UNDER PEER REVIEW

Impact of the layout of a line of high voltage (HTA) on the flora of the locality of Agboville in the South-east of the Côte d'Ivoire

Abstract

The aim was to identify and evaluate the impacts related to the realization of the project in order to put forward measures of attenuation and/or corrective.

Study design: The vegetations were delimited into small squares plots and/or pieces. These small squares plots were distributed in all the flora of the study

Place and duration of study: This work relates to the identification and the evaluation of the negative impacts of the layout of the line of high voltage on the flora and was conducted in Agboville, a locality in the south of Côte d'Ivoire during July to September 2013

Methodology: The itinerant inventory and the method of "quadrat" were associated during floristic inventories.

The results showed that the flora is rich approximately 89 species. It little is however, diversified and rather homogeneous. The destruction of the woody flora (DFL), the destruction of the floristic potential of regeneration (DPE) and the evolutions of floristic diversity (EDF) and the aspect of vegetation (EPV) were the major average impacts during the phases of prospection of exploitation and at the end of the project. These impacts caused with all the phases of the project contributed to weaken the flora of the site the exhibitor to the risks of the biological, ecological and climatic imbalances.

Keywords: Impact, flora, Agboville, High voltage, line, traced

I-Introduction

The natural resources available on planet become exhausted over the years under the weight of human activities. The recrudescence of the sources activities of impact is partly related to the growth of the demography of the many countries throughout the world. In many African countries, in particular, those whose economy is based on the exploitation of natural resources, the preservation of these resources and biodiversity is from now on a priority. In addition, the problem of rural land, sometimes source of fatal conflicts, is one of the emergent causes of the destruction of the biodiversity.

The leading causes of this evolutionary destruction are inter alia, inherent agriculture, forestry holding, the bush fires etc During these last years, of the additional causes in particular, the fast urbanization, with its corollaries: the real estate transactions, constructions of great production units and transformation, mechanized creations of industrial plantations (Kouassi *et al*. [1]) became sources activities of impacts. In addition, in many African countries, the pressure exerted on the natural resources believes inordinately (Kouassi *et al* [2]). Face to these problems more and more, measurements of durable or integrated management of the natural resources are recommended to prevent possible biological imbalances. One of measurements sedentary and protective of the environment before any source activity of deep disturbance of the ecosystems is the identification, the evaluation and the proposal and the correction of environmental impact. Indeed, the destruction of many components of nature requires the taking into account of corrective measures or compensation aiming at minimizing the damage caused (impact of the projects) with the environment. Actually, they are the human beings and the animals which pay the full price of the consequences of much destruction caused within nature. This is why, any activity, source of impacts must be made in a reasoned way, to be in adequacy with the dynamics of the

UNDER PEER REVIEW

natural resources. The management of the environment must thus from now on integrate realities of the medium of kind to support the life in all its forms. For this purpose, this report highlights and evaluates primarily the impacts of the opening of the layout of the line of high voltage (HTA) on the flora of the ecosystems crossed by the layout.

2-Materials and Methods

From the floristic point of view, the site (Fig.1) of the project belongs to the Guinean field. In this locality, one notes the presence of many hydromorphic vegetable formations closed by place. This forest was made of three principal layers (Reizer, [3]; Guillaumet and Adjanohoun, [4]). In addition to the hydromorphic formations, one meets the wet dense forest there sempervirente, the marshy forests of the enclaves, the raphiales, etc. The layer of the large trees was dominated by specimens of 50 with 60 m high and was characterized by woody species such as the Mahogany tree of Bassam (*Khaya ivoirensis*), Azobé (*Lophira alata*) and Niangon (*Terrieta utilis*). The hydromorphic formations were made up of marshy forests and mangrove swamps. This wide forest is today very threatened in Ivory Coast, since it comprises several exploited species (Aubréville, [5]).

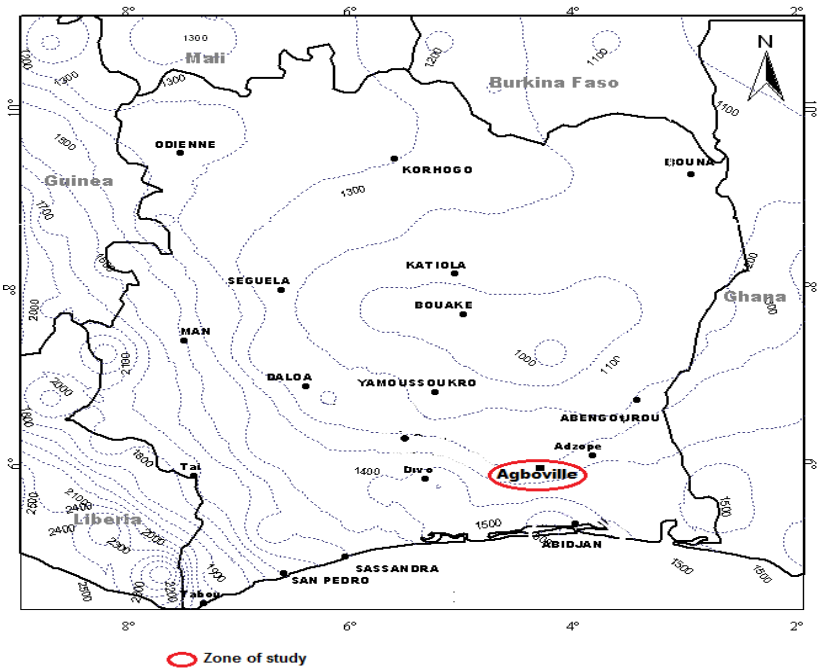


Fig. 1: Localization of the zone of study

2-1- Floristic inventory

The flora of the site and that of the ecosystems contiguous (zone cultivated, marshy zone, plantations of cacao-trees) were inventoried. Two methods were associated to conduct this study. They were: the itinerant inventory of the flora by the enumeration of the species on layouts and the method of the small squares (Gautier *et al.*, 1994) which consists in describing the vegetation (enumeration and classification of the species) on surfaces of approximately 20 m on side (Fig. 2) according to the four cardinal points, with a precise spacing. With this intention, 10 small squares of approximately 400 m² of surface were inventoried in each type of vegetation crossed by the line of high voltage. They are approximately 5 types of vegetations which were crossed by the layout of the line.

UNDER PEER REVIEW

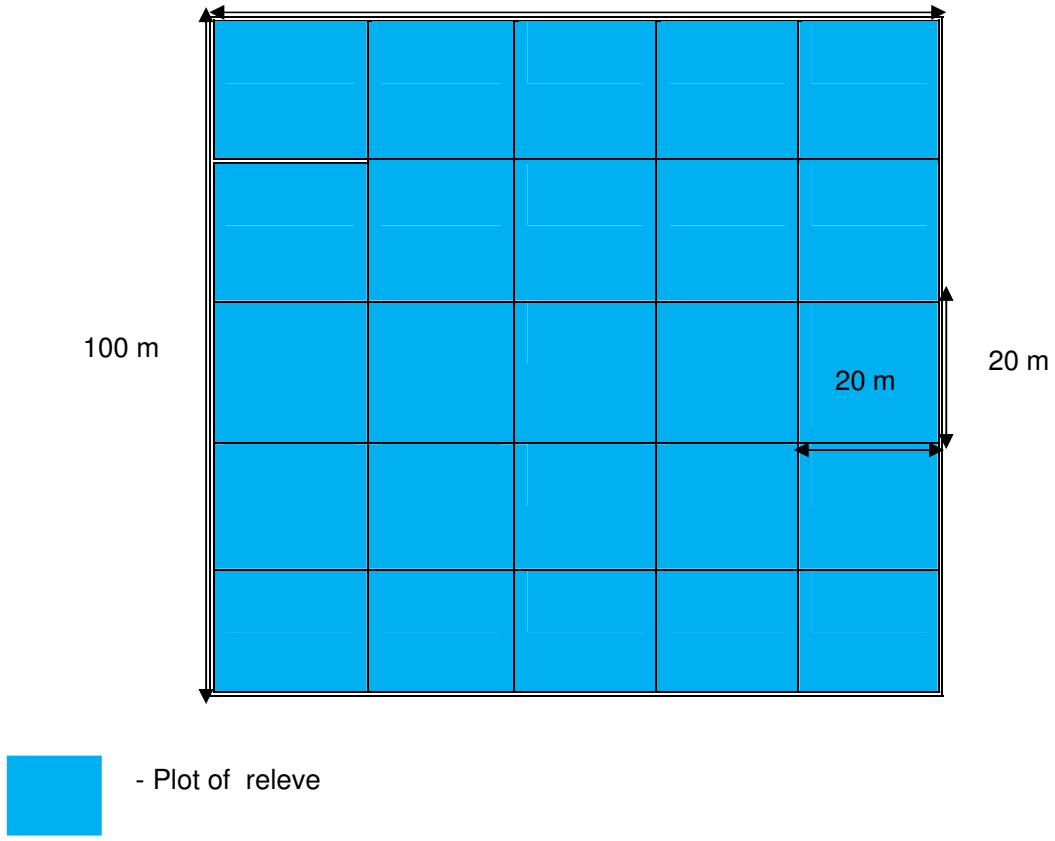


Fig. 2: Configuration of the plot of inventory

2-2- Analysis of the flora

One makes use of several indices to analyze floristic diversity, the index of SHANNON and WEAVER [6] which we used during this analysis, has as formula: $H = -\sum Pi(Log(2)Pi)$ With, pi: floristic contribution or relative frequency. This index varies from 0 (1 only species) with Log of NR, when all the species have same abundance. To this index the Equitablity of pielou is associated (E). this equitability is a relationship between floristic diversity observed and maximum theoretical diversity. The equitability of pielou is written: E= H/log (N), With, N : total staff complement of the studied station. The equitability varies from 0 to 1. It tends towards 0 when the near total of species is concentrated on only one species and is equal to 1 when all the species have same abundance.

3-Results

3-1- Actual statute of the vegetation

The vegetations of the site at one time luxuriant, are seriously started and almost disappeared to the profit of the fragments of fallow (Fig. 3 A and B) completely in waste lands. The plots of culture and marshy zones were find in addition (Fig. 4 and 5). However, there exists by places of the well preserved vegetations.

UNDER PEER REVIEW

A B

Fig. 3: Fallow in Agboville (near petit Yapo)

Fig. 4: Plot of Cassava (*Manihot esculenta*) Fig. 5: Marshy zone with *Bambousa vulgaris*

3-2- Wealth and specific diversity of the sector of Agboville

The floristic wealth and diversity estimated starting from the frequencies absolute and relative of the inventoried species gave the characteristics below (Tableau1). Thus, the flora of the site is rich approximately 81 species. The values of H and E estimated are respectively, H = 3.6; E = 0.57 (Table 1).

Table 1: Estimate of the values of the indices of diversity (H) and homogeneity (E)

N°	Species	Family	Fa	Fr	Pi	H
1	*Abrus precatorius*	Fabaceae	1	0,33333333	0,00411523	0,0326124
2	*Adenia cissampeloides*	Passifloraceae	3	1	0,01234568	0,07826975
3	*Ageratum conyzoides*	Asteraceae	2	0,66666667	0,00823045	0,05699434
4	*Albizia adianthifolia*	Mimosaceae	3	1	0,01234568	0,07826975
5	*Albizia zygia*	Mimosaceae	3	1	0,01234568	0,07826975
6	*Alchornea cordifolia*	Euphorbiaceae	3	1	0,01234568	0,07826975
7	*Alstonia boonei*	Apocynaceae	1	0,33333333	0,00411523	0,0326124
8	*Ananas comosus*	Bromeliaceae	1	0,33333333	0,00411523	0,0326124
9	*Anthocleista djalonensis*	Loganiaceae	1	0,33333333	0,00411523	0,0326124
10	*Antiaris toxicaria subsp africana*	Moraceae	1	0,33333333	0,00411523	0,0326124
11	*Antrocaryon micraster*	Anacardiaceae	2	0,66666667	0,00823045	0,05699434
12	*Aspilia africana*	Asteraceae	1	0,33333333	0,00411523	0,0326124

UNDER PEER REVIEW

13	*Baphia nitida*	Fabaceae	1	0,33333333	0,00411523	0,0326124
14	*Blighia sapida*	Sapindaceae	1	0,33333333	0,00411523	0,0326124
15	*Carica papaya*	Caricaceae	1	0,33333333	0,00411523	0,0326124
16	*Cassia hirsuta*	Caesalpiniaceae	1	0,33333333	0,00411523	0,0326124
17	*Cassia siamea*	Caesalpiniaceae	3	1	0,01234568	0,07826975
18	*Cecropia peltata*	Cecropiaceae	2	0,66666667	0,00823045	0,05699434
19	*Ceiba pentandra*	Bombacaceae	2	0,66666667	0,00823045	0,05699434
20	*Centrosema pubescens*	Fabaceae	2	0,66666667	0,00823045	0,05699434
21	*Chromolaena odorata*	Asteraceae	3	1	0,01234568	0,07826975
22	*Cissus aralioides*	Vitaceae	2	0,66666667	0,00823045	0,05699434
23	*Cnestis ferruginea*	Connaraceae	2	0,66666667	0,00823045	0,05699434
24	*Combretum zenkeri*	Combretaceae	2	0,66666667	0,00823045	0,05699434
25	*Cordia platythyrsa*	Boraginaceae	1	0,33333333	0,00411523	0,0326124
26	*Croton hirtus*	Euphorbiaceae	1	0,33333333	0,00411523	0,0326124
27	*Cyperus sp.*	Cyperaceae	1	0,33333333	0,00411523	0,0326124
28	*Desmodium adscendens*	Fabaceae	1	0,33333333	0,00411523	0,0326124
29	*Delonix regia*	Caesalpiniaceae	2	0,66666667	0,00823045	0,05699434
30	*Dioscorea smilacifolia*	Dioscoreaceae	2	0,66666667	0,00823045	0,05699434
31	*Dissotis rotundifolia*	Melastomataceae	1	0,33333333	0,00411523	0,0326124
32	*Elaeis guineensis*	Arecaceae	2	0,66666667	0,00823045	0,05699434
33	*Entandrophragma angolense*	Meliaceae	1	0,33333333	0,00411523	0,0326124
34	*Erigeron floribundus*	Asteraceae	2	0,66666667	0,00823045	0,05699434
35	*Ficus exasperata*	Moraceae	1	0,33333333	0,00411523	0,0326124
36	*Ficus sur*	Moraceae	1	0,33333333	0,00411523	0,0326124
37	*Hevea brasiliensis*	Euphorbiaceae	1	0,33333333	0,00411523	0,0326124
38	*Hoslundia opposita*	Labiatae	1	0,33333333	0,00411523	0,0326124
39	*Ipomoea sp*	Convolvulaceae	1	0,33333333	0,00411523	0,0326124
40	*Lantana camara*	Verbenaceae	1	0,33333333	0,00411523	0,0326124
41	*Leucaena sp*	Mimosaceae	1	0,33333333	0,00411523	0,0326124
42	*Mallotus opositifolius*	Euphorbiaceae	2	0,66666667	0,00823045	0,05699434
43	*Manihot esculenta*	Euphorbiaceae	2	0,66666667	0,00823045	0,05699434
44	*Manniophyton fulvum*	Euphorbiaceae	2	0,66666667	0,00823045	0,05699434
45	*Mareya micrantha*	Euphorbiaceae	1	0,33333333	0,00411523	0,0326124
46	*Margaritaria discoidea*	Euphorbiaceae	1	0,33333333	0,00411523	0,0326124
47	*Mezoneuron benthamianum*	Caesalpiniaceae	2	0,66666667	0,00823045	0,05699434
48	*Milicia excelsa*	Moraceae	1	0,33333333	0,00411523	0,0326124
49	*Millettia zechiana*	Fabaceae	2	0,66666667	0,00823045	0,05699434
50	*Momordica charantia*	Cucurbitaceae	1	0,33333333	0,00411523	0,0326124
51	*Morinda lucida*	Rubiaceae	1	0,33333333	0,00411523	0,0326124
52	*Motandra guineensis*	Apocynaceae	1	0,33333333	0,00411523	0,0326124
53	*Musa paradisiaca*	Musaceae	1	0,33333333	0,00411523	0,0326124
54	*Musanga cecropiodes*	Moraceae	2	0,66666667	0,00823045	0,05699434
55	*Myrianthus libericus*	Moraceae	1	0,33333333	0,00411523	0,0326124
56	*Nauclea latifolia*	Rubiaceae	1	0,33333333	0,00411523	0,0326124

UNDER PEER REVIEW

57	*Nelsonia canescens*	Acanthaceae	1	0,33333333	0,00411523	0,0326124
58	*Panicum maximum*	Poaceae	1	0,33333333	0,00411523	0,0326124
59	*Passiflora foetida*	Passifloraceae	1	0,33333333	0,00411523	0,0326124
60	*Paullinia pinnata*	Sapindaceae	2	0,66666667	0,00823045	0,05699434
61	*Phyllanthus amarus*	Euphorbiaceae	1	0,33333333	0,00411523	0,0326124
62	*Phyllanthus muellerianus*	Euphorbiaceae	1	0,33333333	0,00411523	0,0326124
63	*Phyllanthus sp.*	Euphorbiaceae	2	0,66666667	0,00823045	0,05699434
64	*Piptadeniastrum africanum*	Mimosaceae	1	0,33333333	0,00411523	0,0326124
65	*Pouzolzia guineensis*	Urticaceae	1	0,33333333	0,00411523	0,0326124
66	*Psidium guajava*	Rutaceae	1	0,33333333	0,00411523	0,0326124
67	*Pueraria phaseloides*	Euphorbiaceae	2	0,66666667	0,00823045	0,05699434
68	*Pycnanthus angolensis*	Myristicaceae	3	1	0,01234568	0,07826975
69	*Raphia hookeri*	Arecaeae	1	0,33333333	0,00411523	0,0326124
70	*Rauvolfia vomitoria*	Apocynaceae	2	0,66666667	0,00823045	0,05699434
71	*Ricinodendron heudelotii*	Euphorbiaceae	2	0,66666667	0,00823045	0,05699434
72	*Sida acuta*	Malvaceae	1	0,33333333	0,00411523	0,0326124
73	*Secamona afzelii*	Asclepiadaceae	1	0,33333333	0,00411523	0,0326124
74	*Solanum erianthum*	Solanaceae	1	0,33333333	0,00411523	0,0326124
75	*Solanum turvum*	Solanaceae	1	0,33333333	0,00411523	0,0326124
76	*Sterculia tragacantha*	Sterculiaceae	2	0,66666667	0,00823045	0,05699434
77	*Tabernaemontana crassa*	Apocynaceae	2	0,66666667	0,00823045	0,05699434
78	*Tragia benthamii*	Euphorbiaceae	1	0,33333333	0,00411523	0,0326124
79	*Trema orientalis*	Ulmaceae	1	0,33333333	0,00411523	0,0326124
80	*Triplochiton scleroxylon*	Euphorbiaceae	2	0,66666667	0,00823045	0,05699434
81	*Xanthosoma maffama*	Araceae	1	0,33333333	0,00411523	0,0326124
					I =	3,59513622
					E =	0,5670696

Five (5) species with particular status were inventoried in this flora (Table 2). Among these species, some are vulnerable or at the risk, others still are in danger because of their intense uses.

Table II: list of the species with particular status met in the sector of Agboville

N°	Species	Family	Statut
1	*Antrocaryon micraster*	Anacardiaceae	vulnarable (UICN, 2009)
2	*Cordia platythyrsa*	Boraginaceae	vulnarable (UICN, 2009)
3	*Entandrophragma angolense*	Meliaceae	vulnarable (UICN, 2009)
4	*Milicia excelsa*	Moraceae	vulnarable (UICN, 2009)
5	*Triplochiton scleroxylon*	Sterculiaceae	at the risk (UICN, 2009)

3-3- Identification, analyzes and evaluation of the impacts related to the project

3-3-1 phase of prospection and construction

UNDER PEER REVIEW

The evolution of the curves (Fig. 6) shows the variation of the impacts related to the phase of prospection on the flora and the vegetation of the line and on that of the contiguous vegetable formations. Thus, the destruction of the woody flora (DFL) was intense (3), extended (3) and from long life (3). On the other hand it was fairly important (2). The duration and the extent of the destruction of the potential of regeneration of flora (DPE) were average (2). But it was slightly intense (1) and slightly important (1). The ecological disturbances (EP) caused by the activities were fairly intense and fairly (2), important and fairly wide (2). They were minor (1) and of short time (1).

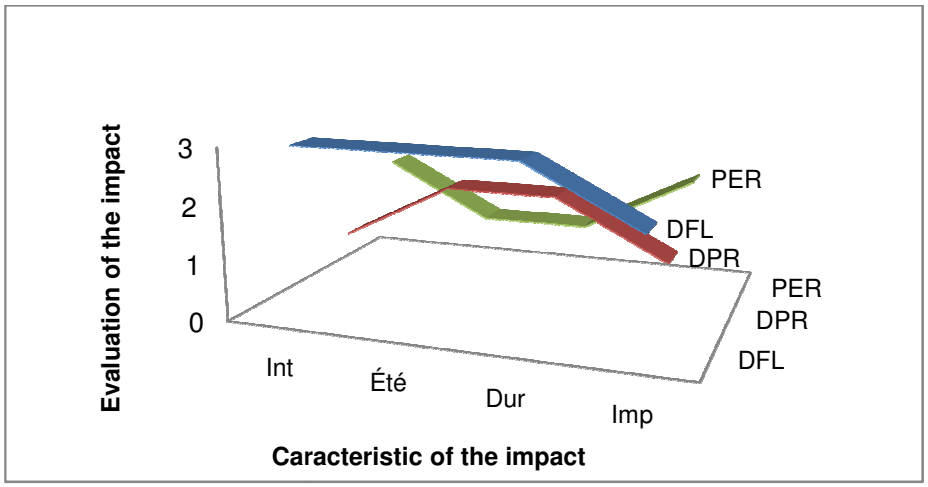


Fig. 6 : Evolution of the impacts related to the phase of prospection with, Int = intensity, Ete = wide; Dur = duration; Imp = importance; DEV. = destruction of the plant species; DPR = destruction of the potential of regeneration; Ecological EP = disturbance

The evolution of the average impacts on the flora during this phase (Fig. 7), watch that destruction of the woody flora (DFL) at summer more accentuated (2.75). The ecological disturbance (EP), and the destruction of the potential of regeneration (EPD) were fairly high (1.5).

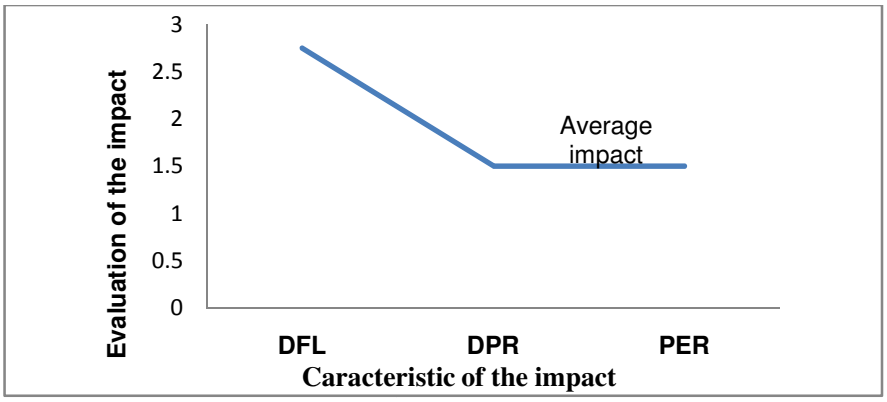


Fig. 7: Evolution of the average impacts related to the phase of prospection and construction, with; DFL = Destruction of the species of the woody flora; DPR = destruction of the potential of regeneration; PER = ecological disturbance

2-3-2- Phase of exploitation

UNDER PEER REVIEW

The evolution of the curves (Fig. 8) shows the variation of the impacts related to the phase of the exploitation on the vegetation, the flora of the site and on that of the contiguous vegetable formations. During this phase, destruction of the woody flora (DFL) and destruction of the potential of regeneration (DPR) was very intense (3), very long (3) and important (3). On the other hand they were fairly wide. The herbaceous proliferation was intense (3) and long (3). It was fairly wide (2) and average importance (2).

The evolution of the average impacts on the flora during this phase (Fig.9), watch that the destruction of the woody flora (DFL) and the destruction of the potential of regeneration (DPR) were higher (2.75) with this phase. The proliferation of herbaceous was less intense (2.50).

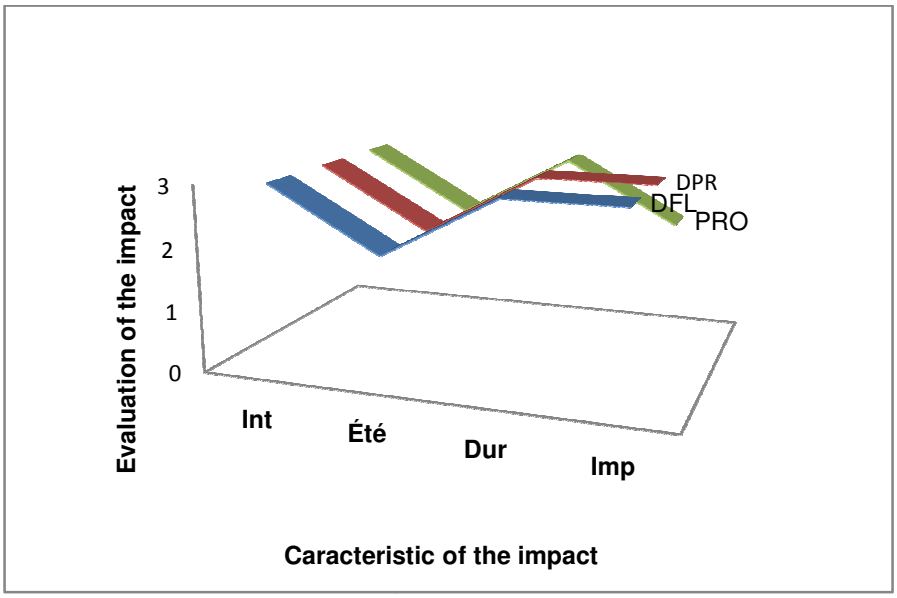
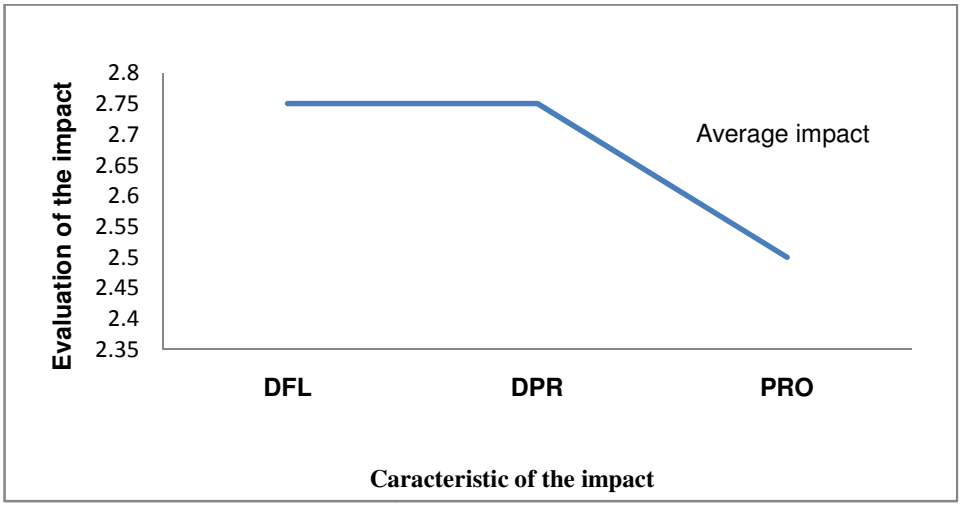


Fig. 8: Evolution of the impacts related to the exploitation phase, with; Int = intensity, Ete = wide; Dur = duration; Imp = importance; PRO = proliferation of the herbaceous one; DFL = destruction of the woody flora, DPR = destruction of the potential of regeneration



UNDER PEER REVIEW

Fig. 9: Evolution of the average impacts related to the Exploitation phase, with; DFL = destruction of the woody flora; EPD = destruction of the potential of regeneration; PRO = proliferation of the herbaceous population

2-3-3- End of the Project

The evolution of the curves (Fig. 10) shows the variation of the impacts related to the closing of the project on the vegetation, the flora of the site and on that of the contiguous vegetable formations. During this phase, the fragmentation of vegetation (FRV) was intense (3), important, fairly wide (2) and of short time (1). The evolution of floristic diversity (EDF) was fairly intense (2) and fairly wide (2) On the other hand this impact was long (3) and important (3). The evolution of the aspect of vegetation (EPV) was intense (3) and important (3). But it was fairly wide (2) and of lasted average (2). the evolution of the average impacts on the flora during this phase (Fig. 11), showed that the evolution of floristic diversity (EDF) and the evolution of the aspect of vegetation (EPV) were higher (2.5). The fragmentation of the vegetation (FRV) was average (2.25).

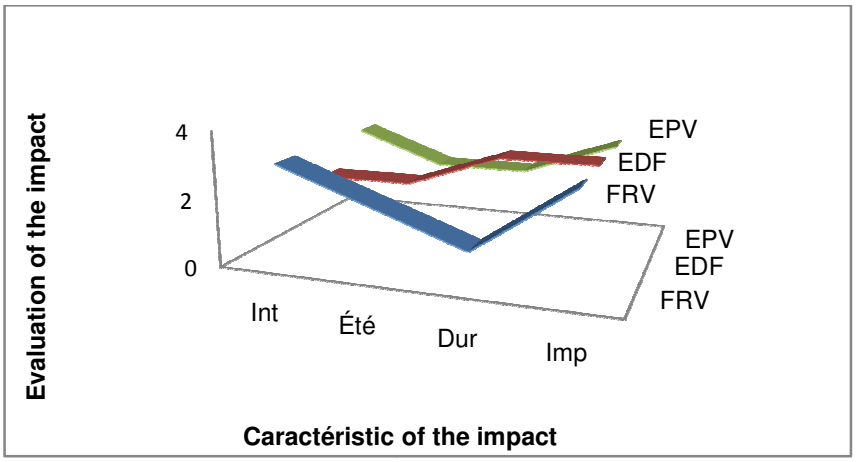


Fig. 10: Evolution of the impacts related to the closing of the project; with Int= intensity, Ete = wide; Dur = duration; Imp = importance; EDF = evolution of the diversity of the flora; EPV = Evolution of the aspect of the vegetation; FRV= Fragmentation of the vegetation

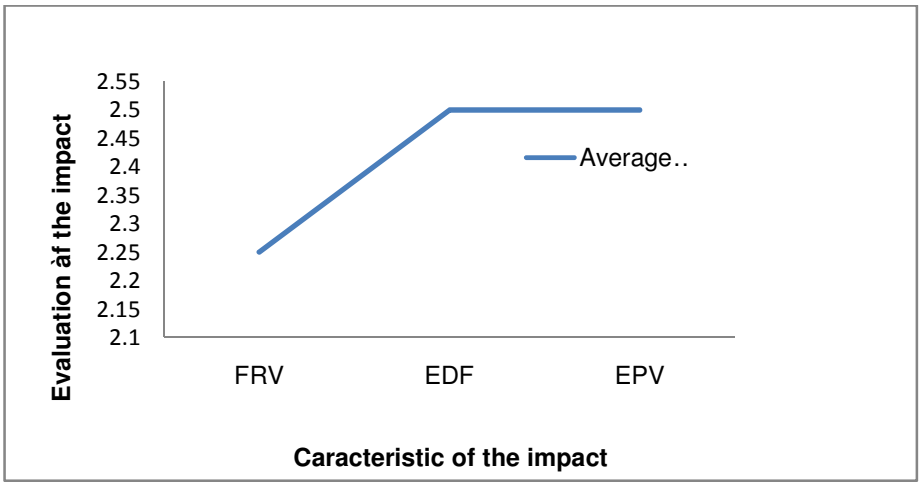


Fig. 11: Evolution of the average impacts dependent of the end of the project, with; EDF = evolution of the diversity of the flora; EPV = Evolution of the aspect of vegetation; FRV = Fragmentation of the vegetation

UNDER PEER REVIEW

4-Discussion

4-1- Evolution of floristic diversity

The analysis of the flora of the site shows that it is diversified little (H= 3.60) and rather homogeneous (E = 0.57). The various activities undertaken in this zone were ecological sources of disturbances, and they can be regarded as major disturbances of the ecosystems. Indeed, the vegetations crossed by the path of the line are mainly the plots of culture or fallow which are intensely put in culture. This setting in permanent crop influenced the floristic diversity of the site. Also, with the agricultural practices based on the systems traditional of cultures, much deforestation of the vegetation was associated. These destructions were related to the anarchistic and abusive exploitations of the arborescent species. The impacts related to the path of the line were caused by the machines motorized through scourings and the ground compaction, the cutting of the woody species and the hiding of the seeds of certain woody species of the original flora. These destructions have also involved ecological and biological disturbances (destruction of the ecosystems). Moreover, these actions caused the dynamics of the contiguous vegetable formations of the site.

3-2- Evolution of the environmental impacts

The environmental impacts were observed during the phases, of prospection, of exploitation, like at the end of the project. During the phase of prospection, the opening of the access roads and the demarcations have caused the destruction on the path of the line that of certain bordering vegetations of the line. 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 usually closed formations exposing thus the species of the underwoods very sensitive to excesses of light. The epiphytes are found on the ground following the demolition of the large trees. All these movements caused an ecological imbalance within the vegetable formations concerned. During the exploitation phase, the extent of the disturbances was accentuated. The destruction of the woody species was more important in the flora of the contiguous vegetations. The proliferation of numerous herbaceous species is due to the exposure of the underwood to the too strong luminosities and their capacity to quickly colonize the mediums degraded like it was mentioned by Claude *et al*. [7]. In addition, the regular cleanings of the path of the lines and the many frequentations of the blue-collar workers of the landscapes surrounding in search of woody species had an additional effect on the impacts; especially with regard to the destruction of vegetable numerous species. At the end of the project, the original vegetation almost disappeared after the many woody species destruction perpetrated in the zone. The aspect of the vegetation was modified on the lines. Numerous species endemic, rare, etc which were on the site sheltered during long moments do not exist today any more in the zone. The evaluation and the characterization 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 average impact most important during the phase of prospection was the destruction of the woody flora (DFL). The destruction of the potential of regeneration (DPR) and the proliferation of herbaceous (PRO) were less important. These impacts were caused by mechanical undergrowth clearances, the regular cleaning of the line of high voltage, etc the regular maintenance of the site which comprises destruction of certain woody species have intensely affected all the components of the flora, sometimes compromising its total regeneration as it was mentioned by Mitja and Puig [8] in forest zone and Yossi [9] in savanna zone. During the exploitation phase, the average impacts most important (DFL, DPR) were only the consequences of the activities which started since the phase of construction; they are amongst other things the regular cleaning of the site, the cutting of woody species, etc. The proliferation of herbaceous (PRO), less important during this phase was also related to the activities of maintenance during which the herbaceous ones are

UNDER PEER REVIEW

exposed to the destruction. At the end of the project, the importance of the evolution of the diversity of the flora (EDF) and aspect of vegetation (EPV) are related to the stoppage of the works. This suspension of the activities is what supported this renewal of diversity and the vegetation transformation. But this transformation is slow because of the slow growth of the woody species like it was mentioned by Ettien [10] and Kouadio *et al*. [11].

Conclusion

The flora of the path of the line is less diversified. This sector which inherited many crop years presents a floristic homogeneity all the same. The floristic diversity was strongly influenced by the installation, and the execution of the project. Many impacts whose destruction of the potential of regeneration of the flora, the impoverishment of the flora in woody species and the proliferation of the herbaceous ones in the flora were observed at certain places of the path of the line. However, of measurements of attenuation such as: the afforestations with the arborescent leguminous plants and the protection of certain vegetable formations will be able to strongly contribute to reduce the risks of imbalances ecological which could occur in the zone on the long run. Moreover the integral protection of the fallow still present on the site will be able to contribute to set up not only reservoirs of phytogenetic resources and wells of Carbon (CO2) but also of the refuges of the animals in migration.

References

Aubréville, A. In search of the forest in Côte d'Ivoire: wood and forests of the tropics, n° 56et 57 : 47 P ; 1957

Ettien DT. Potentials of regeneration of the commercial forest trees by the germination of seeds, in the classified forest of Haut-Sassandra (Mid-west of). Doctorate 3e cycle, U.F.R. Biosciences, Abidjan-Cocody University, Abidjan, Côte d'Ivoire, 259 p ; 2005

Claude F., Floret Ch., Paul M. et Jean D. Tec., 4è éd., 102 p ; 1998

Gautier, L., Chatelain, C.V. et R. Spichiger. Presentation of a releve methode for vegetation studies based on high resolution satellite imagery In: comptes rendus de la treizième reunion plénière de l'A.E.T.F.A.T., Zomba malawi. Nat. Herb. Bot. Gard. Malawi. **1994** ; Vol. 2: 1339-1350

Guillaumet J. L. et Adjanohoun E. Ecology: Scientific and practical approach. ED: Lavoisier La végétation. *in :* "Le milieu naturel de Côte d'Ivoire". Mém. ORSTOM, Paris. 1971 **;** n°50 : 161-262

Kouadio K, Kouassi KE, Kouamé NF, Traore D. Impact of the clearance on the natural regeneration of the principal forest trees, in the classified forest of Bossematié (Côte d'Ivoiret). ; 2007, Sci. Nat. vol. 4 (1): 27-35

Kouassi KH., Kouassi RH., Ayolié K., and N'guéssan K. Evolution of floristic diversity according to altitude in the localities of Bangolo and Logoualé west of Côte d'Ivoire. 2014; RRBS, 9(2), 2014 [63-69];

Mitja D. et H. Puig. Essartage itinerant culture and reconstitution of the vegetation of the fallow in wet savanna of Côte d'Ivoire (Booro-Borotou). In: CH. Floret and G Serpantié (eds), fallow in West Africa, Collection: Conferences and Seminars. ORSTOM, Paris. 1993; 377-392

UNDER PEER REVIEW

Reizer R. Installation of the artificial lake of Ayamé. N°30 publication of the tropical forest technical centre, 108 p; 1967

Shannon C.E. and W. Weaver.The mathematical Theory of communication.University of Illinois press, Urbana, 120 p; 1948

Yossi H. Dynamics of the post-farming vegetation in zone soudanienne in Mali. Phd, Population environment, ISFRA, University of Bamako, 154 p; 1996