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CARTOGRAPHIC ANALYSIS OF ANTHROPOGENIC IMPACT ON THE FAYA FOREST IN MALI

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Mali's forests have been subjected to extensive human pressures in recent decades. This Sahel country where 90% of the population lives on 30% of the territory is very dependent on forest resources through multiple activities. Malian forest resources are subject to several pressures, including: agricultural clearing, cumulative consumption of wood and charcoal, harvesting of wood and services, pastoralism, hunting, bush fires (early and late) which devastate more than 100 000 ha per year and also for reasons of traditional medicine. The protected forest of Faya, which covers an area of 80 000 ha, located 40 km from Bamako, has not escaped this destruction despite its status as a protected forest and the new management plan which only grants the right to use by residents of the Faya in terms of forest exploitation. The methodology was based on the realization of the collections and documentary analysis, the analyzes of cartographic and figure, the realization of the qualitative surveys, the treatment and the analysis of the data. The study revealed to us that the Faya forest has been under enormous pressure and that the gallery forests and wooded savannah are turning into shrub savannah. This article aims to analyze the pressures on plant formations of Faya in recent decades.

Keywords: *GIS maps, anthropogenic pressure, Faya, protection, forest management.*
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INTRODUCTION

From Stockholm in 1972 to Rio in 1992, considering the environment is a major concern of the community of nations, which is witnessing the effects of our devastating activities on our environment [4]. If the problems of pollution, nuisances, the combustion of fossil resources which affects biodiversity and worries the experts, the first to report on the disasters which generate, one of the cruellest major problems would be above all deforestation, the exploitation irrational use of our faunal and floristic resources [8].

In most countries, on all continents, this drama exists at worrying proportions. This is the case with industrial and mining exploitation, excessive logging, climate change, devastating natural fires, bush fires, developments, the expansion of agriculture, concessions crowned with incivility [17].

In Mali, the program for defining national land degradation neutrality objectives by makes extremely serious observations in terms of management. Forests and reforestation, forest resources are drastically decreasing due to the consumption of wood energy and agricultural desertification reinforced by economic growth [2, 6].

Malian forest resources are subject to several pressures, including: agricultural clearing, increased consumption of wood and charcoal, removal of timber and service timber, bush fires (early and late) which devastate more than 100 000 ha per year and harvesting for traditional medicine purposes [10].

Faced with the threats to these resources, the Malian authorities have increased the number of forests and protected areas, which currently number 113 and cover an area of 1338991 ha, or 1% of the country's area [1]. The Faya forest, the first protected forest by the authorities in history is the largest among many others; covering an area of nearly 80.000 ha, 40 km from the capital Bamako

on National Road N°6 does not resist degradation due to population explosion, large-scale urbanization and high demand for wood [7]. Forest products meet the basic needs of Malian communities. Among them the use of wood as energy (90% of needs), service wood, sawn wood, pharmacopoeia, socio-cultural needs. The Faya is now threatened with extinction by human activities [3, 17]. Nowadays it suffers from several causes of degradation such as:
Excessive and uncontrolled logging;
Strong pastoral pressure on natural formations;
The incivility of the actors in charge of protection;
Climate change;
Bush fires [19].

MATERIAL AND METHODS

The general pattern of research on the classified forests of Mali is based on methodological approaches proposed by scientists such as [14, 16, 18] and experts in the field in different organizations in Mali. The studies were conducted in 2 stages: documentary research and field research. Preparatory stage in the office. At this stage, information was collected on the vegetation and soil cover, topography and climatic conditions of the territories studied, the causes of deforestation in the research objects were identified, Landsat 8 images and a brief review of the research world scientists on forest management was carried out.

Field step.

Initially, field studies were carried out from June to September 2021 in the classified forest of Faya but also with the human resources of the various technical services which deal with Faya: Ministry of Sanitation, Environment and Sustainable Development, National Directorate of Water and Forests, Regional Directorate of Water and Forests, Cantonment of Water and Forests, Management of the Forest Information System, Water and Forest Post, Decentralized Forest Management Program and Institute of Rural Economy .Finally, some researchers at university level and research departments were consulted for further information and analysis.

RESULTS AND DISCUSSION

Here, we were able to have the maps of the year 1990 and the year 2020, i.e. a period of 30 years based on the Landsat 5 tool for the 1990 map and Landsat8 for that of 2020 which allowed us to know the state of forest formations during these two periods and to measure the state of their degradation or improvement in the face of natural phenomena and anthropogenic pressures that threaten its existence. the tables below taken from the information on the maps will allow us to have even more precision on the surface covered on each of these formations (Figure 1).

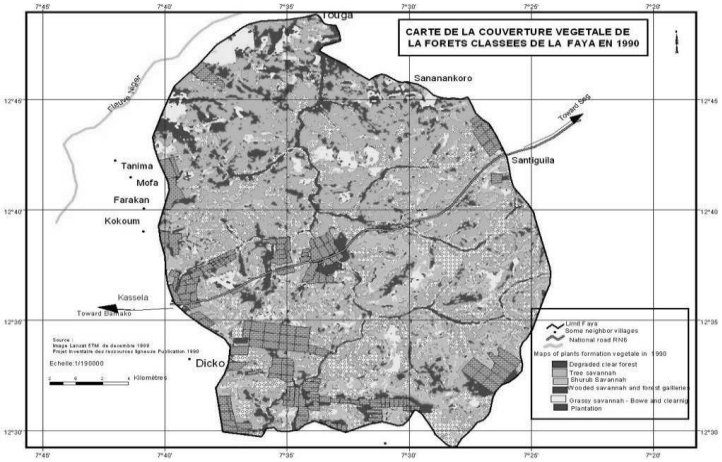

Fig.1. Maps of Faya plant formations in 1990

This table below is a complement to the map to see more details on the covered area of each forest formation (Table 1).

Table 1.

Areas of plant formations in the Faya forest 1990

Type of plant formations	Area in 1990	
	ha	%
Wooded savannahs and degraded galleries	12794	16%
Degraded clear forests	10058	13%
Tree Savannah	9954	12%
Wooded Savannah	16220	20%
Shrub savannas	21210	26.51%
Grassy savannah - Bowé and clearing	5197	6.49%
plantations	4 531.08	6%
Total	79964.08	100

With regard to this 1990 map, we see the predominance of shrub savannah over an area of 26.51% followed by wooded savannah with 20%. Regarding this map of the Faya of the year 1990, wooded on an area of 40% followed by shrubby savannah with 19%. This predominance also of the wooded savannah, which comes in second place, is explained by the non-exploitation or the controlled exploitation of the forest resources of the Faya at that time. It is followed by wooded savannah and gallery forests, which are bands of vegetation with more or less closed cover, located along certain watercourses and in depressions. They constitute an ecologically unstable and very fragile environment. These are the galleries which have undergone strong cutting pressure and whose regeneration has led to the formation of savanna along the main watercourses. It covers an area of 12794 ha or 16% of the massif.

Then is positioned the degraded clear forest on an area of 10058 hectares or 13% of the forest. This indicates the deterioration of forest resources. The tree savanna generally results from the permanent and continuous degradation of the vegetation under the combined effect of human action and successive droughts. It covers an area of 9954 or 12% of the massif.

The grassy savannah, bowe and glades occupies an area of 5197 or 6.49% of the forest. The total coverage of tree savannas, degraded clear forest, shrubby savannah and grassy savannah, bowe and clearing cover an area of 35267 ha or 58% of the entire forest, hence the need to adopt strategies for the conservation of this f forest hence the idea of planting. The latter covers an area of 4531.08 or 6% of the forest. It is safe to say that taking into account the preservation of forest biodiversity was a reality and a battle horse for the government after the droughts of the 1990s that hit the Sahel countries hard. Massive plantations have been carried out by importing exotic species to correct deforestation due to massive exploitation by communities and green forests in general have been well protected by effective protection mechanisms (Figure 2).

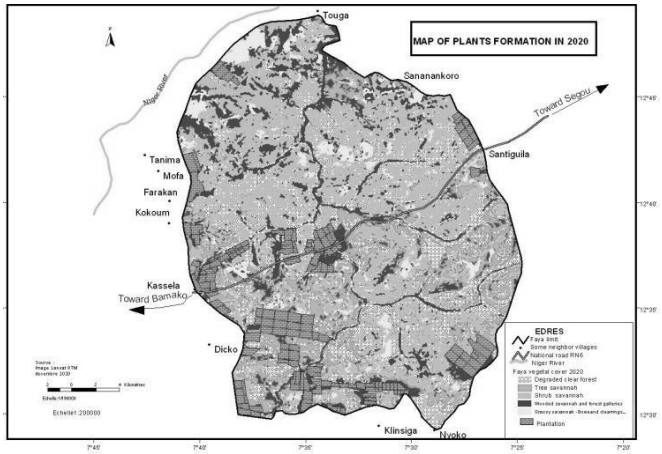

Fig.2. Maps of Faya plant formations in 2020

This 2020 map clearly shows us the natural and human factors of degradation that weigh on this massif. In view, we noted the predominance of shrubby savannah that covers an area of 37372 ha or 47% of the total area of the forest, followed by wooded savannah 9594 or 12%, grassy savannah, bowe and clearing 8770 or 11% (Table 2).

Table 2.

Areas of plant formations in the Faya classified forest 2020

Type of plant formations	Area in 2020	
	ha	%
Wooded savannahs and degraded galleries	5250	6%
Degraded clear forests	8195	10%
Tree Savannah	6250	8%
Wooded Savannah	9594	12%
Shrub savannas	37374	47%
Grassy savannah - Bowé and clearing	8770	11%
plantations	4 531.08	6%
Total	79964.08	100

The predominance of these savannas is striking proof of the degradation of forest resources in the Faya. These savannahs listed except the wooded savannah instead of the wooded savannah cover an area of 60589 ha or 76% of the protected forest of the Faya. The wooded savanna occupies 8% of an area of 6250 ha. In addition, finally the planting 6.0 % on an area of 4531.08 ha.

This detection of changes made by Landsat 5 for the year 1990 and Landsat 8 for 2020, i.e. an interval of 30 years, will allow us to observe the dynamics of change either the dynamics of change either in terms of degradation or improvement of forest management in this vast classified forest near the capital of Mali, Bamako.

In view of the Landsat 5 and 8 data on the state of the two maps of the Faya of 1990 and 2020, the detection of changes in the forest resources of the Faya is of great concern to us and challenges each of us for its protection. We are witnessing a serious degradation of almost all of its resources (Table 3).

Table 3.

Types of plant formations and its evolution of forest area from 1990-2020

Types of plant formations	Area in 1990	Area in 2020	Evolution of forested areas from 1990 - 2020
Wooded savannahs and degraded galleries	12794	5250	-7544
Degraded clear forests	10058	8195	-1863
Tree Savannah	9954	6250	-3704
Wooded Savannah	16220	9594	-6626
Shrub savannas	21210	37374	+16164
Grassy savannah - Bowé and clearing	5197	8770	+3573
plantations	4531.08	4531.08	0
Total	79964.08	79964.08	

During the last thirty years, the forest resources of Faya Forest have been under strong pressure, pressure due to the proximity of the city of Bamako which has an increasingly growing need for domestic energy; to this must be added the effects of drought relating to climate variability since the 1980s [15]. All this justifies the degradation of forest resources in this classified area. The potential of the various formations, especially around the villages and the Bamako-Ségou national road, has been strongly affected. It is thus in the various formations with high woody potential that it has been observed in:

Wooded savannah and gallery forest the cover is 12794 in 1990 against 5250 ha in 2020 a loss of 5250 ha;

Degraded open forest 10058 ha in 1990 against 8195 ha, i.e. a loss of 1863 ha:

Savannah 9954 ha in 1990 against 6250 ha in 2020, i.e. a loss of 3703 ha;

Wooded savannah 16220 ha in 1990 against 9594 in 2020, i.e. a loss of 6626 ha;

Shrubby savannah 21210 in 1990 against 37374 in 2020;

Grassy savannah – Bowé-and Clearing 5197 ha in 1990 against 8770 ha in 2020.

On analysis, it can be said that a large part of the area of this classified forest covered by the formations (wooded savannah, gallery forest, wooded savannah, tree savannah) has been transformed into shrub savannah or grassy savannah, Bowé and clearing [13]. This sufficiently demonstrates the strong degradation of resources in this period notwithstanding the concession of Faya in 2013 with a management plan, the degradation continues at a very worrying rate in the forest. This tendency to degradation is also stronger in gallery forests. In 1990, it covered an area of 12794 ha or 16% of the total area of forest resources of Faya, in 2020, it covers an area of 5250 ha, or only 6%. This can be explained by the effects of climate change, which dry up the rivers that water these gallery forests, or by anthropogenic pressures in the search for service timber that is abundant in this forest formation. In any case, the tendency to deterioration is present. Despite the awareness of the role that forests play, the consequences of deforestation and the vast reforestation campaigns or dare we say "reforestation propaganda" by the Malian authorities every year for decades, the detection of changes in the level of plantations assesses the inefficiency of reforestation campaigns by perhaps a lack of monitoring and/or exploitation of planted resources [9, 12]. From 1990 to 2020, the area of plantations has not changed. Most essences are exotic such as: Gmelina arborea, Tectona grandis, Eucalyptus sp, Azadirchta indica for utility purposes [5]. In fact,

the inventories carried out in these forests over a time interval of about 10 years (1996 and 2005) showed that the area of gallery forests has greatly decreased and that tree savannahs have receded to give way to shrubby savannahs and forest clear degraded [11].

CONCLUSION

This forest has been classified, that is to say protected since the colonial period in order to constitute a reserve of wood for the supply of Bamako and wooden rails attracts all the greed of the neighboring communities to the number of 17 villages but also of Bamako which is located 40 km from this forest. Faced with the dependence of communities (rural and urban) on timber, firewood, tree bark for traditional therapy, animal husbandry, intensive agriculture, the absence of other generative activities income, large-scale anarchic urbanization and finally the population explosion, all attempts, all efforts to restore the Faya by politicians have failed. Through the new public-private partnership contract tested several times for its preservation in the name of ecotourism and participation, without the implementation of a strategy of dependence on forest resources through a strong energy transition, nothing is not possible indicates the success of this strategy. The gigantic measure that must be implemented is the fencing of this forest, the endowment of forest services with modern technological tools such as the drone to facilitate its surveillance and rapid intervention actions, the creation of income-generating activities for local communities, awareness and ecotourism.

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MALİNİN FAYA MEŞƏLƏRİNƏ ANTROPOGEN TƏSİRİN KARTOQRAFİK TƏHLİLİ

Adama Toqola

Son onilliklərdə Mali meşələri güclü antropogen təzyiqə məruz qalmışdır. Əhalinin 90%-nin ərazinin 30%-də yaşadığı bu Sahel ölkəsi müxtəlif fəaliyyətlər səbəbindən meşə ehtiyatlarından çox asılıdır. Malinin meşə ehtiyatları müxtəlif təzyiqlərə məruz qalır, o cümlədən: kənd təsərrüfatı üçün meşələrin qırılması, oduncaq və kömür istehlakı, oduncaq hazırlanması və ekosistem xidmətləri, heyvandarlığın inkişafı, ovçuluq, ildə 100000 hektardan çox ərazini məhv edən meşə yanğınları (erkən və gec), həmçinin xalq təbabəti üçün istifadə və s. Bamakodan 40 km məsafədə yerləşən 80000 hektarlıq Faya meşəsi qorunan meşə statusuna və yalnız Faya əhalisinə meşədən istifadə hüquqlarını verən yeni idarəetmə planına baxmayaraq, bu məhv olmadan xilas ola bilməmişdir. Metodologiya toplanmış materialların analizinə, kartoqrafik məlumatların və şəkillərin təhlilinə, keyfiyyət müşahidələrinin aparılmasına, məlumatların emalına və təhlilinə əsaslanmışdır. Tədqiqat bizə göstərdi ki, Faya meşələri böyük təzyiq altındadır, qalereya meşələri və meşəlikli savannalar getdikcə kol savannasına çevrilir. Bu məqalə son onilliklərdə Fayanın bitki formasiyalarına olan yüklənmələri təhlil etmək məqsədini daşıyır.

Açar sözlər: *CİS xəritələr, antropogen yüklənmə, Faya, mühafizə, meşələrin idarəedilməsi*

КАРТОГРАФИЧЕСКИЙ АНАЛИЗ АНТРОПОГЕННОГО ВОЗДЕЙСТВИЯ НА ЛЕСА ФАЯ В МАЛИ

Адама Тогола

В последние десятилетия леса Мали подвергались сильному антропогенному давлению. Эта страна Сахеля, где 90% населения проживает на 30% территории, очень зависит от лесных ресурсов благодаря множеству видов деятельности. Малийские лесные ресурсы подвергаются многочисленным нагрузкам, в том числе: вырубка лесов для сельскохозяйственных нужд, потребление древесины и древесного угля, заготовка древесины и оказание экосистемных услуг, пастбищное животноводство, охота, лесные пожары (ранние и поздние), которые опустошают более 100 000 га в год, а также использование в целях традиционной медицины. Охраняемые леса Фая площадью 80 000 га, расположенный в 40 км от Бамако, также не избежал этого уничтожения, несмотря на его статус охраняемого леса и новый план управления, который предоставляет право лесопользования только жителям Фаи. Методология основывалась на проведении анализа собранных материалов, анализе картографических материалов и рисунков, проведении качественных обзоров, обработке и анализе данных. Исследование показало нам, что леса Фая находится под огромным давлением и что галерейные леса и лесистая саванна постепенно превращаются в кустарниковую саванну. В данной статье ставится задача проанализировать нагрузки на растительные формации Фая в последние десятилетия.

Ключевые слова: *ГИС-карты, антропогенная нагрузка, Фая, охрана, управление лесами*