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Floristic dynamics on the anthropogenic site of the National Pedagogical University of Kinshasa

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Abstract

The site of the National Pedagogical University is experiencing a phenomenon of increased anthropization due in particular to academic activities for many years, to the socio-political crisis and to the effects of climate change on the quality of biodiversity.

The study focuses on the dynamics of the flora of the National Pedagogical University based on the comparison of two inventories respectively carried out in 2012 and 2022.

Factors related to farming methods and those related to climate and soil have an influence on vegetation. Through the analysis of floristic parameters and the dynamics of land use of this site, a negative evolution of the flora emerges. The appreciation of the floristic parameters is based on the interpretation of floristic inventory data. A total of 49 plant species belong exclusively to spermatophytes, distributed among the classes Magnoliopsida (93.9%) and Liliopsida (6.1%).

Anthropogenic action has played a role both in the degradation of the site and in the mitigation of climate change.

Keywords: Anthropogenic effects; Flora dynamics; National Pedagogical University; Floristic parameters

1. Introduction

At present, in the Democratic Republic of Congo, the knowledge available on natural ecosystems or ecosystems modified by anthropogenic action and on all national biological resources still remains sectoral and fragmentary. Serious gaps still remain in the areas of specific diversity, functioning and dynamics of natural ecosystems in general and plant communities in particular [1].

Vegetation evolves under the influence of a set of factors divided into two groups:

- Environmental factors related to climate and soil;
- Factors related to the modes of exploitation [2,3]

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Disturbance is defined as a change in a factor in the environment of a biological system that interferes with its initial functioning. It is defined by its nature and its intensity determined by the difference between the resulting state and the normal state of the system [4-6].

The impact of human activities is likely to cause changes in plant succession and environmental degradation [7-9].

In order to determine the nature and intensity of human activities on the site of the National Pedagogical University, two studies spaced 10 years apart were carried out. The first, which dates from 2012, concerns the qualitative and quantitative analysis of the flora of the site of the National Pedagogical University [10] The initial state and the current state of the system.

This research aims to study the evolution of the florule on an anthropic site dominated by cultivated plants.

Specifically, it consists of:

- Inventory the plant species established on the UPN site;
- Determine their ecological and chorological characteristics;
- Evaluate the state of floristic evolution in 10 years.

2. Material and methods

2.1. Study framework

The National Pedagogical University is located in the commune of Ngaliema in Kinshasa at the crossroads of the Matadi road and the avenue de la Liberation in the Binza/UPN district. It is the first pedagogical university created by the Congolese State and is instituted by decree n°05/007 of February 23, 2005. It inherited the commitments made and stipulated on behalf of the National Pedagogical Institute (IPN) as well as elements of its heritage.

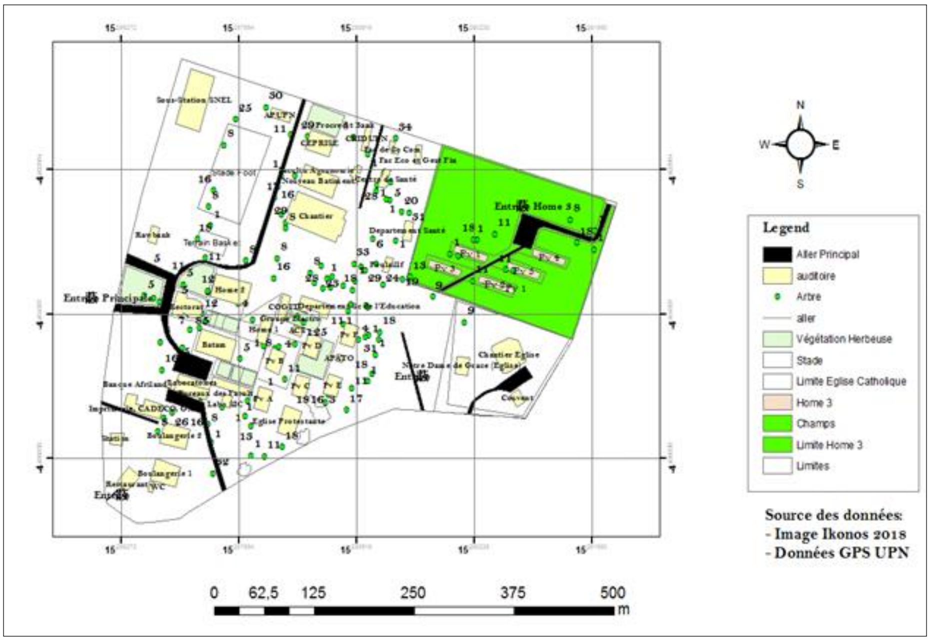

Figure 1 presents the map of the National Pedagogical University

Its creation followed the departure of Belgian secondary school teachers following independence in 1960. To fill this void, the Congolese government requested technical assistance from UNESCO. A team of expatriate teachers was recruited to revitalize this project in order to train qualified teachers on site for secondary education, in all areas.

The first lessons began on December 5, 1961 with the opening of the Pilot Normal Middle School for the training of science graduates for lower secondary education. On December 6, 1969, the IPN opened its Ecole Normale Supérieure for the training of associates in sciences intended for upper secondary education. This school will be transformed into a bachelor's degree section for the training of graduates in applied pedagogy.

By ordinance law n°71-075 of August 6, 1971, the IPN is part of the National University of Zaire (UNAZA) which includes university campuses and higher technical institutes.

From the reform which put an end to the period of the UNAZA, until the eve of the academic year 2003-2004, the IPN was governed by the ordinance law n°18-145 of October 03, 1981.

By decree n°05/007 of February 23, 2005, the IPN is transformed into a public institution called National Pedagogical University. The UPN thus constitutes the second formation, public university in the city of Kinshasa.

3. Results

3.1. Floristic study

The identification of plant species in the field was carried out by Professor IDRISSA ASSUMANI ZABO. It was then confirmed by comparison with the specimens kept at the Laboratory of Plant Systematics of the Department of Biology at the UPN. The phylogenetic classification conforms to APG IV. Labels were attached to the living collection to facilitate learning the systematics of higher plants.

Table 1 Characteristics of species relating to biological, ecological and phytogeographical parameters

Species	**MT**	**BT**	**DT**	**LT**	**DP**	**Years**	
						2012	**2022**
Acacia auriculiformis A. Cunn. Ex Benth	tree	MsPh	Ballo	Lepto	Cosmo	X	X
Acacia farnesiana (L.) Wild.	shrub	McPh	Baro	Lepto	Pan	X	
Acacia mangium Willd.	tree	MsPh	Ballo	Lepto	Cosmo	X	X
Albizia adianthifolia (Schumach.) W.F. Wight	tree	MsPh	Sarco	Lepto	At	X	X
Albizia lebbeck (L.) Benth.	tree	McPh	Baro	Lepto	Pan	X	X
Annona reticula L.	tree	McPh	Sarco	Méso	Pan	X	
Azadirachta indica A. Juss	tree	MsPh	Sarco	Méso	GC		X
Bambusa vulgaris Schrad. ex Wendl.	shrub	MsPh	Scléro	Micro	Pan	X	X
Bombacopsis glabra (Pasquale) A.Robyns	tree	McPh	Pogo	Méso	Pan	X	
Bougainvillea spectabilis Willd.	liana shrub	Phgr	Sarco	Micro	Cosmo	X	
Cajanus cajan (L) Millsp.	shrub	NPh	Ballo	Nano	Pan	X	
Calliandra surinamensis Benth.	shrub	MsPh	Ballo	Lepto	Pan	X	X
Carica papaya L .	shrub	McPh	Baro	Macro	Pan	X	
Dacryodes edulis (G.Don) H.J.Lam	tree	MsPh	Sarco	Méso	CGC	X	X
Delonix regia Raf.	tree	MsPh	Ballo	Lepto	Pan	X	X
Elaeis guineensis Jacq.	tree	MsPh	Sarco	Méso	Pan	X	X
Eucalyptus citriodora Hook.	tree	MsPh	Scléro	Nano	Pan	X	X
Euphorbia tirucalli L.	arb	McPh	Sarco	Nano	Pan	X	X
Ficus bubu Warb et De wild	tree	Msph	Sarco	Méso	GC		X

Ficus lutea Vahl	tree	MsPh	Sarco	Méso	GC		X
Ficus vogeliana (Miq.) Miq	tree	MsPh	Sarco	Méso	At	X	
Gmelina arborea Roxb.	tree	McPh	Sarco	Méso	Pan	X	X
Hibiscus rosa sinensis L.	shrub	NPh	Sarco	Méso	Cosmo	X	
Hibiscus tiliaceus L.	tree	McPh	Ballo	Méso	Pal		X
Hura crepitans L .	tree	MsPh	Ballo	Méso	Pan	X	X
Leucaena leucocephala (Lam.) de Wit	tree	McPh	Ballo	Lepto	Pan	X	
Mangifera indica L.	tree	MsPh	Sarco	Méso	Pan	X	X
Markhamia tomentosa (Benth.) K.Schum	tree	McPh	Ptéro	Méso	GC	X	
Melia azedarach L.	tree	McPh	Sarco	Méso	GC	X	X
Millettia laurentii De Wild.	tree	MsPh	Ballo	Méso	Pan	X	X
Moringa oleifera Lam.	tree	MsPh	Baro	Nano	Pan	X	X
Musa paradisiaca L.	perennial grass	Gb	Sarco	Mega	Pan	X	
Peltophorum pterocarpum (D.C) Baker ex K. Heyne	tree	MsPh	Baro	Lepto	Pan	X	X
Persea americana Mill.	tree	MsPh	Sarco	Méso	Pan	X	X
Loranthus globosus Roxb	shrub	PhE	Sarco	Méso	Pan	X	
Pterocarpus angolensis DC.	tree	MsPh	Ballo	Nano	Pan		X
Polyalthia longifolia (Sonn.) Thwaites	tree	McPh	Sarco	Méso	Pan		X
Ricinus communis L.	shrub	McPh	Ballo	Méso	GC	X	
Samanea saman (Jacq.) Merril	tree	McPh	Ballo	Lepto	Pan	X	
Senna siamea (Lam)Irwin &Barneby	tree	MsPh	Ballo	Micro	Pan	X	X
Senna spectabilis DC.	tree	MsPh	Baro	Micro	Pan		X
Strychnos pungens Solered	shrub	McPh	Ballo	Micro	At	X	
Syzygium guineense (Wild.) DC *subsp. macrocarpum* (Engl.) F. White	tree	MsPh	Sarco	Micro	GC	X	X
Syzygium malaccense (L.) Merr	tree	MsPh	Sarco	Micro	Pan		X
Terminalia catappa L.	tree	MsPh	Sarco	Méso	Pan	X	X
Terminalia mantaly H.Perrier	tree	MsPh	Sarco	Nano	Pan	X	X
Theobroma cacao L.	shrub	McPh	Sarco	Méso	Pan		X
Treculia africana Decne	tree	MsPh	Sarco	Méso	GC		X
Trema orientalis (L.) Blume	tree	McPh	Sarco	Méso	At	X	X
TOTAL						40	36

3.2. Ecological study

It concerns biological types, leaf types, diaspore types. The analysis of biologicals refers to the Raunkiaer system, adapted to tropical regions by [11-14].Leaf types were analyzed using the Raunkiaer classification adapted to tropical regions [12, 16, 17]. That of the type of diaspores was defined according to Dansereau and Lems taken up in [12] and [18].

3.3. Chorological study

The study of the phytogeographical distribution (PD) is inspired by the chorological divisions recognized for tropical Africa by various authors: [11, 17, 19, 20]

3.4. Comparative analysis of the 2012 and 2022 readings

The comparative analysis of the 2012 and 2022 readings consisted of placing the 2 readings side by side and detecting the co-occurring species and the differential species. The inventory of these 2 groups makes it possible to reveal the positive or negative evolution of the phanerophytes on the studied site.

The Sorensen index calculation made it possible to determine the degree of similarity between the readings.

Comparative floristic analysis of sites

The comparative analysis of these different sites consisted in determining the Sorrëssen Similarity Index (SI).

The SORENSSEN index weights the co-occurrence term by 2.[21]

Its formula is $IS = 2a/((2a+b+c))$

Interpretation

- If IS is greater than 0.7 ($x>0.7$) then the similarity is very strong between the sites or the stations;
- If IS varies between 0.5 and 0.69 ($0.5 \leq x \leq 0.69$) then the similarity is average, with disparities;
- If IS is less than 0.5, ($x<0.5$) then the difference between the flora of the sites is very pronounced.

3.5. Ecological and chorological analyzes

3.5.1. Morphological types

Trees predominate with a score of 73.5%. They are followed by shrubs (22.4%). Liana shrubs and perennial herbs are less represented (2% each)

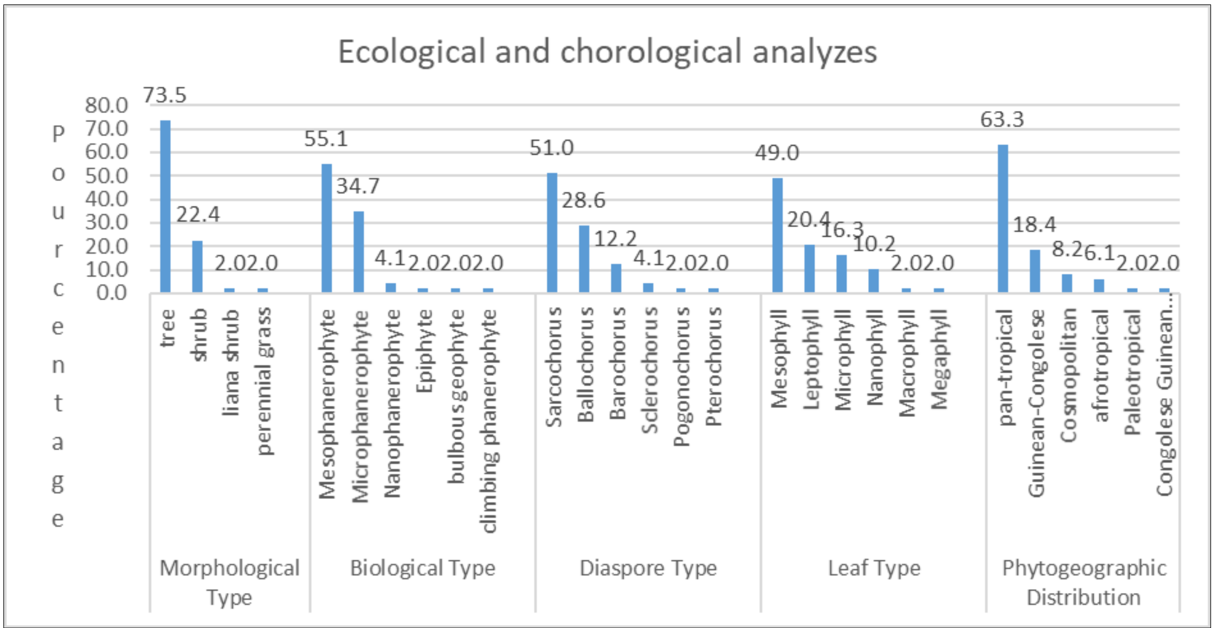

Figure 2 The situation on the ecological analyses

3.5.2. Biological types

Mesophanerophytes come in first position with a score of 55.1%. They are followed by microphanerophytes (34.7%). Nanophanerophytes intervene with 4.1%. Finally, epiphytic phanerophytes, climbing phanerophytes and bulbous geophytes are evaluated at 2% each.

Types of Diaspores

The Sarcochores are the best represented with 51%. They are followed by Ballochores (28.6%), Barochores (12.2%) and Sclerochores (4.1%) Finally, Pterochores and Pogonochores each intervene with 2%.

leaf types

The mesophylls represent 49% of the florule. They are followed by leptophylls (20.4%), microphylls (16.3%) and nanophylls (10.2%). The megaphylls and the macrophylls each intervene with 2%.

Phytogeographic distribution

Pantropical species are predominant with 63.3%. They are followed by Guinean-Congolese species (18.4%). Cosmopolitan species each intervene with 8.2% while Afrotropical species represent 6.1%. Finally, paleotropical and Centro-Guineo-Congolese species complete the list with 2% each.

Floristic evolution through the similarity index

The SORENSEN index is equivalent to 0.6486. This shows an average similarity, with disparities between 2012 and 2022. While some species have disappeared, others have appeared as a result of factors related to farming methods and those related to climate and soil.

In the first category, let us mention in particular: *Bombacopsis glabra* (Pasquale) A.Robyns ,*Bougainvillea spectabilis* Willd., *Cajanus cajan* (L) Millsp., *Carica papaya* L., *Ficus vogeliana* (Miq.) Miq., *Hibiscus rosa sinensis* L., *Leucaena leucocephala* (Lam.) de Wit., *Markhamia tomentosa* (Benth.) K. Schum., *Musa paradisiaca* L., *Loranthus globosus* Roxb, *Ricinus communis* L., *Samanea saman* (Jacq.) Merril, and *Strychnos pungens* Solered.

In the meantime, there has been the introduction of: *Azadirachta indica* A. Juss, *Ficus bubu* Warb and De Willd, *Ficus lutea* Vahl, *Hibiscus tiliaceus* L., *Pterocarpus angolensis* DC. *Polyalthia longifolia* (Sonn.) Thwaites, *Senna spectabilis* DC., *Syzygium malaccense* (L.) Merr, *Theobroma cacao* L., *Treculia africana* Decne.

4. Discussion

The pressure that the vegetation of tropical regions is subjected to is, directly or indirectly, the result of Man: transformation of landscapes (deforestation, desertification, cultivation, etc.), propagation and extinction of species, emission of substances that modify ecological balances in water and soil, etc.[22].

The wide variety of physiognomies and floristic compositions reflects the stages of the succession process and their various modalities depending on the environment and region. These temporal and spatial variabilities are under the control of various factors, some of which are related to human activities. It is certain that the climate, the soils, the cultivation methods, etc., have an effect on the successions, but it is still difficult to say according to which hierarchy their influence is organized [23].

On the site of the National Pedagogical University, the results obtained show that in 2012, the florule was 40 species. Ten years later, the figure is revised downwards (36 plant species). Most of these species were mowed following the completion of the auditorium and store construction project.

The introduction of new species is justified by responses to climate change, research projects, and/or site beautification. Indeed, during the celebration of Arbor Days each year, in addition to conferences, the Department of Biology organizes reforestation sessions.

As part of research projects or for the sake of beautifying the site, the Faculty of Agronomic Sciences has planted species such as Theobroma cacao L., Azadirachta indica A. Juss, Hibiscus tiliaceus L. and Polyalthia longifolia.

Senterre (2005) [24] suggests defining ecological types and chorological types independently and homologously. The analysis of morphological types reveals that trees predominate with a score of 73.5%. That of the biological types shows that the mesophanerophytes come in first position with a score of 55.1%. Regarding the types of diaspore, sarcochores are the best represented with 51%. As for the leaf types, the mesophylls represent 49% of the florule. Finally, for the phytogeographical distribution, pantropical species are predominant with 63.3%.

5. Conclusion

Our research aimed to study the evolution of the florule on an anthropic site dominated by cultivated plants. Thus, it consisted of:

- Inventory the plant species established on the UPN site;
- Determine their ecological and chorological characteristics;
- Evaluate the state of floristic evolution in 10 years.
- It emerges that, on the UPN site, the florule of 2012 experienced a regression justified by the disappearance of certain species. Indeed, the auditorium construction project had a negative impact on the vegetation.
- Despite these dramatic circumstances characterizing the mowing of plant species to favor the development of the site, it should be noted that other species have been planted for reasons of resilience to climate change.
- Anthropogenic action has played a role both in the degradation of the site and in the mitigation of climate change.

Compliance with ethical standards

Acknowledgments

We thank everyone who participated in this study. We think particularly of the Biology students who agreed to stick labels on the plants inventoried.

Disclosure of conflict of interest

There is no conflict of interest be the authors of this manuscript.

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