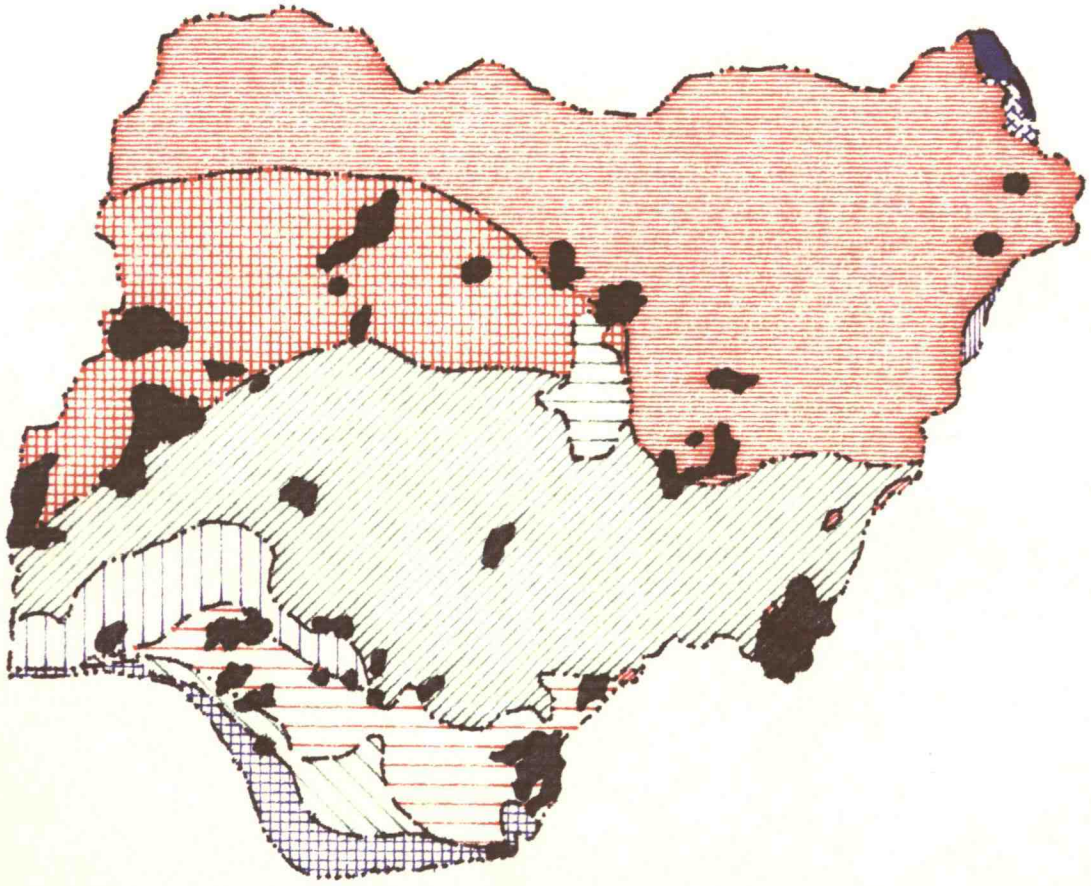
first was Falgore in 1948, which was converted to a game reserve in 1969. The second was Omo, created in 1949 and updated in 1977 to a strict nature reserve (IUCN/UNEP 1987). The first game reserve conforming to our definition of a protected area was created in 1956 and opened to the public in 1962 (Afolabi-Ojo 1978).

2. Analysis.

Nigerian vegetation is diverse. Eleven types specified on Figure 5 are mainly distributed with reference to rainfall distribution (Ola-Adams and Iyamabo 1977). The largest vegetation type is the Sudanian undifferentiated woodland, covering 36.4% of the country. Mosaic of lowland rain forest and secondary grassland is second with 29.9%. Four main vegetation forms are identified. The Sudanian form the most important, covers 53% of the country. Guinea-Congolia on the other side covers nearly 14%. The rest of the country is mainly a transition zone between rain forest and savanna. (see Table 7).

Large areas tend to be allocated to the preservation of large vegetation types. Indeed, nearly 70% of protected areas in Nigeria are established in the three dominant vegetation types. Sudanian woodland with Isoberlinia, for example, has 32.4% of protected areas. Another example relates to mosaic

Fig.5 VEGETATION TYPE AND PROTECTED AREA DISTRIBUTION IN NIGERIA



N

LEGEND

- Sudanian Undifferentiated Woodland
- Mandara Plateau Mosaic
- Jos Plateau Mosaic
- Sudanian Woodland with Isoberlinia
- Undifferentiated Montane Vegetation
- Mosaic of Lowland R.F. and Sec. Grassland
- Guinea-Congolian Rain Forest Drier Type
- Guinea-Congolian Rain Forest Wetter Type
- Swamp Forest
- Mangrove
- Swamp
- Lake
- Protected Area

Scale: 1/8712500

Source: White, 1983; IUCN/UNEP, 1987

Table 7. Nigeria: Size of the country, Protected areas, and Vegetation types

Vegetation Type	Total Area in Vegetation type		Total Area in Protected designation	
	Sq. Km (a)	Percentage (b)	Sq. Km (c)	Percentage (d)
Sudanian Undifferentiated Woodland	291315.865	36.64	6376.189	13.6
Swamp	1840.433	0.23	0	0
Sudanian Woodland With Isoberlinia	130625.579	16.43	15186.395	32.4
Mandara Plateau Mosaic	1525.898	0.19	0	0
Jos Plateau Mosaic	9869.947	1.24	67.746	0.14
Mosaic of Lowland Rain Forest and Sec.Grassland	237722.327	29.9	11120.022	23.72
Undifferentiated Montane Vegetation	2853.397	0.36	1511.381	3.22
Guineo-Congolian Rain Forest Drier Type	32018.05	4.03	1258.14	2.68
Guineo-Congolian Rain Forest Wetter type	51335.338	6.46	10392.559	22.17
Swamp Forest	15584.806	1.96	406.476	0.87
Mangrove	20449.614	2.57	553.259	1.18
Total	795141.254	99.99	46872.167	99.8

Source: Geographic Information System

of lowland rain forest and secondary grassland, covering 23.72%. Sudanian undifferentiated woodland covers 13.6%.(see Table 7)

Preservation policy in three vegetation types is beyond the optimum variation index -- Sudanian woodland with Isoberlinia, Undifferentiated montane vegetation, and Guineo-Congolian rain forest wetter type. Among them the most over represented is undifferentiated montane vegetation.(see Table 8). Nine of eleven vegetation types are protected. Six vegetation types are under protected, and two have seen no preservation measures taken. The two exceptions are swamp and Mandara plateau mosaic, both located in the northeastern part of the country.

The historical analysis of protected area establishment has not been done in this case since very few areas were established during the colonial period.

From the above descriptions, and with reference to White's main vegetation classification, Afromontane archipelago-like is the most well protected area. However, the distribution policy appears to be aimed more at protection of forest vegetation types. According to Table 8, Guinea-Congolia form is overrepresented. Despite a lack of a long pre-colonial

Table 8

Nigeria: Expected Vs Actual Protected Area Designations by Vegetation Type

Vegetation Type	(1) % of Area Expected *	(2) Actual % of Protected areas **	Index of Variation 1=random***
Sudanian Undifferentiated Woodland	36.64	13.60	.37
Swamp	.23	0.00	0.00
Sudanian Woodland with Isoberlinia	16.43	32.40	1.97
Mandara Plateau Mosaic	.19	0.00	0.00
Jos Plateau Mosaic	1.24	.14	.11
Mosaic of Lowland Rainforest and Secondary Grassland	29.90	23.72	.79
Undifferentiated Montane Vegetation	.36	3.22	8.94
Guineo-congolian Rainforest Drier Type	4.03	2.68	.67
Guineo-congolian Rainforest Wetter Type	6.46	22.17	3.43
Swamp Forest	1.96	.87	.44
Mangrove	2.57	1.18	.45

* Expected if areas were designated randomly with reference to vegetation type. This figure is equal to the percentage of the country covered by each vegetation type. (Table 7. Column a)
** From Table 7. Column d
*** Column 2 divided by Column 1

preservation policy, protected area allocation demonstrates Nigeria willingness to preserve its natural resources. (Curry-Lindahl, 1974)

2. Historical Analysis.

A. Ivory Coast.

Considering the historical aspect of protected area establishment, 75.7% of protected areas were created during the Ivory Coast's colonial period. Most, (60.8%) of all protected areas established during the colonial period were in Sudanian Woodland. European preference for protecting big game animals in savanna or related vegetation types (Burnett and Stiwell 1990) is again confirmed. (see Table 9)

During the colonial period, 4.69% of the country was put into protected areas. After independence, 1.51% more land area was added. During this second period, all areas allocated to preservation were Guineo-Congolian mosaic of lowland rainforest and Guineo-Congolian lowland rain forest. Emphasis was put on Guineo-Congolian mosaic (65.21%), which was almost never protected during the colonial period.

Comparing the two periods, pre- and post-independence, protected areas established seem to be almost equal in terms

Table 9. Ivory Coast--Historical Analysis: Size of the country, Protected areas, and Vegetation types.

Vegetation Type	Total Area in Vegetation type		Total Area in Protected designation Before Independence		Total Area in Protected designation After Independence	
	Sq. Km (a)	Percentage (b)	Sq. Km (c)	Percentage (d)	Sq. Km (e)	Percentage (f)
Sudanian Woodland	79691.88	25.93	8777.946	60.84	0	0
Guineo-Congolian Mosaic of Lowland Rain forest	83484.04	27.17	679.073	4.5	3022.762	65.21
Guineo-Congolian Lowland Rain Forest	53280.62	17.34	2632.416	18.24	0	0
Guineo-Congolian Rain Forest Drier type	90860.29	29.57	2338.85	16.21	1613	34.79
Total	307316.8	99.91	14428.285	99.79	4635.762	100

Source: Geographic Information System

of number of protected areas, six before and five after independence. However, the emphasis has shifted from Sudanian Woodland vegetation type toward a forest type during the post-colonial era. Table 10 illustrates this change in policy. Guineo-Congolian Mosaic of lowland rain forest and Guineo-Congolian rain forest drier type have both, and index higher than one, while others have zero. This was almost the opposite during colonial time.

There is a clear negative relationship between colonial and post colonial policy. The change in designation process can be due to government will to protect areas not sufficiently protected during colonization. Several other factors need to be considered to better understand the process of designation of a protected area. If the only factor is vegetation type, then it is to be expected that more and more protected areas will be designated in the forest type.

B. Zaire.

The historical point of view between the two countries is different. Zaire is a former Belgian colony, while Ivory Coast was a French colony. The Belgians were the first in Africa to implement a strict nature reserve. During their African colonial period (until 1960), they created three protected areas, Garamba in the northeast, Virunga in the

Table 10

Ivory Coast: Expected Vs Pre and Post Independence Protected Area Designations by Vegetation Type

	(1)	(2)		(3)	
Vegetation Type	% of Area Expected *	% of protected area Pre-Indep. **	Index of Variation 1=random ***	% of Protected areas PostIndep ****	Index of Variation 1=random *****
Sudanian Woodland	25.93	60.84	2.35	0.00	0.00
Guineo-Congolian Mosaic of Lowland Rainforest	27.17	4.50	.17	65.21	2.40
Guineo-Congolian Lowland Rainforest	17.34	18.24	1.05	0.00	0.00
Guineo-Congolian Rainforest Drier Type	29.57	16.21	.55	34.79	1.17

* Expected if areas were designated randomly with reference to vegetation type. This figure is equal to the percentage of the country covered by each vegetation type.(Table 9. Column a)
** From Table 9. Column d
*** Column 2 divided by Column 1
**** From Table 9 Column f
***** Column 3 divided by Column 1

east, and Upemba in the southeast. These protected areas represented 1.24% of the actual vegetation types. Emphasis was given to selecting grassland dominated areas. As a matter of fact, 21.94% of preserved areas are Mosaic of lowland forest and secondary grassland, 20.76% in wetter Zambezian Miombo Woodland, 11.36% in Edaphic and secondary grassland on Kalahari, and 11.33% in Mosaic of East African Evergreen bushland (see Table 11).

According to Table 12, during the colonial era, excessive attention was directed toward preservation of herbaceous dominated vegetation. In fact, Mosaic of East African Evergreen bushland has an index of 41.96, Mosaic of wetter Zambezian woodland 3.19, and Edaphic and Secondary grassland on Kalahari 11.35. These vegetation, according to main vegetation form classification, are either in a transitional zone between rain forest and savanna, or in savanna. Undifferentiated Montane vegetation and Swamp areas are also attractive. During Belgian rule, almost no non montane forest vegetation types, as identified in our classification system, were protected. Very little attention was given to Guineo-Congolian rain forest drier type which has an index of 0.07 (see Table 12).

After the 1960 independence, 90,776.4 square kilometers in eight new protected areas were added to colonial designations,

Table 11. Zaire--Historical Analysis: Size of the country, Protected areas, and Vegetation types.

Vegetation Type	Total Area in Vegetation type		Total Area in Protected designation Before Independence		Total Area in Protected designation After Independence	
	Sq. Km (a)	Percentage (b)	Sq. Km (c)	Percentage (d)	Sq. Km (e)	Percentage (f)
Mosaic of Lowland R.F. and Sec. Grassland	505430.3	24.08	5716.472	21.94	30490.539	33.59
Guineo-congolian Rain forest Drier Type	271526	12.94	227.433	0.87	8729.556	9.62
Mosaic of East African Evergreen Bushland	5658.404	0.27	2953.403	11.33	0	0
Undifferentiated Montane Vegetation	53533.86	2.55	3577.634	13.73	1414.601	1.56
Guineo-congolian Lowland Rain forest	519045.7	24.73	201.625	0.77	28700.109	31.62
Transitional Rain Forest	18878.55	0.9	0	0	4006.692	4.41
Mosaic of Swamp Forest and Rain Forest	164574.4	7.84	0	0	11166.799	12.3
Wetter Zambezian Miombo Woodland	299166.3	14.25	5410.002	20.76	3724.417	4.1
Mosaic of Wetter Zambezian Woodland	64023.2	3.05	2535.636	9.73	0	0
Mangrove	1464.604	0.7	0	0	0	0
Edaphic and Sec. Grassland on Kalahari	47643.18	2.27	2958.242	11.35	893.602	0.98
Secondary Wooded Grassland	11166.8	0.53	1442.022	5.53	0	0
Swamp	2300.138	0.11	1035.546	3.97	0	0
Swamp Forest	132662.8	6.32	0	0	1650.099	1.82
Sudanian Undifferentiated Woodland	1990.442	0.95	0	0	0	0
Total	2099065	99.99	26058.015	99.98	90776.414	100

Source: Geographic Information System

Table 12

Zaire: Expected Vs Pre and Post Independence Protected Area Designations by Vegetation Type

	(1)	(2)		(3)	
Vegetation Type	% of Area Expected *	% of Protected areas Pre indep.**	Index of Variation 1=random ***	% of Protected areas PostIndep ****	Index of Variation 1=random *****
Mosaic of Lowland Rainforest and Secondary Grassland	24.08	21.94	.91	33.59	1.39
Guineo-Congolian Rainforest Drier Type	12.94	.87	.07	9.62	.74
Mosaic of East African Evergreen Bushland	.27	11.33	41.96	0.00	0.00
Undifferentiated Montane Vegetation	2.55	13.73	5.38	1.56	.61
Guineo-Congolian Lowland Rainforest	24.73	.77	.03	31.62	1.28
Transitional Rainforest	.90	0.00	0.00	4.41	4.90
Mosaic of Swamp Forest and Rainforest	7.84	0.00	0.00	12.30	1.57
Wetter Zambezian Miombo Woodland	14.25	20.76	1.46	4.10	.28
Mosaic of Wetter Zambezian Woodland	3.05	9.73	3.19	0.00	0.00
Mangrove	.70	0.00	0.00	0.00	0.00
Edaphic and Secondary Grassland on Kalahari	2.27	11.35	5.00	.98	.43
Secondary Wooded Grassland	.53	5.53	10.43	0.00	0.00
Swamp	.11	3.97	36.09	0.00	0.00
Swamp Forest	6.32	0.00	0.00	1.82	.29
Sudanian Undifferentiated Woodland	.95	0.00	0.00	0.00	0.00

* Expected if areas were designated randomly with reference to vegetation type. This figure is equal to the percentage of the country covered by each vegetation type.(Table 11. Column a)
** From Table 11. Column d
*** Column 2 divided by Column 1
**** From Table 11. Column f
***** Column 3 divided by Column 1

mostly in 1970 (IUCN/UNEP 1987). The protection policy seems to be different from that of the colonial period. The emphasis is on the preservation of forest cover, mainly as a result of IUCN recommendations (Curry-Lindahl 1974). Most previously unprotected vegetation types are now protected. For example, the transitional rain forest, and Mosaic of Swamp forest and rain forest have indexes of 4.9 and 1.57, respectively.

Some types which were unprotected during the colonial period are still unprotected after independence. This is the case with mangrove and Sudanian undifferentiated woodland vegetation types. It appears that Zaire and Ivory Coast post colonial policies are very similar. Since the preservation policy during colonial time favored savanna vegetation types, it is expected that future protected areas will be created from forest vegetation type.

C. Kenya.

During British rule, which ended in 1963, protected areas established totalled 22,325.5 square kilometers (see Table 13). Most of attention was focused on protecting Somalia-Masai acacia-commiphora, montane vegetation, and East African coastal mosaic forest patches. Three vegetation types did not benefit from any care-- swamp, Guineo-Congolian rain

Table 13. Kenya--Historic Analysis: Size of the country, Protected areas, and Vegetation types.

Vegetation Type	Total Area in Vegetation type		Total Area in Protected designation Before Independence		Total Area in Protected designation After Independence	
	Sq. Km (a)	Percentage (b)	Sq. Km (c)	Percentage (d)	Sq. Km (e)	Percentage (f)
Somalia_masai Acacia_Commiphora	300479.318	54.33	17517.18	78.46	26685.472	81.17
Semi-Desert Grassland and Shrubland	93092.682	16.83	904.893	4.05	1337.177	4.09
Swamp	1753.331	0.32	0	0	0	0
Mosaic of East African Evergreen Bushland	65932.988	11.92	2280.782	10.22	1332.338	4.08
Undifferentiated Montane Vegetation	41220.215	7.45	872.633	3.91	1041.998	3.19
Mosaic of Lowland R.F. and Sec Grassland	15431.571	2.79	0	0	196.786	0.6
Guineo-Congolian R.F. Drier type	2335.624	0.42	0	0	80.65	0.25
Altimontane Vegetation	1604.935	0.29	83.876	0.38	0	0
East African Coastal Mosaic Zanzibar Inhambane	28098.46	5.08	498.417	2.23	1953.343	5.98
East African Coastal Mosaic Forest Patches	3113.09	0.56	167.752	0.75	29.034	0.89
Total	553062.214	99.99	22325.533	100	32656.798	100

Source: Geographic Information System

forest drier type, and Mosaic of lowland rain forest. Too little attention was paid to the conservation of semi-desert grassland and shrubland.(see Table 14).

After independence, 32,656.8 square kilometers were added to the previous protected areas. The number of protected areas has also increased, 32 compare to 10 before independence, have been established in less than 20 years, for an average of 1.6 per year. There seems to be some changes in policy, because some vegetation types which were unprotected during the colonial period are now preserved. Mosaic of lowland rain forest and secondary grassland, and Guineo-Congolian rain forest drier type have gained some attention after colonization but are still underrepresented. Two of the three vegetation types overrepresented during colonization are still overrepresented after independence.(see Table 14).

An overview of the post-independence era shows that the pattern of protected area designation in relation to vegetation type did not change significantly from the previous period. The emphasis is still most on formerly protected vegetation types. Almost the same proportion of area provided for protection of semi-desert grassland and shrubland, and undifferentiated montane vegetation, exists during both periods, and swamp remains unprotected.

Table 14

Kenya: Expected Vs Pre and post Independence Protected Area Designations by Vegetation Type

	(1)	(2)		(3)	
Vegetation Type	% of Area Expected *	% of Protected areas Pre Indep.**	Index of variation 1=random ***	% of Protected areas PostIndep ****	Index of variation 1=random *****
Somalia-masai Acacia-commiphora	54.33	78.46	1.44	81.17	1.49
Semi-desert Grassland and Shrubland	16.83	4.05	.24	4.09	.24
Swamp	.32	0.00	0.00	0.00	0.00
Mosaic of East African Evergreen Bushland	11.92	10.22	.86	4.08	.34
Undifferentiated Montane Vegetation	7.45	3.91	.52	3.19	.43
Mosaic of Lowland Rainforest and Secondary Grassland	2.79	0.00	0.00	.60	.21
Guineo-congolian Rainforest Drier Type	.42	0.00	0.00	.25	.59
Altimontane Vegetation	.29	.38	1.31	0.00	0.00
East African Coastal Mosaic Zanzibar Inhambane	5.08	2.23	.43	5.98	1.18
East African Coastal Mosaic Forest Patches	.56	.75	1.34	.89	1.58

* Expected if areas were designated randomly with reference to vegetation type. This figure is equal to the percentage of the country covered by each vegetation type.(Table 13. Column a)
** From Table 13. Column d
*** Column 2 divided by Column 1
**** From Table 13. Column f
***** Column 3 divided by Column 1

Kenya's policy is nearly a continuation of the British rule. As Burnett and Stiwell (1990) have noticed, this attitude may be attributed to a more mature tourism industry developed in the country before independence and the post independence government has decided to continue a policy which has been deemed successful.

C. Analysis of all countries combined.

A comprehensive understanding of preservation policy in some sub-Saharan African countries has led to a combination of similar areas in four studied countries. White's vegetation form classification helped to put different vegetation types into an areal scheme. To analyze areas protected versus non protected, and protected areas before and after independence, the same methodology is used as was applied earlier in the analysis of each country.

It is found (see Table 15) that a positive relationship exists between the size of White's areas and the size of the protected area. Guineo-Congolia for example has the largest protected area. Table 16 was deduced from Table 15, from which an index of variation of protected areas with reference to expected areas was calculated. It results that three are overrepresented--Guinea-Congolia/Zambezia, Somalia-Masai, and

Table 15. Vegetation types, Protected areas, and Size of four combined countries.

Vegetation Form	Total Area in Vegetation type		Total Area in Protected designation	
	Sq. Km (a)	Percentage (b)	Sq. Km (c)	Percentage (d)
Guinea-Congolia	1371680.683	36.68	73877.013	31.1
Lake Victoria	7994.028	2.14	3034.053	1.28
Guinea-Congolia/Zambezian	505430.324	13.52	36207.011	15.24
Guinea-Congolia/Sudania	323196.81	8.64	14821.857	6.24
Zambezia	421999.512	11.29	16963.921	7.14
Sudania	513029.167	13.72	30408.276	12.8
Zanzibar-Inhambane	31211.55	8.35	2648.546	1.11
Somalia-Masai	459504.988	12.29	50057.842	21.07
Afromontane	99212.404	2.65	8502.123	3.58
Swamp	5893.902	1.58	1035.546	4.36
Total	3739153.368	100	237556.188	101.95

a: Total Tables 1,3,5,7 column a
c: Total Tables 1,3,5,7 column c

Table 16. Expected versus Actual Protected areas by vegetation and rainfall.
in Ivory coast, Zaire, Kenya, and Nigeria.

Vegetation Form	% of area Expected	Actual % of Protected	Index of variation 1=random	Rainfall mm/year	Vegetation Physiogno
	(1) *	(2) **	(3) ***	(4) ****	(5) ****
Guinea-Congolia	36.68	31.1	0.85	1600-2000	rainforest
Lake Victoria	2.14	1.28	0.6	1500-2000	rainforest
Guinea-Congolia/Zambezian	13.52	15.24	1.13	1400-1600	open f.
Guinea-Congolia/Sudania	8.64	6.24	0.72	1400-1600	open f.
Zambezia	11.29	7.14	0.63	500-1400	savanna
Sudania	13.72	12.8	0.93	500-1400	savanna
Zanzibar-Inhambane	8.35	1.11	0.13	800-1200	savanna
Somalia-Masai	12.29	21.07	1.71	20-500	savanna
Afromontane	2.65	3.58	1.35		
Swamp	1.58	4.36	2.76		

* From Table 15 column b
** From Table 15 column d
*** Column 2 divided by column 1
**** Source: White (1983)

Afromontane. All of them but one are located in an open forest or savanna area.

The historical analysis, as illustrated on table 17, shows a shift from grass dominated vegetation types to more woody types. Before independence most of savanna types were overrepresented, while after the preservation policy is almost evenly distributed in different vegetation types.

III. Conclusion

This paper was an attempt to detect any relationship between protected area and vegetation type distribution. Four countries were studied to fulfill the goal, Ivory Coast, Zaire, Kenya, and Nigeria. One of the tasks of the analysis was the identification of vegetation types in each of the countries. It was found that some vegetation types are different from country to country, making comparison difficult. To make the interpretation of results easier, the vegetation classes are referred to in terms of vegetation form (grass or wood density within each vegetation type). White's main vegetation classification was also used in order to compare vegetation types.

Large protected areas are generally found in extensive vegetation types. Comparison of each vegetation type to a derived variation index, resulted in the discovery that more areas were

Table. 17 Variation of indexes before and after independence by vegetation types and rainfall in Ivory Coast, Zaire, and Kenya.

Vegetation Form	General Index	Index Before Independence	Index After Independence	Rainfall mm/year	Vegetation Physiognomy
	(1)	(2)	(3)	(4)	(5)
Guinea-Congolia	0.85	0.2	1.03	1600-200	rainforest
Lake Victoria	0.6	0.59	0.27	1500-200	rainforest
Guinea-Congolia/Zambezia	1.13	0.53	1.39	1400-160	open f.
Guinea-Congolia/Sudania	0.72	0.37	0.82	1400-160	open f.
Zambezia	0.63	1.38	3.6	500-1400	savanna
Sudania	0.93	5.19	0	500-1400	savanna
Zanzibar-Inhambane	0.13	1.01	1.48	800-1200	savanna
Somalia-Masai	1.71	2.12	1.48	20-500	savanna
Afromontane	1.35	2.21	0.59		
Swamp	2.76	1.2	0		

(1) from Table 16 column (3)

allocated to grassland and related area conservation than should have been expected. In Ivory Coast, Sudanian woodland is more protected than the rest. In Zaire mosaic of East African evergreen bushland, and swamp, and in Kenya Somalia-masai Acacia-commiphora are overrepresented. Protected area designation policy tends to avoid the more woody, and desert types. This conclusion confirms Burnett and Butler's (1987) findings that savanna and its wildlife have been most likely to be protected.

It has been found that small areas are likely to be overrepresented. Montane vegetation is the case found in almost every studied country. In Zaire for example swamp, and mosaic of east African evergreen bushland are overrepresented.
The attractiveness of these areas has yet to determined.

According to historical comparisons, countries with a long and well organized protected area history tend to have a well balanced protected area system as a whole. Ivory Coast, Zaire, and Kenya seem to have better systems than Nigeria. This study again confirms Butler and Burnett's (1982) findings. Ivory Coast and Zaire, both non-British colonies, did not follow their colonial policies after independence. Most post-independence protected areas were established in forest areas which were neglected during colonial times. Kenya, however, virtually perpetuated its pre-independence policies by protecting more savanna types. Despite preservation policies before and after independence, the study also

shows some still unprotected vegetation types. Mangroves and swamp are among them.

An overall point of view shows an overrepresentation of Guinea-Congolia/Zambezia, Somalia-Masai, Aframontane, and swamp. This general protected area distribution conforms with Pritchard's (1979) distribution. The trend, drawn from these four countries, is the shift from savanna types before independence toward forest types after colonization leading to a possible equilibrium in protection policy in the future.

IV. Observations

In order to complete this study, two assumptions were made: that vegetation types and protected areas did not change from colonization until the 1970s. This is not true for several reasons:

1. Human disturbance. Sub-Saharan Africa is one of the continent with a highest human population growth rate. This growth requires more space for housing, more firewood,more agricultural areas, and more meat. Pressure has always existed on wildlife and habitat, bringing changes over time.

2. National politics and interests have changed during the history of each country. Some protected areas have been

reduced, others extended, and others established, especially after independence. Considering these changes may lead to other conclusions.

3. This analysis is mainly descriptive. Numbers obtained through GIS were used to calculate percentages, develop indices, and support conclusion. The use of alternative quantitative methods might help draw additional insight than did the descriptive method used herein. A model might be developed for more precise prediction.

4. This analysis points towards some obvious "gaps" in the pattern of protected areas where no protection measures have been taken. Mangroves are one example. Sudanian undifferentiated woodland in Zaire is another. Studies should be done to understand the reason, and eventually incorporate them in future protected areas.

5. Factors not considered in this study might help explain the distribution pattern of protected area designation. The more likely are soil, wildlife, and population distribution. More difficult to map, but important, is human perception toward wildlife and habitat conservation. It involves several views --local people, government, international institutions, and foreign countries. Some research related to local perceptions have been attempted (Abel and Blaikie 1986; Lewis et al. 1990)

but a comprehensive analysis is needed.

Most research is targeted toward location and protection of protected area policy. A further study might consider the size of each protected area and the effectiveness of the protection policy. Several scientists have advocated small designations, to the detriment of the larger protected areas (Gilpin and Diamond 1980; Higgs and Usher 1980; Helliwell 1976). Research should be done in Africa to verify the applicability of their models.

V. References

Abel, N. and P. Blaikie. 1986. Elephants, people, parks and development: the case of Luangwa valley, Zambia. Environmental Management, 10(6): 735-751.

Afolabi-Ojo, G.F. 1978. Nigerian national parks and related reserves. In International Experience with National Parks and Related Reserves, ed. J.G. Nelson, R.D. Needham, and D.L. Mann, pp. 271-293. Department of Geography Publication Series, No. 2. Waterloo:University of Waterloo.

Bell, R.H.V. 1987. Conservation with a human face: conflict and reconciliation in African land use planning. In Conservation in Africa: People, Policy and Practice, ed. D. Anderson and R. Grove, pp. 79-101. Cambridge:Cambridge University Press.

Burnett, G.W. and L.M. Butler. 1987. National parks in the Third World and associated national characteristics. Leisure Sciences, 9:41-51.

Burnett, G.W. and R. Conover. 1989. The efficacy of Africa's national parks: an evaluation of Julius Nyerere's Arusha Manifesto of 1961. Society and Natural Resources, 2:251-260.

Burnett, G.W. and H.B. Stiwell. 1990. National park and equivalent reserve creation in French and British Africa. Society and Natural Resources. 3:229-241.

Butler, L.M. and G.W. Burnett. 1982. National characteristics and the establishment of national parks in Sub-Saharan Africa. Environmental Conservation, 9:344-346.

Coolidge, H.J. 1972. Evolution of the concept, role and early history of national parks. In World National Parks: Progress and Opportunities, ed. R. VanOsten, pp. 29-38. Brussels:Hayez.

Côte d'Ivoire: 1989. Carte routière et touristique. Paris:Pneu Michelin, 1989.

Curry-Lindahl, K. 1972. Africa: national parks, habitats, biomes and ecosystems. In World National Parks: Progress and Opportunities, ed. R. VanOsten, pp. 105-118. Brussels:Hayez.

Curry-Lindahl, K. 1974. Conservation problems and progress in Equatorial African countries. Environmental Conservation, 1(2):111-122.

Eidsvik, H.K. 1980. National parks and other protected areas: some reflections on the past and prescriptions for the future. Environmental Conservation, 7(3):185-190.

Gilpin, M.E. and J.M. Diamond. 1980. Subdivision of nature reserves and the maintenance of species diversity. Nature, 285:567-568.

Harrison, J., M.R. Kenton, and J. McNeely. 1982. The world coverage of protected areas: development goals and environmental needs. In National Parks, Conservation, and Development. The Role of Protected Areas in Sustaining Society. Proceedings of the World Congress on National Parks, ed. J.A. McNeely and M.R. Kenton, pp. 24-33.

Helliwell, D.R. 1976. The extent and location on nature conservation areas. environmental Conservation, 3(4):255-258.

Higgs, A.J. and M.B. Usher. 1980. Should nature reserves be large or small? Nature, 285:568-569.

IUCN/UNEP. 1987. The IUCN Directory of Afrotropical Protected Areas. Gland:IUCN.

Kenton, M.R. 1982. The natural protected areas of the world. In National Parks, Conservation, and Development: The Role of Protected Areas in Sustaining Society. Proceedings of the World Congress on National Parks, ed. J.A. McNeely and M.R. Kenton, pp. 20-22.

Laclavère, G. 1979. Atlas de la Republique due Zaire. Paris:Jeune Afrique.

Lewis, D. et al. 1990. Wildlife conservation outside protected areas--lessons from an experiment in Zambia. Conservation Biology, 4(2): 171-180.

Lusigi, J.W. 1981. New approaches to wildlife conservation in Kenya. Ambio, 10(2-3):87-92.

Lusigi, J.W. 1982. Future directions for the Afrotropical realm. In National Parks, Conservation, and Development: The Role of Protected Areas in Sustaining Society. Proceedings of the World Congress on National Parks, ed. J.A. McNeely and M.R. Kenton, pp. 137-146.

Map of Kenya. 1989. Munchen:Nettes Verlag.

Monod, T. 1962. The strict nature reserve and its role. In First World Conference on National Parks, ed. A.B. Adams, pp. 259-267. Washington, DC:United States Department of the Interior.

Ola-Adams, B.A. and D.Z. Iyamabo. 1977. Conservation of natural vegetation in Nigeria. Environmental Conservation, 4(3):217-223.

Olindo, P.M. 1974. Park values, changes, and problems in national parks. In Second World Conference on National Parks, ed. S.H. Elliott, pp. 52-60. Morges:National Parks Centennial Commission.

Pritchard, J.M. 1979. Africa: A study geography for advanced students. Hong Kong: Longman Group.

Pullman, R.A. 1988. Conservation and the development of national parks in the humid tropics of Africa. Journal of Biogeography, 15:171-183.

Verschuren, J. 1962. Science and nature reserves. In First World Conference on National Parks, ed. A.B. Adams, pp. 269-279. Washington, DC:United States Department of the Interior.

White, F. 1983. The Vegetation of Africa. Switzerland:UNESCO.

Wilkinson, P.F. 1978. The global distribution of national parks and equivalent reserves. In International Experience with National Parks and Related Reserves, ed. J.G. Nelson, R. D. Needham, and D.L. Mann, pp. 603-624. Department of Geography Publication Series, No. 2. Waterloo:University of Waterloo Press.