

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

Abstract

The aim of this was to identify and evaluate the impacts related to the realization of high voltage on the flora of Agboville in order to put forward measures of attenuation or corrective.

Study design: The vegetations were delimited into small squares plots 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 of the study zone. It 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 approximately rich 81 species. It is however little, diversified and rather homogeneous. The destruction of the woody flora (DFL), the destruction of the floristic potential of regeneration (DPE), the evolutions of floristic diversity (EDF) and the aspect of vegetation (EPV) were the major average impacts during the prospection, the exploitation phases and at the end of the project. These impacts caused during all the phases of the project contributed to weaken the flora of the site and exposed it 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 year. The recrudescence of the activities causes of impact is partly related to the growth of the demography of 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 a priority. In addition, the problem of rural land, sometimes source of fatal conflicts, is one of the emergent causes of biodiversity destruction.

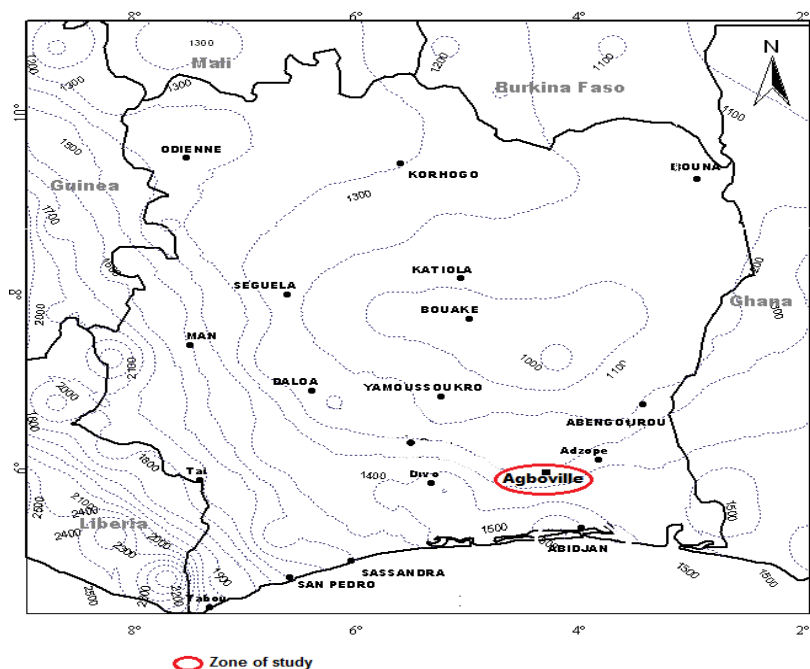
The leading causes of this evolutionary destruction are inter alia, inherent agriculture, forestry holding, bush fires, etc. During these last years, of the additional causes in particular, the fast urbanization, with its corollaries: the real estate transactions, great production units and transformation constructions and creations of industrial plantations (Kouassi *et al.* [1]) became activities, sources 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 these measurements, before any activity cause of great disturbance of the ecosystems is the identification, the evaluation 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) on the environment. Actually, human beings and the animals are the component which pays the full price of the consequences of much destruction caused within nature. This is why, any activity, source of impacts must be done in a reasoned way, in order to be in adequacy with the dynamics of the 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

46 purpose, this report highlights and evaluates primarily the impacts of the opening of the
47 layout of the line of high voltage (HTA) on the flora of the ecosystems crossed by the layout.

48 2-Materials and Methods

49 2-1- study area

50 From the floristic point of view, the site (Fig.1) of the project belongs to the Guinean field. In
51 this locality, one notes the presence of many hydromorphic vegetation closed by place. This
52 forest was made of three principal layers (Reizer, [3]; Guillaumet and Adjanohoun, [4]). In
53 addition to the hydromorphic formations, one meets there the wet dense forest, the marshy
54 forests of the enclaves, the raphiales, etc. The layer of the large trees was dominated by
55 specimens of 50 with 60 m high and was characterized by woody species such as *Khaya*
56 *ivoirensis*, *Lophira alata* and *Tarrieta utilis*. The hydromorphic formations were made up of
57 marshy forests and mangrove swamps. This wide forest is today very threatened in Côte
58 d'Ivoire since it comprises several exploited species (Aubréville, [5]).



59
60 Fig. 1: Localization of the study area

61

62 2-2- Actual statute of the vegetation

63 The vegetation of the site made up of dense forest always green dense forest at one
64 time luxuriant, are seriously started and almost disappeared to the profit of the fragments of
65 fallow (Fig. 2 A and B). The plots of culture, the marshy zones (Fig. 3 and 4) and the well
66 preserved vegetation.

67



A

B

Fig. 2: Fallow in Agboville (near petit Yapo)



Fig. 3: Plot of Cassava (*Manihot esculenta*) Fig. 4: Marshy zone with, *Bambousa vulgaris*

2-3- Floristic inventory

The flora of the whole area of the site have been inventoried. Two methods were associated to conduct this study. The itinerant inventory of the flora by the enumeration of the species on layouts and the method of the small squares (Gautier *et al.*, [6]) which consists in describing the vegetation (enumeration and classification of the species) on surfaces of approximately 20 m on side according to the four cardinal points, with a precise spacing. With this intention, the floristic composition of 10 small squares of approximately 400 m² of surface in each type of vegetation crossed by the line of high voltage have been inventoried. During inventories we noted the presence or the absence of each species. So that at the end of the inventories, the species most frequent appeared with a frequency of 10 appearances. They are 5 types of vegetations which were crossed by the layout of the line: they are: semi-deciduous forests, fallow comprising some trees, marshy zones comprising species such *Rafia hookeri*, plots of culture of *Hevea* and plot of food cultures (*Zea mays*, *Manihot esculenta*).

2-4- Analysis of the flora

The methods of analysis of diversity of the flora are available today. In the present analysis, the index of diversity of Shannon and weaver [7] was used to estimate the diversity of flora. Its formula is $H = -\sum p_i \log p_i$, with p_i = floristic contribution or relative frequency. This index varies from 0 (only 1 species) to $\log N$, (when all the species have same abundance). To this index the Equitability of Pielou (E) is associated. 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 all species is concentrated on only one (1) species and is equal to 1 when all the species have same abundance. For the analysis and the evaluation of the impacts, the parameter qualitative which characterize the impacts were codified. Thus, with the three values: High, medium and low have been respectively associated the numbers : 3, 2 and 1.

3-Results

3-1- Plant species diversity of the sector of Agboville

The flora of the site is rich approximately 81 species. The values of Shannon index (H) and Equitability (E) estimated are respectively, $H = 3.6$; $E = 0.57$ (table 1).

Table I: Estimate of the values of the indices of diversity (H) and homogeneity (E), with F_a = absolute frequency, F_r = relative frequency, P_i = floristic contribution, H = Shannon index

N°	Species	Family	F_a	F_r	P_i	H
1	<i>Abrus precatorius</i>	Fabaceae	1	0,333	0,004	0,032
2	<i>Adenia cissampeloides</i>	Passifloraceae	3	1	0,012	0,078
3	<i>Ageratum conyzoides</i>	Asteraceae	2	0,666	0,008	0,056
4	<i>Albizia adianthifolia</i>	Mimosaceae	3	1	0,012	0,078
5	<i>Albizia zygia</i>	Mimosaceae	3	1	0,012	0,078
6	<i>Alchornea cordifolia</i>	Euphorbiaceae	3	1	0,012	0,078
7	<i>Alstonia boonei</i>	Apocynaceae	1	0,333	0,004	0,032
8	<i>Ananas comosus</i>	Bromeliaceae	1	0,333	0,004	0,032
9	<i>Anthocleista djalensis</i>	Loganiaceae	1	0,333	0,004	0,032
10	<i>Antiaris toxicaria subsp africana</i>	Moraceae	1	0,333	0,004	0,032
11	<i>Antrocaryon micraster</i>	Anacardiaceae	2	0,666	0,008	0,056
12	<i>Aspilula africana</i>	Asteraceae	1	0,333	0,004	0,032
13	<i>Baphia nitida</i>	Fabaceae	1	0,333	0,004	0,032
14	<i>Blighia sapida</i>	Sapindaceae	1	0,333	0,004	0,032
15	<i>Carica papaya</i>	Caricaceae	1	0,333	0,004	0,032
16	<i>Cassia hirsuta</i>	Caesalpiniaceae	1	0,333	0,004	0,032
17	<i>Cassia siamea</i>	Caesalpiniaceae	3	1	0,012	0,078
18	<i>Cecropia peltata</i>	Cecropiaceae	2	0,666	0,008	0,056
19	<i>Ceiba pentandra</i>	Bombacaceae	2	0,666	0,008	0,056
20	<i>Centrosema pubescens</i>	Fabaceae	2	0,666	0,008	0,056
21	<i>Chromolaena odorata</i>	Asteraceae	3	1	0,012	0,078
22	<i>Cissus aralioides</i>	Vitaceae	2	0,666	0,008	0,056
23	<i>Cnestis ferruginea</i>	Connaraceae	2	0,666	0,008	0,056
24	<i>Combretum zenkeri</i>	Combretaceae	2	0,666	0,008	0,056
25	<i>Cordia platythyrsa</i>	Boraginaceae	1	0,333	0,004	0,032
26	<i>Croton hirtus</i>	Euphorbiaceae	1	0,333	0,004	0,032
27	<i>Cyperus sp.</i>	Cyperaceae	1	0,333	0,004	0,032
28	<i>Desmodium adscendens</i>	Fabaceae	1	0,333	0,004	0,032
29	<i>Delonix regia</i>	Caesalpiniaceae	2	0,666	0,008	0,056

30	<i>Dioscorea smilacifolia</i>	Dioscoreaceae	2	0,666	0,008	0,056
31	<i>Dissotis rotundifolia</i>	Melastomataceae	1	0,333	0,004	0,032
32	<i>Elaeis guineensis</i>	Arecaceae	2	0,666	0,008	0,056
33	<i>Entandrophragma angolense</i>	Meliaceae	1	0,333	0,004	0,032
34	<i>Erigeron floribundus</i>	Asteraceae	2	0,666	0,008	0,056
35	<i>Ficus exasperata</i>	Moraceae	1	0,333	0,004	0,032
36	<i>Ficus sur</i>	Moraceae	1	0,333	0,004	0,032
37	<i>Hevea brasiliensis</i>	Euphorbiaceae	1	0,333	0,004	0,032
38	<i>Hoslundia opposita</i>	Labiatae	1	0,333	0,004	0,032
39	<i>Ipomoea sp</i>	Convolvulaceae	1	0,333	0,004	0,032
40	<i>Lantana camara</i>	Verbenaceae	1	0,333	0,004	0,032
41	<i>Leucaena sp</i>	Mimosaceae	1	0,333	0,004	0,032
42	<i>Mallotus opositifolius</i>	Euphorbiaceae	2	0,666	0,008	0,056
43	<i>Manihot esculenta</i>	Euphorbiaceae	2	0,666	0,008	0,056
44	<i>Manniophyton fulvum</i>	Euphorbiaceae	2	0,666	0,008	0,056
45	<i>Mareya micrantha</i>	Euphorbiaceae	1	0,333	0,004	0,032
46	<i>Margaritaria discoidea</i>	Euphorbiaceae	1	0,333	0,004	0,032
47	<i>Mezoneuron benthamianum</i>	Caesalpiniaceae	2	0,666	0,008	0,056
48	<i>Milicia excelsa</i>	Moraceae	1	0,333	0,004	0,032
49	<i>Millettia zechiana</i>	Fabaceae	2	0,666	0,008	0,056
50	<i>Momordica charantia</i>	Cucurbitaceae	1	0,333	0,004	0,032
51	<i>Morinda lucida</i>	Rubiaceae	1	0,333	0,004	0,032
52	<i>Motandra guineensis</i>	Apocynaceae	1	0,333	0,004	0,032
53	<i>Musa paradisiaca</i>	Musaceae	1	0,333	0,004	0,032
54	<i>Musanga cecropioides</i>	Moraceae	2	0,666	0,008	0,056
55	<i>Myrianthus libericus</i>	Moraceae	1	0,333	0,004	0,032
56	<i>Nauclea latifolia</i>	Rubiaceae	1	0,333	0,004	0,032
57	<i>Nelsonia canescens</i>	Acanthaceae	1	0,333	0,004	0,032
58	<i>Panicum maximum</i>	Poaceae	1	0,333	0,004	0,032
59	<i>Passiflora foetida</i>	Passifloraceae	1	0,333	0,004	0,032
60	<i>Paullinia pinnata</i>	Sapindaceae	2	0,666	0,008	0,056
61	<i>Phyllanthus amarus</i>	Euphorbiaceae	1	0,333	0,004	0,032
62	<i>Phyllanthus muellerianus</i>	Euphorbiaceae	1	0,333	0,004	0,032
63	<i>Phyllanthus sp.</i>	Euphorbiaceae	2	0,666	0,008	0,056
64	<i>Piptadeniastrum africanum</i>	Mimosaceae	1	0,333	0,004	0,032
65	<i>Pouzolzia guineensis</i>	Urticaceae	1	0,333	0,004	0,032
66	<i>Psidium guajava</i>	Rutaceae	1	0,333	0,004	0,032
67	<i>Pueraria phaseloides</i>	Euphorbiaceae	2	0,666	0,008	0,056
68	<i>Pycnanthus angolensis</i>	Myristicaceae	3	1	0,012	0,078
69	<i>Raphia hookeri</i>	Arecaeae	1	0,333	0,004	0,032
70	<i>Rauvolfia vomitoria</i>	Apocynaceae	2	0,666	0,008	0,056
71	<i>Ricinodendron heudelotii</i>	Euphorbiaceae	2	0,666	0,008	0,056
72	<i>Sida acuta</i>	Malvaceae	1	0,333	0,004	0,032
73	<i>Secamona afzelii</i>	Asclepiadaceae	1	0,333	0,004	0,032

74	<i>Solanum erianthum</i>	Solanaceae	1	0,333	0,004	0,032
75	<i>Solanum turvum</i>	Solanaceae	1	0,333	0,004	0,032
76	<i>Sterculia tragacantha</i>	Sterculiaceae	2	0,666	0,008	0,056
77	<i>Tabernaemontana crassa</i>	Apocynaceae	2	0,666	0,008	0,056
78	<i>Tragia benthamii</i>	Euphorbiaceae	1	0,333	0,004	0,032
79	<i>Trema orientalis</i>	Ulmaceae	1	0,333	0,004	0,032
80	<i>Triplochiton scleroxylon</i>	Euphorbiaceae	2	0,666	0,008	0,056
81	<i>Xanthosoma maffama</i>	Araceae	1	0,333	0,004	0,032
				I =		3,595
				E =		0,567

108

109 3-3- Species with particular status inventoried in the zone

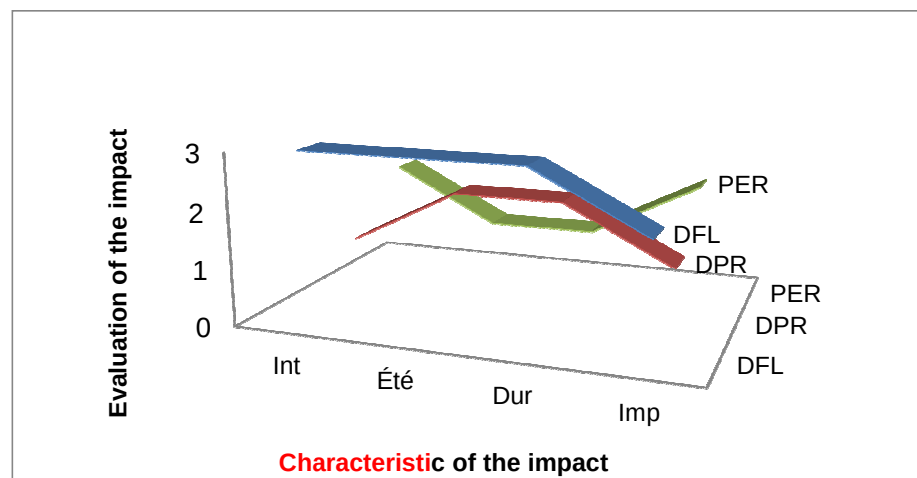
110 Five (5) species with particular status have been registered. Among them, four (*Antrocaryon*
111 *micraster*, *Cordia platythyrsa*, *Entandrophragma angolense* and *Milicia excelsa*) are
112 vulnerable and one present risks of extinction according to IUCN (2013)

113

114 3-4- Identification, analyzes and evaluation of the impacts of the project

115 3-4-1 phase of prospection

116 The curves (Fig. 6) show the variation of the impacts related to the phase of prospection on
117 the flora and the vegetation of the line. The destruction of the woody flora (DFL) was intense
118 (3), extended (3) and very long (3). The impact of this activity was medium important (2). The
119 duration and the extent of the destruction of the potential of regeneration of flora (DPE) were
120 medium (2). But it was low intense (1) and low important (1). The ecological disturbances
121 (EP) caused by the activities were medium intense (2), medium important (2), and medium
122 wide (2). They were very short (1).



123

124 Fig. 6: Evolution of the impacts related to the phase of prospection with, Int = intensity, Ete =
125 wide; Dur = duration; Imp = importance; DEV. = destruction of the plant species; DPR =
126 destruction of the potential of regeneration; EP= ecological disturbance
127

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

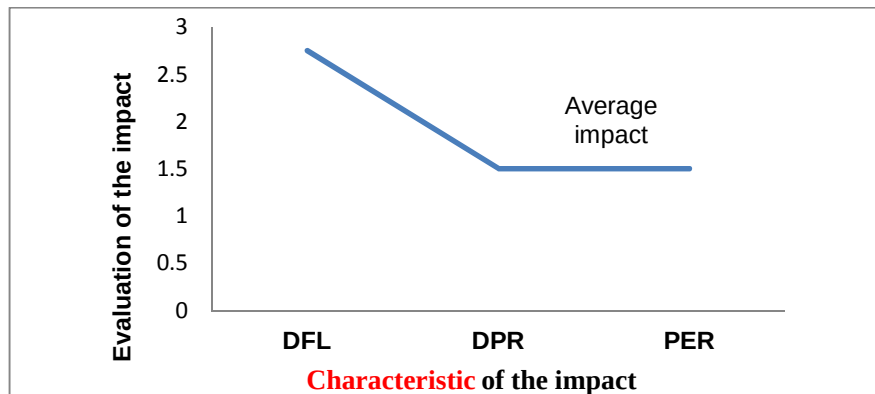


Fig. 7: Evolution of the average impacts related to the prospecting and construction phase, with; DFL = Destruction of the species of the woody flora; DPR = destruction of the potential of regeneration; PER = ecological disturbance

2-3-2- Phase of exploitation

The evolution of the curves (Fig. 8) shows the variation of the impacts related to the phase of exploitation on the vegetation, the flora of the site and on that of the contiguous vegetation. During this phase, the woody flora destruction (DFL) and the potential of regeneration (DPR) destruction were highly significant (3), very long (3) and highly important (3). But they were low lying (1). The herbaceous proliferation were highly significant (3) and long (3). It was medium wide (2) and medium importance (2).

The Characterization of the average impact impacts on the flora (Fig.9), shows that the destruction of the woody flora (DFL) and the destruction of the potential of regeneration (DPR) were high (2.75) during this phase. The herbaceous proliferation was low intense (2.50).

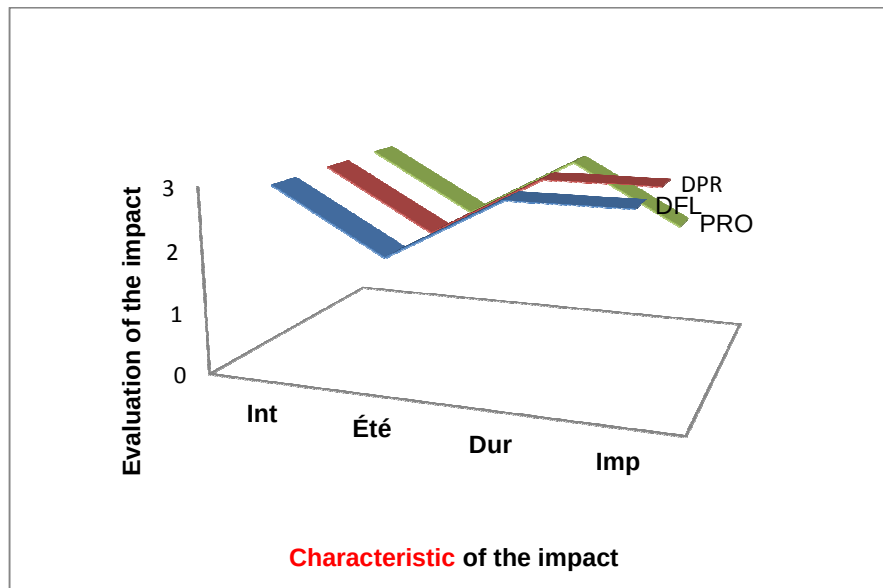


Fig. 8: Evolution of the impacts related to the exploitation phase, with; Int = intensity, Ete = wide; Dur = duration; Imp = importance; PRO = the herbaceous proliferation; DFL = destruction of the woody flora, DPR = destruction of the potential of regeneration

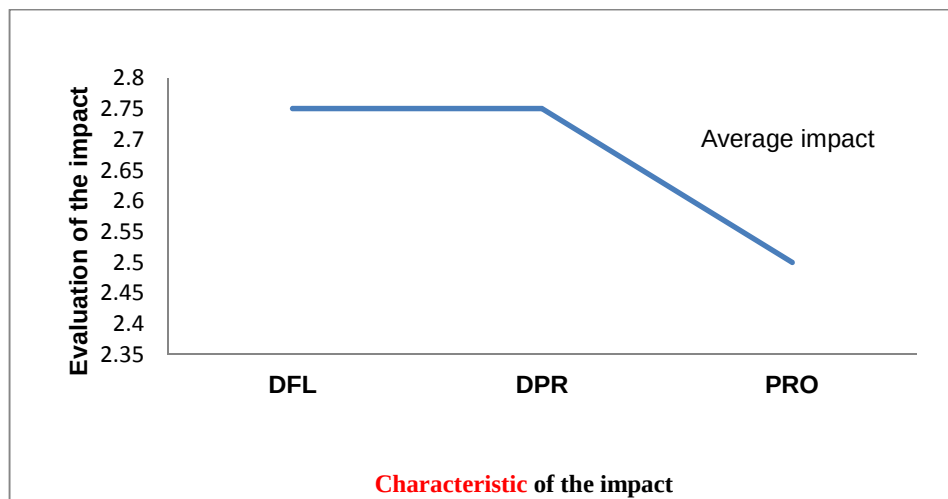


Fig. 9: Evolution of the average impacts related to the Exploitation phase, with; DFL = destruction of the woody flora; EPD = destruction of the potential of regeneration; PRO = the herbaceous proliferation

2-3-3- End of the Project

At the end of the project (Fig. 10), the fragmentation of the vegetation (FRV) were highly significant (3), very important (3), medium wide (2) and short (1). (EDF) The flora of the site has been medumly diversified (2) and medium wide (2). This impact was very long (3) and very important (3). The appearance of the vegetation (EPV) has changed significantly (3) and very important (3). But it was medium wide (2) and have had medium duration (2). The average impacts evolution (Fig. 11) showed that the evolution of floristic diversity (EDF) and

the appearance of the vegetation (EPV) were high (2.5). The fragmentation of the vegetation (FRV) was medium (2.25).

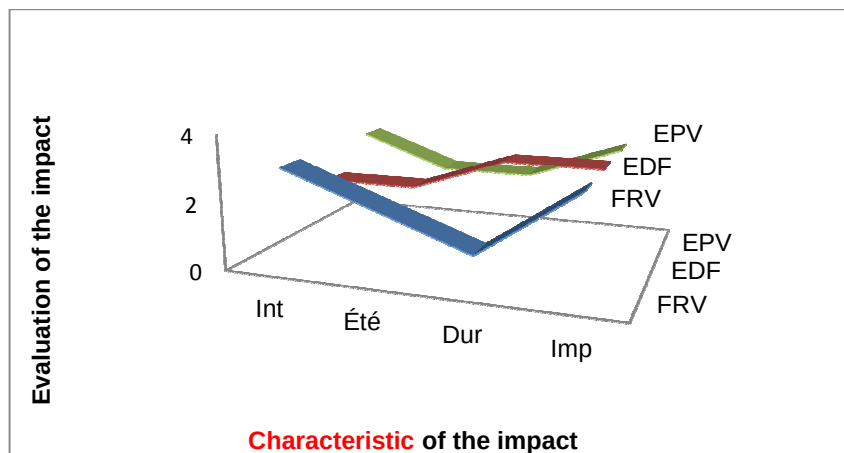


Fig. 10: Evolution of the impacts related to the end of the project; with Int= intensity, Ete = wide; Dur = duration; Imp = importance; EDF = evolution of the diversity of the flora; EPV = Evolution of the aspect of the vegetation; FRV= fragmentation of the vegetation

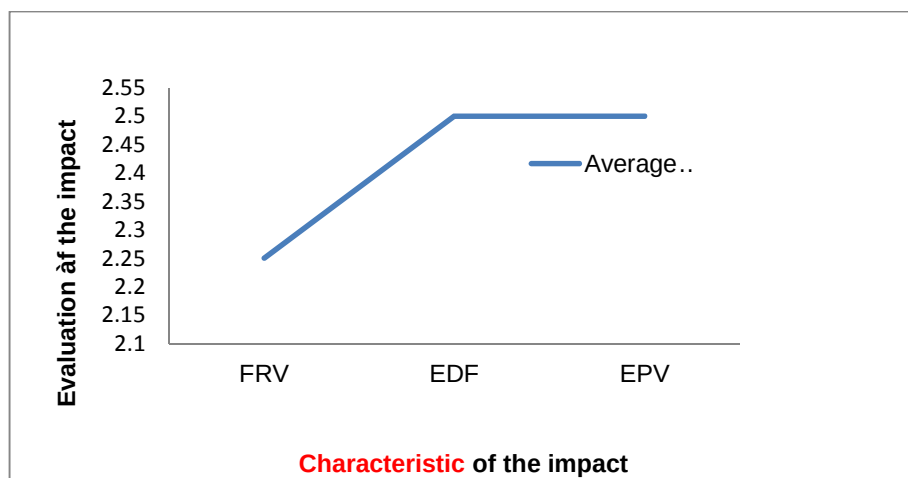


Fig. 11: Evolution of the average impacts dependent of the end of the project, with; EDF = evolution of the diversity of the flora; EPV = Evolution of the aspect of vegetation; FRV = Fragmentation of the vegetation

4-Discussion

4-1- Evolution of floristic diversity

The evaluation of the impacts on the flora of the vegetations showed that these vegetation were low diversified ($H = 3.60$) and rather homogeneous ($E = 0.57$). The various activities undertaken in this zone can be regarded as major causes of the disturbances and vegetations fragmentation. 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 traditional systems of cultures, cause of many deforestation was associated. These destructions were related to the anarchistic and abusive exploitations of the trees species. The impacts related to the path of the line were caused by the machines through scourings and ground compaction, woody species cutting 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 vegetation** of the site.

3-2- Evolution of the impacts on the flora of the site

The major impacts were observed at all project phases. During the phase of prospection, the openings of the access roads and the demarcations have caused the destruction on the path of the line **and 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 **the species of the underwoods very sensitive, to excesses light**. The epiphytes are found on the **soil** following the demolition of the large trees. **All these major impacts caused an ecological imbalance in many vegetation.** The ecological disturbances caused by the linked activities with the projects involve changes within the flora. These changes are related to the characteristics of the flora. Kittur et al. (2014) noted that these characteristics are evolutionary. But among the elements which condition this evolution, the factors anthropic are those which emergent nowadays with the anarchistic urbanisation of rural environment.

3-2-1-Evolution of the impact during the exploitation phase

The activities carried out during the exploitation phase contributed to increase the impacts generated during the previous phases. The destruction of the original flora is a factor which facilitated the installation of herbaceous which has a great capacity to develop themselves. Their proliferation is due to the opening of the canopy of the vegetation which was closed before the realization of the project. The exposure of the **soil** to strong luminosity of the sun and rain erosion are additional factors which involved the regression of the original flora to the profit of the adventitious, like it was mentioned by Claude et al. [8]. Also, the regular cutting of vegetation of the line of the high voltage (H T A) weakened the protection of the soil against erosion.

3-2-1-Evolution of the impact at the end of the project

At the end of the project, The vegetations of the site were deeply impoverishes by the project. Indeed, numerous species listed in the zone before the realization of the project disappeared from the site. **The aspect of the vegetation was modified on the lines.** The evaluation and the characterization of the impacts on the flora of the site are supposed to bring a thorough lighting on **the nature of the impacts**. Thus, the average impact most important during the phase of prospection was the woody flora destruction (DFL). The destruction of the potential of regeneration (DPR) and the **herbaceous proliferation (PRO) were less important.** These impacts **were caused by undergrowth clearances, the regular cleaning of the path of the line, 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 [9] in forest zone **and Yossi [10] in savanna.** 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 woody species cutting, etc.** The proliferation of herbaceous (PRO), less important during this phase was also **related to the activities of maintenance.**

The importance of the evolution of the diversity of the flora (EDF) and the aspect **of the vegetation (EPV) were related to the end 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 [11] and Kouadio et al. [12]. **The activities undertaken during this project**

were sources of significant impacts which will be of the factors of destruction of nature. Indeed, these impacts contributed to weaken the homogeneity and the stability of the flora. This brittleness exposes the flora

of the site to fire hazards like it was announced by Jharya et al. [13]. According to these authors, the type of vegetation determines the fire hazard in forest medium. In addition, the changes in forests natural and homogeneous are carried out slowly but by preserving the biodiversity. But the catastrophes sometimes related to the impact of the activities carried out during the phases of realization of the specific projects involve the destruction of the structural complexity of the ecosystem like it has been showed by Schindele *et al.* [13]. with the fires in forest medium.

Conclusion

The flora of the path of the line is less diversified. This sector which inherited many years crop presents a floristic homogeneity. The floristic diversity was strongly influenced by the installation, and the execution of the project. Many impacts (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, mitigation measures such as: the afforestations with the legume trees and the protection of certain vegetation will strongly contribute to reduce the risks of ecological imbalances which could occur in the zone on the future. Moreover the integral protection of the fallow still present on the site will encourage setting up reservoirs of phytogenetic resources, wells of carbon (CO₂) and also the refuges of the animals during their migration.

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