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Impact of the creation of a plantation of banana serves on the flora of Niagaramadougou in the north of Côte d'Ivoire

Kouassi Kouadio Henri[1*], Kouassi Roland Hervé[2], Kouassi N'dri Jacob[1], N'Guessan Koffi[3]

[1]*Université Jean Lorougnon Guede, UFR Agroforesterie; BP 150 Daloa, Côte d'Ivoire*

[2]*Ecole Normale Supérieure d'Abidjan (Côte d'Ivoire), 08 BP 10 Abidjan 08, Département des Sciences et Technologies, Section Sciences de la Vie et de la Terre, Côte d'Ivoire*

[3]*Université Felix Houphouet Boigny UFR Biosciences, Laboratoire de Botanique 22 Bp 582 Abidjan 22, Côte d'Ivoire*

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Abstract

This work relates to the identification and the evaluation of the negative impacts and positive of the creation of banana plantations serves on the flora of the natural landscape near to the river Bandama, a locality of Niakaramadougou in the north of Côte d'Ivoire. It comprises, the analysis of eco-climatic imbalances related on creation, the exploitation and the end of the creation project of banana serves plantation on the flora of the perimeter of exploitation. Based on floristic inventories, the main aim was to characterize the impacts related to the activities of demolition, and maintenance of plantations of Banana trees on the flora of the localities targeted and to put forward measures of attenuation and/or corrective. The results show that the flora of the study is rich approximately 63 species of which 1 is with particular status. This flora is slightly diversified and its characteristics predict the risks of imbalances biological which can occur with short, average and long run in this locality. The flora knows a gradual degradation related to the former activities of exploitation. Many impacts with which the reduction of the diversity of the exploited woody species, the fragmentation of the forests and the rarefaction of some species in particular, the lianas were identified in this locality. The linked activities with the project have been be potential sources of negative impacts on the flora and have contributed to destroy it to a significant degree if the flora of this locality.

* **Corresponding Author:** Kouassi Kouadio Henri ✉ atoumanikouadiokan@yahoo.fr

Introduction

The current context of sustainable development with its corollaries (fast urbanization, demography increase, land pressure etc.) breaks sometimes the balance within the ecosystems; in particular those which are fragile and which are sometimes the object of overexploitation. Moreover, the natural resources available on planet are born, evolve and become exhausted over the years. In many African countries, in particular in Côte d'Ivoire, the problematic, population growth-availability of the natural resources is deeply posed. Also, the land pressure is felt it in a gradual way. The problem of land rural moreover into frequent, sometimes source of fatal conflicts, is one of the immediate causes of the land pressure. Face to these problems more and more, solutions of durable or integrated spaces and natural resources management are recommended to prevent eco-climatic imbalances. The evaluation of the impacts of the activities undertaken during the creation of the banana serves plantations in the locality of Niakaramadougou is a subsequent phase with the realization of the project in order to put forward palliative measures of the positive impacts and negative on the flora, the environment, fauna and on the whole of the populations living on the perimeter. From the floristic point of view, the perimeters of exploitation belong to the Sudanese field. One meets the dry dense forest there, savanna raised or timbered, the bordering formations of the waterways, marshy formations etc. nowadays, these at one time timbered vegetable formations, are seriously started and are frequently devastated by fire at certain places. One notes also the presence of pieces of food crops (rain rice, corn, yam), and of the pastures and the points of breeding of pets. The problems of the development, with its corollaries (destruction of many components of nature) require the taking into account of the recommendations of many researchers whose activities are directed towards the safeguard of the biodiversity. It is inter alia Kouassi *et al.* (2013), Baker *et al.* (2001), etc. These recommendations aim compensating for or at correcting the damage caused by the man with the environment. Actually, they are the human beings and the animals which are mainly exposed with the consequences of much destruction caused within nature. Over the years, the environment and living environment become increasingly invaluable for the survival of the living beings. Its management must thus from now on integrate realities of the medium of kind to support the life in all its forms.

The present study main objective was to contribute to identify and to evaluate the impacts of the creation project of banana serves plantation on the flora of the aforesaid locality ; that in order to put forward measures of attenuation and/or corrective.

Materials and methods

The area of Niakaramadougou (Fig. 1) belongs to the Sudanese field and the sector sub-Sudanese (Guillaumet and Adjanohoun, 1971). This sector is characterized by a mixture of dry dense forests and wooded savannas. We will not insist on the well-known physiognomical characters of the dry dense forests and of timbered savannas, the floristic species of this sector are characterized by the predominance of the herbaceous ones. Let us recall in addition, the presence of two layers, and the dense afforestations by places. The general aspect of the perimeter shows a zone constantly burned with early and/or late fires. The true wooded vegetable formations are those which border the river Bandama (Fig. 2). The others, regularly subjected to the action of fire are replaced by raised savanna, with underwood almost absent (Fig. 3).

The study of the flora of the vegetations of the site and that of the contiguous vegetations, was based on inventories. During floristic inventories, two methods were combined to minimize the margins of error. It was: the itinerant inventory by the enumeration of the species and the method of the small squares (Gautier and *al.*, 1994) which consists in describing the vegetation on surfaces of approximately 20 m of dimensioned, according to the four cardinal points, with a precise spacing (fig. 4). Thus, the vegetations of the site and those bordering of the Bandama river were inventoried. Specific diversity and the particular status of the species (endangered species, species in

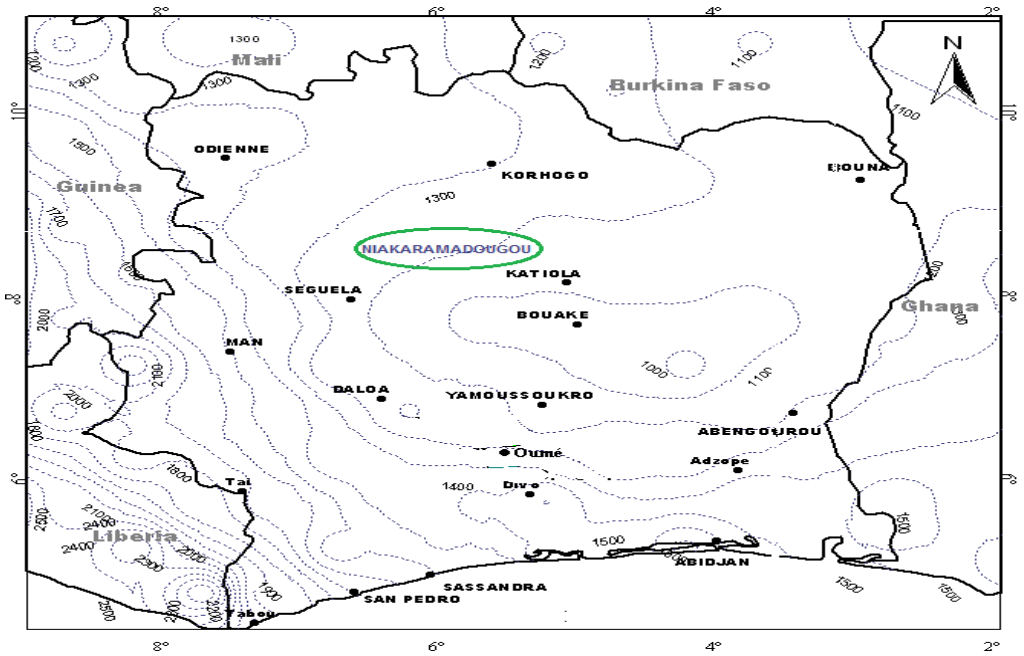

Fig 1. Localization of the study zone (Source: Monnier, 1983)

Site of the study ○

danger, species vulnerable, species at the risk, species endemic,...), were studied.

Two aspects of the vegetation were approached. IT was the typology of the ecosystems and the specific diversity of the flora.

Analysis of the flora

Several indices make it possible to express the diversity of a flora. The index of Shannon-weaver (1948) which we chose for the processing the data of this study is the much used one. It is expressed according to the formula:

H = - pi (Log pi). With, pi = Fr/N,

NR being the full number of inventoried species;

Fr = F (a)/i, With, I = full number of the inventories plots

F (a) = number of appearance of a species during the inventory.

The values evolve of 0 with log (N), N being the full number of inventoried species. Equitability is expressed starting from the index of Shannon. It is expressed as follows:

E = H/log (N) and evolves from 0 to 1

The distribution of the species was given starting

Fig 2. Gallery forest near of the Bandama river

Fig 3. Raised savanna subjected to fire

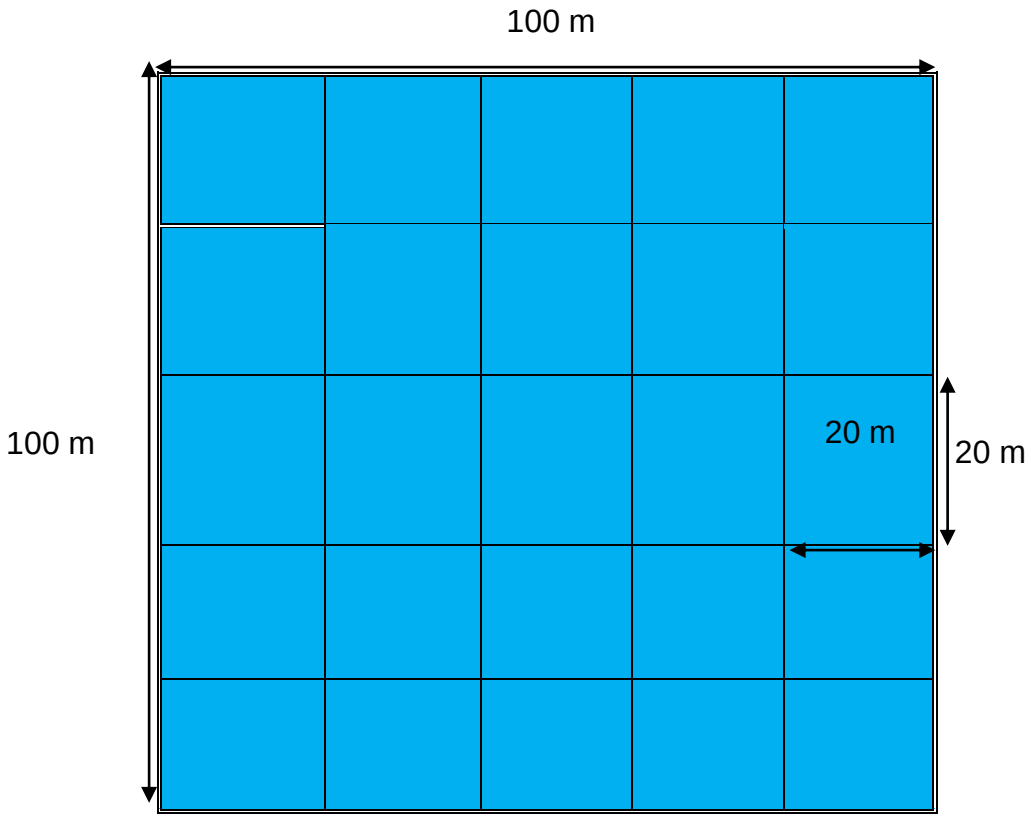

Fig 4. Configuration of the plots of the flora inventories

■ Plot of the flora inventories

from the absolute frequencies (Fa), the relative frequencies (Fr) and the index of Shannon. In addition, the floristic Homogeneity of the mediums was evaluated starting from Equitability.

Results

Wealth and specific diversity of the zone

The calculations based on the estimates of the Indices of diversity (H) and Equitabilité of Pielou (E) of each medium, made it possible to obtain the characteristics below (Table 1).

With the analysis, the flora of the inventoried zone is rich approximately 63 species (Table 1). In addition, the value of the index of diversity calculated is: H= 4.00317052 bits, with log (N) = 6. The equitability of calculated Pielou is about: E = 0.66.

Species with particular status

One (1) species (*Milicia regia*, Fig. 5) with particular status was met in this flora. This taxon is classified vulnerable on list UICN (2009).

However of food numerous species, medicinal and/or of works exist in the zone. they are inter alia: Vittelaria paradoxa (Shea tree, Fig. 6) in dense afforestation, Parkia biglobosa (Néré, Fig. 7) strongly represented, Saba thomsonii (buissonnant) etc**.**

Identification and evaluation of impact

The evolution of the curves (Fig. 8) shows the variation of the parameters characteristic of the impacts related to the phases of exploration, the exploitation and the closing of the project on the vegetation and the flora of the zones concerned with the exploitation and on the contiguous vegetable formations. With the analysis, the maximum intensity (3) of the impacts was obtained with, the destruction and the anthropisation of the vegetable formations (DAA). The minimal values (1) were obtained with the layonnage and/or the creation of lines (LAY) for the planting of the banana trees. On the other hand, the evolution of the impacts extent shows that the maximum values (3) were obtained with the layonnage (LAY), the taking away in flora (PDF), the

Table 1. list of let us tax inventoried on the site and the landscapes surrounding, with Indices of biological diversity.

N°	Species	Family	Fa	Fr	Pi	H
2	*Abrus precatorus*	Caesalpiniaceae	2	0,66666667	0,01058201	0,06944172
1	*Acacia pennata*	Mimosaceae	1	0,33333333	0,00529101	0,04001186
3	*Acanthospermum hispidum*	Asteraceae	1	0,33333333	0,00529101	0,04001186
4	*Adansonia digitata*	Bombacaceae	3	1	0,01587302	0,09487746
5	*Adenia cissampeloides*	Curcubitaceae	1	0,33333333	0,00529101	0,04001186
6	*Affamomum* sp.	Zigiberaceae	2	0,66666667	0,01058201	0,06944172
7	*Ageratum conizoides*	Asteraceae	1	0,33333333	0,00529101	0,04001186
8	*Albizia coriaria*	Mimosaceae	3	1	0,01587302	0,09487746
9	*Alchornea cordifolia*	Euphorbiaceae	1	0,33333333	0,00529101	0,04001186
10	*Alternanthera* sp	Amaranthaceae	1	0,33333333	0,00529101	0,04001186
12	*Anacardium occidentale*	Anacardiaceae	3	1	0,01587302	0,09487746
11	*Annona senegalensis*	Annonaceae	2	0,66666667	0,01058201	0,06944172
13	*Anthocleista nobilis*	Loganiaceae	2	0,66666667	0,01058201	0,06944172
14	*Antiaris toxicaria*	Moraceae	3	1	0,01587302	0,09487746
15	*Blighia sapida*	Sapindaceae	3	1	0,01587302	0,09487746
16	*Bombax costatum*	Bombacaceae	2	0,66666667	0,01058201	0,06944172
17	*Cassia hirsuta*	Caesalpiniaceae	2	0,66666667	0,01058201	0,06944172
18	*Cassia siamea*	Caesalpiniaceae	2	0,66666667	0,01058201	0,06944172
19	*Ceiba pentandra*	Bombacaceae	2	0,66666667	0,01058201	0,06944172
20	*Chromolaena odorata*	Astercaceae	3	1	0,01587302	0,09487746
21	*Cissus* sp.	Vitaceae	2	0,66666667	0,01058201	0,06944172
22	*Cola gigantea*	Sterculiaceae	2	0,66666667	0,01058201	0,06944172
25	*Croton hirtus*	Euphorbiaceae	1	0,33333333	0,00529101	0,04001186
26	*Desmodium adscendens*	Arecaceae	1	0,33333333	0,00529101	0,04001186
23	*Dioscorea* sp.	Dioscoreacea	2	0,66666667	0,01058201	0,06944172
24	*Dissotis* sp	Melastomataceae	1	0,33333333	0,00529101	0,04001186
27	*Erigeron floribundus*	Asteraceae	1	0,33333333	0,00529101	0,04001186
28	*Eucaluptis sp*	Myrtaceae	1	0,33333333	0,00529101	0,04001186
29	*Ficus exasperata*	Moraceae	2	0,66666667	0,01058201	0,06944172
30	*Ficus sp*	Moraceae	2	0,66666667	0,01058201	0,06944172
31	*Ficus sur*	Moraceae	2	0,66666667	0,01058201	0,06944172
32	*Imperata cylindrica*	Poaceae	3	1	0,01587302	0,09487746
33	*Lophira lanceolata*	Sapotaceae	3	1	0,01587302	0,09487746
34	*Mangifera indica*	Anacardiaceae	3	1	0,01587302	0,09487746
35	*Margaritaria discoidea*	Euphorbiaceae	2	0,66666667	0,01058201	0,06944172
36	*Mariscus cylindristachus*	Cyperaceae	1	0,33333333	0,00529101	0,04001186
37	*Mezoneuron bentamianum*	Caesalpiniaceae	2	0,66666667	0,01058201	0,06944172
38	*Milicia regia*	Moraceae	1	0,33333333	0,00529101	0,04001186
39	*Mucuna pruriens*	Fabaceae	1	0,33333333	0,00529101	0,04001186
40	*Nauclea latifilia*	Rubiaceae	2	0,66666667	0,01058201	0,06944172
41	*Nelsonia canescens*	Acanthaceae	2	0,66666667	0,01058201	0,06944172
42	*Nephrolepis biserrata*	Davalliaceae	1	0,33333333	0,00529101	0,04001186
44	*Olira latifolia*	Poaceae	1	0,33333333	0,00529101	0,04001186
45	*Panicum maximum*	Poaceae	2	0,66666667	0,01058201	0,06944172
46	*Parkiabiglobosa*	Mimosaceae	1	0,33333333	0,00529101	0,04001186
43	*Paullinia pinnata*	Sapindaceae	1	0,33333333	0,00529101	0,04001186
47	*Penisetum* sp.	Poaceae	3	1	0,01587302	0,09487746
48	*Persea americana*	Lauraceae	1	0,33333333	0,00529101	0,04001186
49	*Phyllanthus* sp.	Euphorbiaceae	2	0,66666667	0,01058201	0,06944172
50	*Pilostigma thoningii*	Myrtaceae	3	1	0,01587302	0,09487746
51	*Psydium goyava*	Myrtaceae	2	0,66666667	0,01058201	0,06944172
53	*Pueraria phaseoloïdes*	Euphorbiaceae	1	0,33333333	0,00529101	0,04001186
52	*Saba thompsonii*	Apocynaceae	1	0,33333333	0,00529101	0,04001186
54	*Secamone afzelii*	Asclepiadeceae	1	0,33333333	0,00529101	0,04001186
55	*Sida acuta*	Malvaceae	2	0,66666667	0,01058201	0,06944172
56	*Solanum turvum*	Solanaceae	2	0,66666667	0,01058201	0,06944172
57	*Spondias monbin*	Anacardiaceae	2	0,66666667	0,01058201	0,06944172
58	*Talinum triangulare*	Portulacaceae	1	0,33333333	0,00529101	0,04001186
59	*Terminalia glauscesens*	Combretaceae	2	0,66666667	0,01058201	0,06944172
61	*Tridax procumbens*	Asteraceae	2	0,66666667	0,01058201	0,06944172
60	*Uvaria afzelii*	Annonaceae	3	1	0,01587302	0,09487746
62	*Vernonia conferta*	Asteraceae	2	0,66666667	0,01058201	0,06944172
63	*Vittellaria paradoxa*	Sapotaceae	2	0,66666667	0,01058201	0,06944172
						4,00317052

Fig 5. *Milicia regia* (threatened species)

destruction and the anthropisation of the vegetable formations (DAA). The smallest extent (1) was obtained, with the management (AM) of the flora of site during and after the project. In addition, the long impacts duration (3) were obtained, with the taking away in flora (PDF), the destruction of the species and anthropisation (DAA) of the flora of the vegetable formations present. The short duration of the impacts (1) were obtained, with the layonnage (LAY) and the management of the vegetable formations of the site and the surroundings.

The curve of the evolution of the average impacts of the linked activities to the project on the flora (Fig. 9) shows the high average impacts, with the destruction and the anthropisation of the vegetable formations (3). The taking away in the flora (3) the management of the site flora (1) and the layonnage (1), have generated weak impacts (Fig. 10, A and B).

Fig 7. *Parkia biglobosa* (medicinal and food species)

Fig 6. *Vitellaria paradoxa* (medicinal and food species)

Discussion

Evolution of the indices of diversity

The analysis of the flora shows that it is fairly diversified (H= 4.003 bits) and homogeneous (E = 0.66). The various activities undertaken in this zone were ecological sources of disturbances, and those can be regarded as major disturbances on floristic diversity medium. On the other hand, the high index of equitability (E = 0.66) shows that the medium is floristically homogeneous and stable in spite of the many factors of destruction of the flora.

Environmental impacts

The environmental impacts were observed during the phases of exploration, of exploitation, like with the closing of the project. During the phase of exploration, the layonne for the plantation of the banana trees with its corollaries (demolition of the trees, and clearing of certain ligneous family), involved the destruction of some species of the flora at certain places of the site of the project. Some specimens of trees, shrubs, lianas and herbaceous were destroyed. The openings carried out in the flora contributed to increase to a significant degree the luminosity on the ground in these closed formations exposing thus the species of the underwoods very sensitive to excesses of light. Epiphytes are found on the ground following the destruction of the large trees. All these movements have involved an ecological imbalance within the vegetable formations concerned. During the production run, the extent of the disturbances was accentuated. The destruction became more important on the exploitation sites

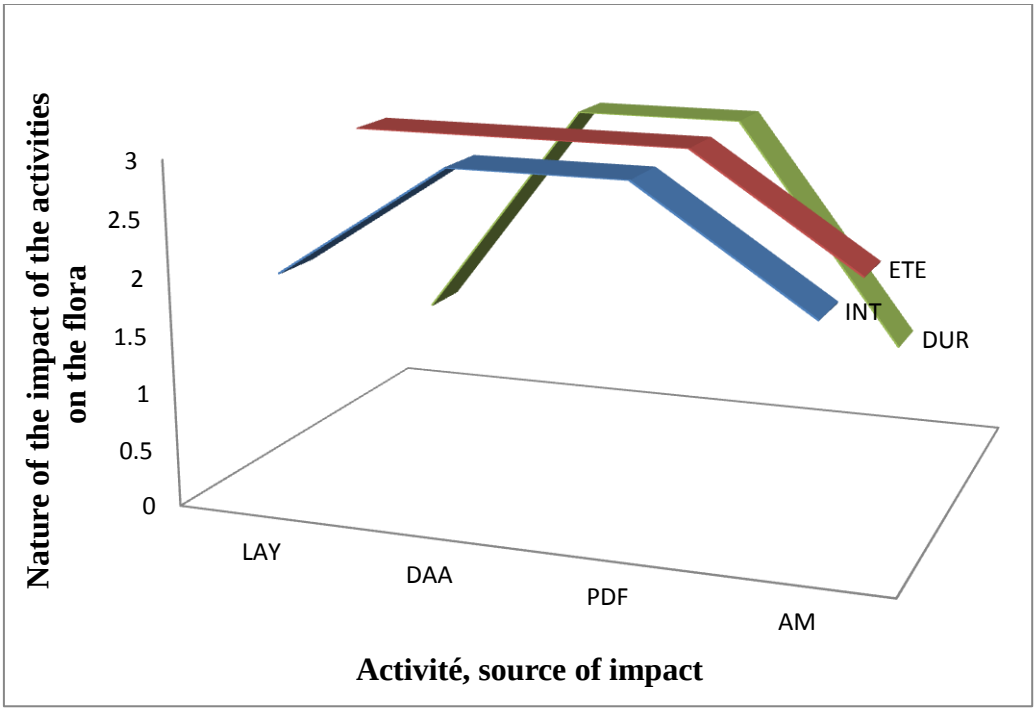

Fig 8. Characterization of the parameters related to impact according to the sources activities of impact in the course of time, with (LAY = layonnage; DAA = destruction and anthropisation of the flora; Pdf = taking away and destruction of the flora; AM = Installation of the site; Imp = importance, Hard = Lasted; SUMMER = wide; INT = Intensity).

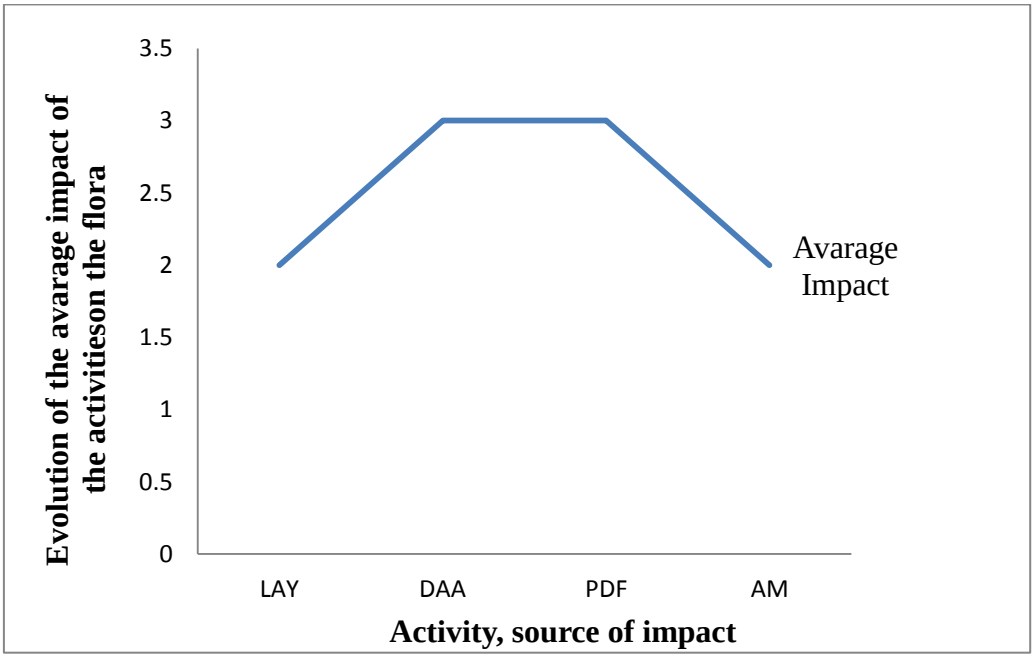

Fig 9. Evolution of the average impacts according to the sources activities of impacts in the course of time, with (LAY = layonnage ; DAA = destruction and anthropisation of the flora; PDF = taking away and destruction of the flora; AM = management of the site flora.

A

B

Fig 10. Destruction and slicing of the trees for the layonnage

because the permanent presence of staff on the site as well as the regular maintenance of the site (sometimes manual, sometimes chemical) were sources of disturbances major in the flora of the site. These disturbances were sometimes opposed the natural regeneration of the plant species. With the closing of the project, the original vegetation was strongly started. The aspect of the vegetation was modified. Species like *Terminalia glauscesens* and *Khaya* sp., initially present, are very threatened in the savannas today. The rich and diversified primary vegetation in cash disappeared and left on the spot new vegetation mainly made up the herbaceous ones and of some woody species. The surrounding formations have been so exposed to the human pressure that they have been more degraded. On the whole, the zone lost its vegetable formations rich and diversified, and the biological diversity has regressed considerably under the pressures of anthropic origins. The characterization and the evaluation of the impacts on the flora of the site are supposed to bring a thorough lighting on the nature (intensity, extended and lasted) of the impacts. Thus, the intense impacts were caused by the regular destruction and cuts in the flora of the site, the destruction of the woody species and the anthropisation of the front natural environment, during and at the end of the project. The regular talks of the site which comprises destructions and the clearing of certain woody species have affected intensely all the components of the sometimes compromising flora, its regeneration like announced by Mitja (1993) in forest zone and Yossi (1996) in zone of savanna. On the other hand the intensities of impacts related on the layonnage and the installation of the site at the end of the project were low probably because of light punctures made in the flora during these activities. Indeed, the layonnages carried out are tracks of 1.5 m width approximately. The intensity of the impacts caused by flora management is low because afforestations carried out have been quantitatively weak and especially of average quality. Moreover, the forest petrols used have a slow growth (Alexandre, 1989, Kouamé, 1998, Ettien, 2005 and Kouadio, 2007) and are often exposed to the blow of the climatic variations. The duration of the impacts related on the taking away in the flora and the anthropisation of the contiguous vegetable formations of the site is long. Because these levy in the flora were carried out front, during and at the end of the project, in the same way, these levy in the flora continued at the end of the project because of the land pressure. On the other hand, the layonnage was a temporary activity.

Main sources of impact

The main sources of impact are the anthropisation of the vegetable formations and the taking away regular in the flora for utility needs. Indeed, these activities are at the same time intense long and wide. Also, many levies in the flora have an additive effect on that of the anthropisation of the vegetable formations. In addition the extent of the activities of layonnage was a source of impact not less important than that-ci-top quoted.

Existance of some woody species

The existence of some woody species is partly related to the fact that during approximately about ten years, the shea and *Parkia biglobosa* trees have been the

object of protection. The sacralization is sometimes the form of protection used to preserve these species against any form of destruction. In spite of these measures of precaution, the dense afforestations and the small forests are constantly burned for the installation of the cultures and for hunting. However, this practice contributes to the elimination of the ligneous family and the proliferation of the herbaceous. The most resistant ligneous family undergoes aggressions whose impacts result in the shape and the rytidum of the plants. Among the identified ecosystems, appear: the waste lands with *Chromolaena odorata*, the afforestations with *Vittelaria paradoxa*, the dense afforestations, the galleries forests which border the Bandama river.

Conclusion

The vegetation of the exploited site was beforehand in constant dynamics; because disturbed by permanent fires early and late. It had a discontinuity by place. However, the vegetations which border the Bandama river remained preserved relatively better compared to the other parts of the exploited perimeter. The flora of the zone of the project is rich approximately 63 species and fairly diversified (H = 4.003 bits). Strongly anthropized, because of many sources activities of impact, the site still comprise relics of rich and luxuriant forest galleries. It presents a floristic homogeneity (E = 0.66). The flora of these forest relics is diversified and comprises a species with particular status (*Milicia regia*). This one was strongly disturbed by the creation of the banana desserts plantation. However, the application of certain measurements of attenuation of impacts has contributed to attenuate certain impacts. The management of the vegetable formations with the technical routes such as the afforestations containing arborescent leguminous plants and the integral protection of certain vegetable formations will be able in the medium term to contribute to reduce the risks of eco-climatic imbalances.

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