Degradation of the Classified Forest of Faya in Mali in the Period 1990-2020

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Abstract

Mali's forests have been subjected to vast human pressures in recent decades. This Sahelian 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, among others: agricultural clearing, accumulated consumption of wood and charcoal, harvesting of timber and services, pastoralism, hunting, bush fires which devastate more than 100,000 ha per year and also for reasons of traditional medicine. The classified forest of Faya, which covers an area of 80 000 ha, located 40 km from Bamako has not escaped this destruction despite its classification long before independence in the colonial period and after. This article aims to analyze the detection of changes in the condition of this forest and in the composition of plant formations over the last 30 years as a result of human activity. Using Landsat8 data from the Faya forest maps for 1990 and 2020, we have monitored the condition of Faya's classified forests for 30 years, resulting in severe degradation of almost all of its resources. If in 1990 the wooded savannah covered 40% of the area of this forest, 30 years later, in 2020, shrub savannah on bowe predominates with 72%, and gallery forests in 1990 occupied an area of 8667 ha, that is, 11% of the total area of forest resources Faya, in 2020 - 1377 ha, that is, only 1%. The detected changes

in classified forest of Faya causes serious concern and requires preparation and adoption of serious measures for the sustainable forest management.

Keywords: *classified forest, Republic of Mali, anthropogenic pressure, monitoring, degradation, charcoal production.*

INTRODUCTION

Mali is a continental country in West Africa that is part of the area called the Sahel. Currently 90% of the population live on 30% of the national territory, in the southern part of the country considered to be harboring most of the forest formations estimated at 37 741 231 ha or 8% of the land area under the national management of water and forests (AEDD 2011, AEDD AGCC-Mali 2019). In Mali, the program for defining national targets for land degradation neutrality by the MAEDD (MAEDD 2020) makes extremely serious observations in terms of management. Forests and reforestation, forest resources are drastically diminishing due to the consumption of wood energy and agricultural desertification reinforced by economic growth. Resources forest Malian undergo several pressures, including among others: agricultural clearing, the increase in a consumption of wood and charcoal, the sampling timber and service wood, bush fires (early and late) which devastate more than 100,000 ha per year and samples for traditional medicine (National forest policy 2017). Faced with the threats to these resources, the Malian authorities have increased the number of forests and protection areas, currently numbering 113 and covering an area of 1,338,991 ha, or 1% of the country's surface area (UNDP 2020).

The classified forest of Faya, the first forest classified by the authorities in history is the largest among many, covering an area of nearly 80,000 ha 40 km from the capital Bamako on the RN6 (Togola 2019). The population explosion, large-scale urbanization and the strong demand for wood leave no chance for this forest to resist human pressure. The essential needs of Malian communities are met by forest products. Among them the use of wood as energy (90% of needs), service wood, sawn wood, pharmacopoeia, and socio-cultural needs. The Faya is today threatened with disappearance by human activities. Nowadays according to Sow (2019), it suffers from several causes of degradation:

- Abusive and uncontrolled logging;
- The strong pastoral pressure on natural formations;
- The incivism of the actors in charge of protection;
- Climate change;
- Artificial plantations;
- Bush fires.

The aim of our study is to diagnose the problems of the degradation of the Faya, to detect the changes during the three decades and to propose an alternation to the successive failed management. The destruction of this classified forest is no different from that of the hundreds of forests in Mali. All these forests have been deprived of their “classified forest” nature because of strong human pressure which, in addition to being abusive, is outlawed. To carry out this study, the environmental approach, field observation and interviews with resource persons were favored.

The case of Mali is not different from that of other regions and countries of the world. Several other researchers have studied this phenomenon (Konate 2001, Monsalve-Cuartas et al. 2019). After their analyzes, in fact most of them recommend co-management and participatory management as strategies to slow down the degradation of forest resources. But

rare are they who have referred to new and renewed energies to reduce or stop deforestation. Despite the biological and cultural richness of the Mayan Selva in Latin America, these forests today face serious dangers. It is estimated that over the past 25 years, in the Guatemalan part of Selva Maya alone, about 38 percent of the forests have disappeared, with forest cover declining from 2.62 million hectares in 1991 to 1.63 million hectares in 2016 (FAO 2020).

Deroueche (2015) made the inventory of the forest formations of DJELFA (Algeria) which are in imbalance and undergo a regression during these last decades. The last decade of dieback has served in close connection with various groups of wood-boring insects, particularly bark beetles, and has been highlighted with the period of drought. Degradation and disappearance of certain species as well as a decrease in forest biodiversity in Algeria due to climate stress and more frequent heat waves and drought have led to bushfires, which will make the forest more vulnerable to degradation. In Côte d'Ivoire, the research presented Raissa and Bakayoko (2013) testifies to the degradation of forests by deforestation for decades in Africa and in his country. With high deforestation rates, the Africa's vegetation cover was reduced by around 44 million hectares between 1990 and 2000.

According to a study carried out by Sawadogo (2009), the main human activities in Burkina Faso which influence the structure and dynamics of natural formations in arid zones are grazing by livestock, bush fires and logging for various purposes. These 3 activities are commonly practiced in classified forests and nature reserves, often clandestinely. Lompo (2015) shows that public participation can promote the sustainable management of forests since it constitutes the means par excellence of education, information and public awareness on the rational use of forests. M'bodj (2014) presents the impact that the decentralization process in Mali may have had on the management of forest resources in a research entitled "Management of forest resources in Mali and land claims: the relationship with the indigenous or migrants from Mandé wood. Local populations have regained their power of control over resources but without having official access to the financial benefits of their exploitation.

According to Dicko (2006), the different geographical and cultural areas of Mali are rich in this knowledge and know-how which, today, constitute a reference for the sustainable management of natural resources. It favors local conventions as a methodological tool and / or legal instrument in the management of natural resources. In their view, the rise of local conventions is part of the overall dynamic of promoting local governance in the management of natural resources. Traore (2010) develops the same thesis given the importance of forest co-management.

Materials and Methods

The general scheme of research on the classified forests of Mali is based on methodological approaches proposed by scientists such as Tangara (2009), Thomas and Samassekou (2003), Traore (2010) and experts of the field in different organizations in Mali. The studies were conducted in 2 steps: desk-preparatory and field researches.

Desk-preparatory step. At this stage, information was collected on the vegetation and soil cover, topography and climatic conditions of the studied territories, the causes of deforestation in the objects of research were identified; fund cartographic materials and taxation indicators of forest of the studied territories were studied (forest composition, completeness, bonitet, wood stock); and a brief review of the research of world scientists on forest management was conducted.

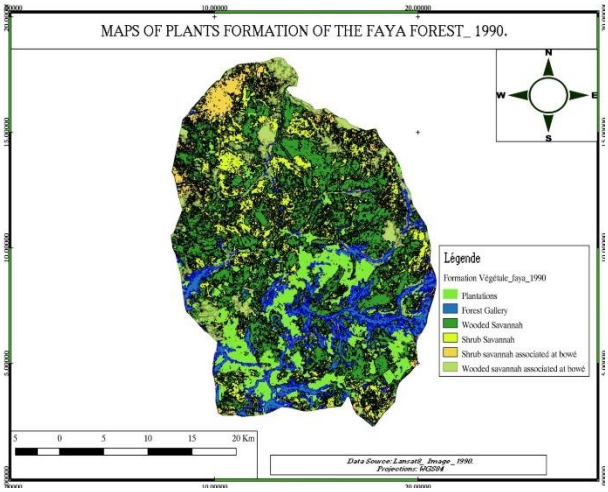
Field step. Initially, field studies were carried out from June to September 2021 in the classified forest of Faya but also with the human resources of the various technical services that deal with Faya: Ministry of Sanitation, Environment and Sustainable Development, National Directorate of Water and Forests, Regional Directorate of Water and Forests, Cantonment of Water and Forests, Forest Information System Management, Water and Forests Post, Decentralized Forest Management Program and Institute of Rural Economy.

Finally, some researchers at the rank of academics and research departments were consulted for further information and analysis. The chosen route made it possible to study the species composition of the trees, the anthropogenic changes noted during these last three decades. Secondly, we used the mapping of the forest on the basis of the GIS by Landsat 8 to see the change detection by doing an in-depth analysis of the changes made on this forest.

Results and Discussion

Several studies (Regional development plan for the Koulikoro region 2011, Ministry of Forests 2017) have been made by domestic experts, partners and foreign researchers about the degradation of Faya which has drawn attention to the role it plays as the green lung of Faya bitter struggle by authorities against climate change by preserving forests. We used the maps of the year 1990 and the year 2020, i.e. a period of 30 years based on the Landsat 8 tool which allowed us to know the changes in the state of forest formations during these periods and to measure the state of their degradation or their improvement in the face of natural phenomena and antropic pressures which threaten its existence. Long before 1990 the Faya had undergone development plans, the 1990 cartographic data indicates to us, compared to the 2020 period, a forest area in more desirable condition (Figure 1, Table 1).

Figure 1 Map of plant formations of the Faya forest (SIFOR 1990)



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

Table 1 Vegetable occupation of Faya Forest in 1990

№	Types of plant formations	Ha	%
1	Plantations	11283	14
2	Forest Gallery	8667	11
3	Wooded savannah	31728	40
4	Wooded savannah on bowe	6970	9
5	Shrub savannah	15245	19
6	Shrub savannah on bowe	5714	7
	Total	79607	100

With regard to this map of the Faya from the year 1990, forested over an area of 40% followed by shrub savannah with 19%. The latter is characterized by the existence of a very open, often thorny shrub layer, dominating a discontinuous herbaceous carpet based on annual grass, the size of which is less than 80 cm. Hydrophilic vegetation is also included in this formation when the woody plants are small (Ministry of Forests 2016). This predominance of wooded savannah is explained by the non-exploitation or controlled exploitation of the forest resources of the Faya at that time. Here as we can see also the plantations come in 3rd position with 14% of the total vegetation. We can safely say that taking into account the preservation of forest biodiversity was a reality and as a battle horse for the government after the droughts of the 1990s which hit the Sahel countries hard. Massive plantations have been achieved 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.

The forest gallery comes in 4 th position with 11%. They are strips of vegetation with more or less closed cover, located along certain rivers and in depressions. They constitute an ecologically unstable and very fragile environment (Tangara 2009). Finally, the wooded savannas on bowe and the shrub savannas on bowe. Bowé are particular form of degraded land where ferricrete, a hard erosion-resistant layer, is exposed (Padonou et al 2014). The latter covers a total area of approximately 5,714 hectares, or 7% of the classified forest of Faya in 1990.

The main woody species most frequently encountered are: Bombax Costatum, Cordyla pinnata, Lannea acida, Combretum micrantum, Sterculia setigera, Combretum glutinosum, Pterocarpus erinaceus, Lannea microcarpa, Acacia ataxancantha (PIRL 1990).

Fig. 2. Map of plant formations of the Faya forest in 2020 (SIFOR 2020)

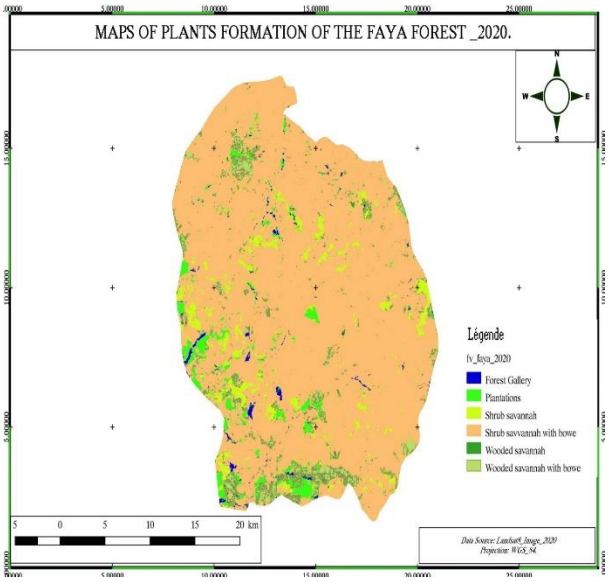


Table 2 is a complement of Fig.2 to see more details on the covered area of each forest formation in 2020

Table 2. Vegetable occupation of Faya forest in 2020

№	Types of plant formations	Ha	%
1	Plantations	3877	5
2	Forest gallery	1377	2
3	Wooded savannah	1453	2
4	Wooded savannah on bowe	8828	12
5	Shrub savannah	5621	7
6	Shrub savannah on bowe	54619	72
	Total	75775	100

With regard to this 2020 map, we can also affirm that the bowe occupy a large part in this forest massif because of the fact that the shrub savannah on bowe occupies more than half of the plant area of this classified forest with 72% over an area of 54,619 ha followed by the wooded savannah on bowe over an area of 8,828 ha, i.e. 11% of its area.

Table 3. Monitoring of the state of vegetation formations of Faya forest between 1990 and 2020

№	Types of plant formations	Years		Difference in 30 years	
		1990	2020	Ha	%
1	Plantations	11283	3877	-7406	-65.6
2	Forest gallery	8667	1377	-7290	-84.1
3	Wooded savannah	31728	1453	-30275	-95.4
4	Wooded savannah on bowe	6970	8828	+1858	+26.7
5	Shrub savannah	15245	5621	-9624	-63.1
6	Shrub savannah on bowe	5714	54619	+48905	+855.9
	Total	79607	75775	- 3832	-4.9

In view of the Landsat 8 data on the state of the two maps of the Faya's forest of 1990 and 2020, the detection changes in the forest resources of the Faya is of great concern to us and calls out to all of us for its protection. We are witnessing a serious degradation of almost all of its resources. If in 1990 the wooded savannah covered 40% of the area of this forest, we found those 30 years later, in 2020, it is the shrub savannah on bowe which predominates with 72%. This sufficiently demonstrates the strong degradation of resources in this period of time notwithstanding the Faya concession in 2013 with a development plan, degradation continues at a very worrying rate in the forest. This degradation trend is also stronger in gallery forests. In 1990, it covered an area of 8,667 ha, i.e. 11% of the total area of forest resources of Faya, in 2020, it covered an area of 1377 ha, i.e. only 1%. Very disturbing! This can be explained by the effects of climate change which dry up the rivers that water these gallery forests and by anthropogenic pressures. In any case, the tendency for deterioration is very 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 decades ago, the detection of changes in level of forest plantations assess the ineffectiveness of reforestation campaigns by perhaps lack of monitoring and exploitation of planted resources. In 1990, the area of plantations were 11,283 ha, or 14%, while in 2020, they were 3877 ha, or only 5%, with a decrease of more than 200% of all plantations in 30 years. Most of the species are exotic such as: Gmelina

arborea, Tectona grandis, Eucalyptus sp, Azadirchta indica for the purpose of service woods (PIRL 1990). The same phenomenon of deterioration has hit hardwood savannas in the Faya 30 years apart. While in 1990 the wooded savannah alone occupied 40%, in 2020 it was only 1% of the entire forest area. Likewise, the shrub savannah has experienced the same trend. It covered an area of 15,245 ha (19%) and in 2020 it was 5621 ha (7%).

The shrub savannas on bowe have a very remarkable change between these two periods (1990-2020). We can notice that in 1990, it was 7% over an area of 5,714 ha, in 2020, it is 54,619 ha or 72% of all the forest formations of Faya. Here we can safely say that the bowes are enlarging, they are making a spectacular advance. Since bowé is a special form of land degradation, vegetation observed on bowé is poor in species and the life forms of therophytes predominate. It is an apocalyptic trend of land degradation, deterioration of the forest despite a development plan following the concession to a private company (TAM VOYAGE) and despite monitoring mechanisms that are undoubtedly failing. Here, we can note that either the shrub savannas are transformed into shrub on bowe as we can notice it on the rate of the latter in this forest, or it is of the excessive exploitation of the classified forest of Faya by the men. These two scenarios are possible concomitantly. Indeed, the inventories carried out in these forests in a time interval of about 10 years (1996 and 2005) have shown that the area of gallery forests has sharply decreased and that wooded savannas have retreated to give way to savannas (FAO 2012).

The services that the Faya forest offers yesterday and today are the same. These include: lumber, service wood, firewood, non-wood products, hunting, aerated fodder, etc. Everything indicates that this forest is overexploited, hence the constant bitter reduction in the area of woody resources between 1990 and 2020 to 3,832 ha.

Wood energy. The impact of fuelwood consumption on forest formations is enormous and as proof, the supply of the Bamako District alone, which concentrates 12.46% of the total population (EMOP- 2015) in fuelwood for the year 2016 required 1,095,070.33 steres, i.e. a clear cut of 21,901.40 ha 6 of a plant formation of the wooded savannah type. For the year 2017, from January to November, 1,103,121.66 cubic meters of wood were needed, i.e. 22,062.43 ha of the same type of plant formation (DNEF 2016).

Charcoal: At level economic, the forests remain the main source of domestic energy through wood and charcoal used by almost all households in Mali, most without access to traditional (gas and electricity) and alternative energy. The consumption of wood and charcoal is estimated at 459 kg per person per year (FONABES 2017). This makes the exploitation of timber forest products the most important forest economic activity in terms of volume and income. It has generated approximately 1 146 584 211 F.CFA of average income per year from 2014 to 2017 (DNEF 2014, 2017). In reality, these are only quantities under the control of the forestry services, and therefore lower than the actual quantities.

Lumber: It is with it that Malian craftsmanship draws most of the timber for the manufacture of musical instruments, statuettes and other art objects, agricultural tools (hoe handles, pickaxes, dabas, etc.). Lumber requirements are limited to joinery lumber, cabinet lumber, shuttering lumber, and industrial lumber. Timber is still of interest only to the modern construction and furniture sector, its quantitative importance remains very limited.

Logging: The northern part of the Faya forest is characterized by the production of firewood and the southern part tends to be distinguished by a massive production of charcoal. Logging

has become the major source of income for the villages bordering the classified forest of Faya. This exploitation appears as a compensation solution for the loss of income generated by the effect of climate change on agricultural activities (agriculture, breeding and fishing. It was counted 4 years before the concession and the current management plan 10,530 loggers in the 16 villages bordering the classified forest of Faya. The number of operators per product is presented as follows: firewood: 3212; lumber: 43; service wood: 2014; charcoal: 1233 (Report of the National Directorate of Water and Forests 2015).

Fishing: Fishing is practiced by seasonal fishermen, the Bozos and Somonos (ethnic groups known only for fishing) and certain sedentary populations for whom this activity goes beyond the framework of simple subsistence. It is practiced in the Niger River, in the Faya River in times of flooding and in other rivers. It is an informal activity.

Hunting: Although prohibited by the management plan, hunters loyal to their profession are most often the residents of Faya and others who come a little further still in search of rare game. However, the possession of firearms or any other means of cutting plants is prohibited within the perimeter classified in accordance with article 45 of the code.

Non-wood products: It is mainly practiced by women in the classified forest of Faya and the village soils. The main products exploited are: nuts of Vitellaria Paradoxa, fruits of Néré, Adansonia Digitata, and Saba Senegalensis; the stakeholders in this picking sector are the producers of shea butter, intermediaries from urban centers. A good part of the production is reserved for local consumption which, in addition to self-consumption, is marketed, processed or even exported by a good number of economic operators who have specialized in these sectors. The production of products forest non -timber in Mali usually has more than doubled from 2014 to 2017, from 2 357 969 kg to 4 988 753 kilograms, all products combined (DNEF 2014, 2017). This activity of gathering non-timber products is authorized by the development plan in accordance with the right of use of the communities bordering the Faya only. Non-timber products are for many communities, sources of income, especially for the women who will find a real opportunity to promote economic and social. The production level of gum Arabic is estimated at 49,380 kg, or a value of 1,234,500 CFA francs (DNEF 2014, 2017).

Pharmacopeia: The forest is also the main base for the pharmacopoeia in Mali as well as in urban areas than in the middle rural, the eyes of the poor access of a large segment of the population to pharmaceuticals. The volume of medicinal plants collected reached around 61 tons in 2017 (DNEF 2017). Malian populations, especially rural ones, use traditional pharmacopoeia to treat or prevent 50 to 80% of their illnesses.

Beekeeping: It is practiced in the neighboring villages. It is especially important in the villages of Zantiguila, Wodougou and Sidjankoro. This activity has seen renewed interest with GEDEFORE, which supports the women of Faya to engage in other income-generating activities to reduce their dependence in the exploitation of wood forest products. The project comes GEDEFORE as part of the sustainable management of forest reserves (Togola 2019).

Pastoralism: Faya forest is highly coveted by sedentary pastoralists (herds from neighboring villages) as well as transhumant that thus exert very strong pressure on the forest. In natural formations, this pressure is much more evident in the north-eastern parts of the forest. It is also found in the south-eastern part of the forest. The areas concerned are 20,133 ha. These areas are quite frequented by sedentary cattle for reasons linked in large part to its proximity to permanent water sources, especially on the Niger River, which is the main watering place

for cattle during periods of low water (Tessogue & Coulibaly 2021).

Conclusion

This forest classified long before independence, since 1943 in order to constitute a reserve of wood for the supply of Bamako and wooden rails attracts all the lust of the riparian communities numbering 17 villages but also of Bamako (the capital and largest city of Mali, with a 2020 population of 2.71 million) which is located at 40 Km from this forest. Faced with the dependence of communities (rural and urban) on timber, fuel wood, tree bark for traditional therapy, animal husbandry, intensive agriculture, the absence of Other income- generating activities, to large- scale anarchic urbanization and finally to the population explosion, all attempts, all efforts to restore the Faya by politicians have failed. Through the new public-private partnership deal tested several times for its preservation in the name of eco-tourism and participation, without the implementation of a strategy of dependence on forest resources through a strong energy transition, nothing is possible indicates the success of this strategy. The gigantic measure that must be implemented is the fencing of this forest, the endowment of the forest services with modern technological tools such as the drone to facilitate its monitoring and rapid intervention actions, the creation of income-generating activities for neighboring communities, awareness and ecotourism.

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