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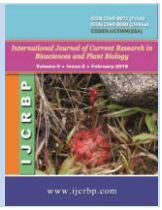

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Climate Change and Assisted Natural Regeneration Practice in the Agroforestry Parklands of Gampela at the Central Burkina Faso

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ABSTRACT

The practice of the assisted natural regeneration (ANR) is essential to remedy the fatal effects of the climate change on the ligneous resources however it is subject to multiple constraints. The present work aims to characterize the ANR in the agroforestry parklands; look for its origins; identify the main climatic factors and their shocks on the ANR; propose strategies to improve this practice. Therefore 55 plots of inventories were settled on various agroforestry parklands. Individual interviews and brainstormings were realized with the farmers to identify the climatic factors observed in the village, the shocks perceived on the ANR and the strategies of improvement. The intensities of these shocks related to climate change were assessed by the indices of severity and incidence. This study shows that 28 woody species from 18 families and 27 genera are regenerating in agroforestry parklands. Three origins characterize the ANR species: spontaneous regeneration; budding strains; zoochoria and organic manure. Some factors affect the practice of the ANR. From these factors emanate 16 shocks of various severities and incidences. Finally, five strategies for improving the practice have been identified.

Introduction

The desertification affects 168 countries in the world. In the Sahel, the combined effects of the climate change, the inadapted agricultural practices and the demographic pressure accelerate the degradation of the ecosystems. Natural resources degradation is a common problem in arid and semi-arid lands in western Africa (Boffa, 2000). In Burkina Faso, rural populations depend strongly on ligneous species for daily needs while plants biodiversity is facing multiple constraints of conservation (Belem et al., 2010). Many governments and their partners use expensive

means to cure the situation. They aimed to develop approaches, practices and technologies for sustainable management of ligneous species. But generally the means deployed do not take into account the endogenous approaches which have notorious impacts on the safeguarding of the natural resources. Among these practices we can cite the Assisted Natural Regeneration (ANR) widespread in the agrarian landscapes of Burkina Faso (IGMVSS, 2015; A/Tipaalga, 2015). The ANR is one of the most effective and efficient endogenous approaches (Thiobane, 2013).

Several authors reported the socioeconomical and ecological advantages of the ANR, notably the plant cover restoration, the agricultural field yields increase and the availability of non-ligneous forest products (Yaméogo et al., 2010). The ANR is well noticed in the rural areas where forests have been cleared for field creation and urbanisation (Fig. 1). In these cases, the ANR practice becomes the main solution to conserve ligneous species diversity. But many factors influence the adoption of this practice in the agroforestry parklands. Farmers perceptions on ANR is an important factor to take into account. Above all, the climate change is a primordial phenomenon recognized to impact negatively the sustainable management of ligneous species. It's supposed to have some consequences on the practice of ANR.

Fig. 1: *Diospyros mespiliformis* in ANR in the agroforestry parklands of Gampela.

Thus the global objective of the present study is to characterize the ANR in the agroforestry parklands in the context of climate change. The specific objectives were to analyze farmers perceptions on the ANR; identify the origin of ANR; identify the main climate change factors and their chocks on the ANR; identify the strategies to improve this practice.

Materials and methods

The site of study

The study was conducted in the agroforestry parklands at Gampela (12°22'59"N, 1°25'01"W) a village located 15 km at the east of Ouagadougou the capital city of Burkina Faso, west Africa. The most common soils in these parklands are tropical ferruginous, generally sandy-clay or gravelly type, with low agronomic potential. These soils have higher content of silt and clay in depressions. The climate in this site is characterized by temperatures which vary between 17°C and 42°C depending on the season. A long dry season is from October to may while the dry season runs from June to September. The monsoon and harmattan are the two wings blowing respectively during the rainy and the dry seasons. The annual rainfall averages are between 600 mm and 800 mm (Sampony, 2016). The vegetation is characterized by shrub savannah. There are forest galleries along the rivers. The dominated land use system is the agroforestry parklands.

The interviews

Samplings: The study was carried out from October 2016 to September 2017, in order to take into account the climate aspects during a year. The village of Gampela is divided into 11 sectors. Two kinds of interviews have been made: some focus groups (brainstormings) and some individual interviews. For the last one, five farmers per sector have been identified and the investigations made in their parklands. Questionnaires were submitted to a total number of 55 parkland holders chosen randomly. The questionary was related to the farmer's perceptions on the ANR; the origins of these ANR; the main climate change factors observed in the village and their chocks on the

ANR; the strategies developing by the farmers to reduce the climate change impacts on the ANR. During the brainstormings the interviewed groups were invited to list the chocks perceived on the ANR beginning by the most important chock.

Floristic inventories

The floristic inventories of the species in ANR were done on 55 agroforestry parklands located in the bush, the village and the neighborhood of human habitations. On each parkland, a plot of 0.25 ha (50m×50m) was delimited and the inventory was done within it.

The number of suckers per stump for cut trees, the distance between two ANR species where determined. Some observations related to the origin of ANR and the nearest adult plants have been done.

Data handling considerations

The farmers perceptions of the ANR were appreciated by the rates of farmers who listed them. The inventoried plants species were determined by using the keys (Von Maydell, 1983; Berhaut, 1988; Arbonnier, 2000) available at the Department of Environment and Forestry at the National Institute of Environment and Agriculture Researches.

The indexes of severity (S) and incidence (I) of Smith et al. (2001), Quinn et al. (2003) calculated to characterize the intensities of the climate change are respectively:

$$S = 1 + (r-1)(n-1). \qquad 1 \leq S \leq 2$$

r= order of the threat according to the interviewed farmer
n = total number of the threats according to the interviewed farmer
I = type of threat x - listed number/number of the participants. $0 \leq I \leq 1$
A high severity is characterized by a low value while a high value of incidence means a strong impact.

Results

The farmer's perceptions on the ANR

The farmers perceptions on the ANR as presented by the Table 1 are both positive and negative aspects. The negative impacts can be ranged into three keys points. The first two points are related to the duration of the fields works and the cultivable area. In fact, depending on the woody species and its density in the field, the duration of the field work is supposed to be increased and they reduce the cultivable area. The third point is the proliferation of animal parasites. These parasites are usually the crop yields predators and the rodents of leaves, fruits, inflorescences and plant roots. The positive effects of the ANR practice are ecological and socioeconomical. The ANR improve soil fertility in their neighborhood characterized by the rapid growth of the crop, the soil humidity, the increased size of the crop ears and the improvement of the quality of the crop ears. Above all the ANR is a source of wood and non-woody products diversity that meets the various needs of rural people. These products are also a source of monetary income for people.

Species in ANR and their origins

A total of 28 local and exotic woody species in ANR divided into 18 families and 27 genera have been inventoried on the agroforestry parklands of Gampela (Fig. 2). Their three main origins are the spontaneous seedling, the zoochoria and the organic manure. The proportions of 18% and 25% of the species are respectively from three and two origins. The others have only one origin. Except for *Vitellaria paradoxa*, the species with three origins are commonly found in the agroforestry parklands of the region.

The main climate change factors observed in the village

Farmers attested that they have experienced local, regional and national climate events that have direct repercussions on natural resources in general and

ANR particularly. These events observed for more than 30 years by the interviewed farmers are the drought, violent winds, floods, erosion, hot season and prolonged cold (Fig. 3).

Farmers perceived that the drought and prolonged cold caused changes in ANR physiology from drying to mortality. The strong winds and floods lead to the dispersal and rotting of the fallen seeds (Fig. 4). The intensities of the chocks caused by the climate effects on the ANR are appreciated by the indexes of severity and incidence.

Table 1. Farmers perceptions of the ANR at Gampela.

Types of perceptions	Perceptions	Proportions of the farmers (%)
Negative effects	Holds back the plowings with daba or by hitched cultures	100
	Reduce the cultivable areas	92
	Increase the duration of field works	100
	Attract birds and multiple parasite	100
	Prevent the progress of the seed drill	100
Positive effects	Accelerate the growth of the corps in the neighbor hood of the RNA	100
	Improve the soil humidity	100
	Increase the weight	88
	Improve the vigour of the crop stalks	81
	Decrease the quantities of fertilizers	97
	Diversify timber and non-timber forest products	100

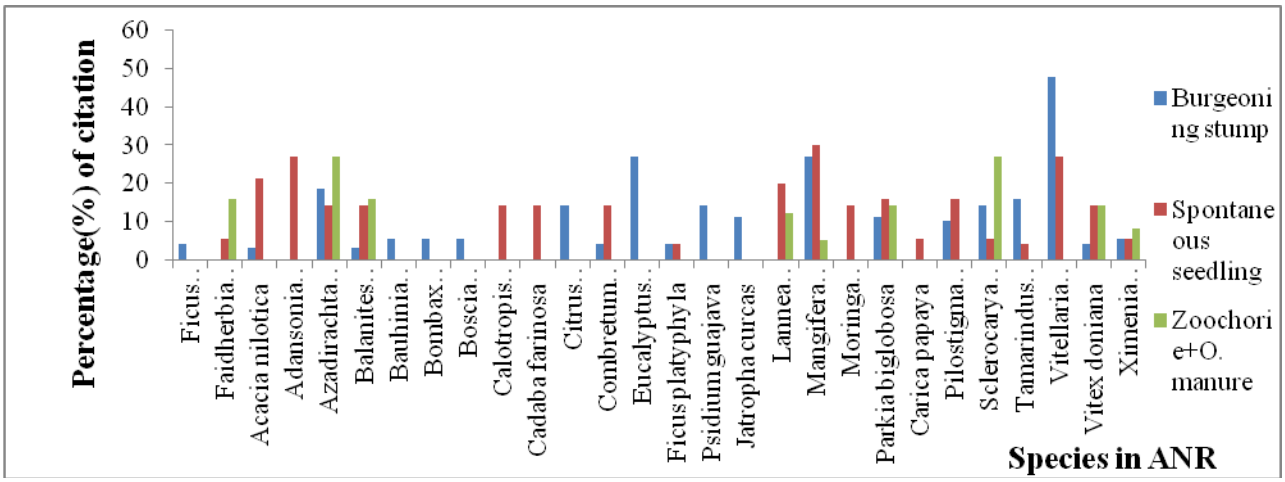

Fig. 2: The inventoried species in ANR and their origins on the agroforestry parklands at Gampela.

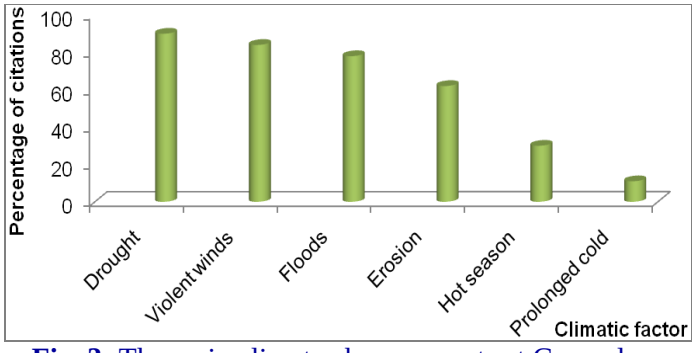

Fig. 3: The main climate change events at Gampela.

The climate change chocks on the ANR

The examination of the shocks (Table 2) reveals that the most severer (1.2 to 1.5) concern the leaves drying, seed viability, seedling mortality and the dispersal of seeds by floods. Farmers perceived that these chocks are caused by droughts, wings and floods. Another group of chocks with severity between 1.6 and 1.8 concern the inflorescences, leaves, seedling roots and seeds. They notice that

these chocks are also caused by the violent wings, droughts and parasites. The last group of chocks, less severer than the two others are related to the seed maturation, the preferred plants disappearance and seedling melting. The soil fertility, the prolonged hot and low temperatures could explain these chocks.

Fig. 4: Dispersal and rotting of fallen seeds at Gampela parklands.

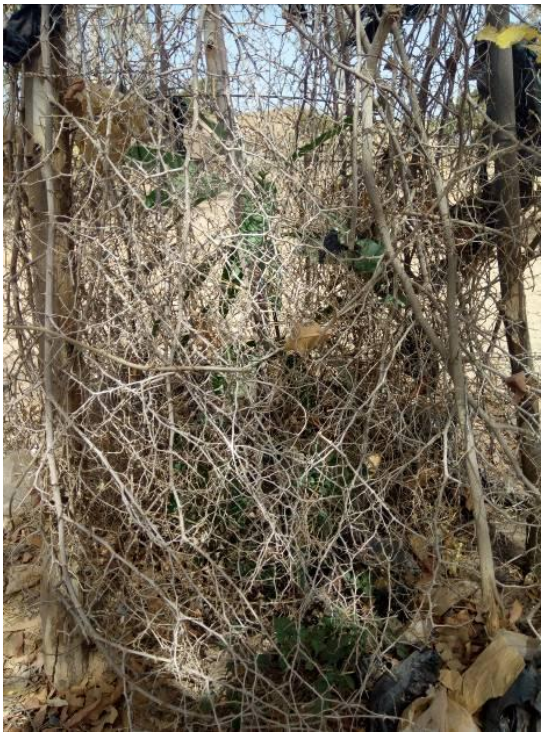

Fig. 5: A grid made of spiny species.

Table 2. The climate change chocks on the ANR and their severity and incidence.

No.	Chocks	Severity	Incidence
1	Drying leaves	1.2	0.8
2	Low viability of seeds	1.3	0.8
3	Seedling mortality	1.5	0.4
4	Seeds washed away by floods	1.5	0.6
5	Plants pathology	1.5	0.7
6	Inflorescence falls	1.6	0.6
7	Low rooting of seedlings	1.7	0.7
8	Yellowing of the leaves	1.7	0.8
9	Seeds perforation	1.7	0.4
10	Uprooting of the seedlings	1.7	0.3
11	Leaves fall	1.8	0.4
12	Slow growth of seedlings	1.8	0.5
13	Gnawed plants	1.8	0.3
14	Immaturity of seeds	1.9	0.5
15	Disappearance of preferred species in ANR	1.9	0.4
16	Seeds melting	2.0	0.2

The strategies developing by the farmers to reduce the climate change impacts on the ANR

Facing the negative impacts of the climate change, the farmers adopted some strategies for the development and the conservation of the ligneous species by ANR (Table 3). All of the plants species are not suitable with climate conditions. Farmers are selecting particulary those who tolerate poor soil and arid land like *Vitellaria paradoxa*, *Mangifera indica*, *Eucalyptus camaldulensis*. Another important strategy is plant watering without what we'll observe a great proportion of mortality of the plants in ANR. Because of

droughts and rains irregularity, there is a lack of water for crops and trees growing. In the same objective to resolve the problem of water, the farmers are digging some bowl around the ANR plant in order to conserve water from rains. The divagation of animals is a crucial problem that results from the rarefaction of the forage resources. Thus the strategies concerned three methods: the grid of protection woven with *Combretum micranthum*; the plastic or metallic grid; the grid made of the heaps of spiny species (Fig. 5) which is considered to be least efficacious because some ruminants graze them. The combined spiny species and plastic grid is used to reinforce the plant protection (Fig. 6). Due to the effects of winds and gains some plants in ANR curved or fell on ground. The staking consists on attaching wooden stem near seedling in order to keep them up.

Table 3. The strategies developed by the farmers to improve the ANR practice.

No.	Strategy	Rate of adoption (%)
1	Selection of adapted plants	42
2	Plant watering	36
3	Protection devices	29
4	Digging bowl around the plants in ANR	29
5	Staking	18

Fig. 6: A combined spiny species and plastic grids.

Discussion

The climate change is recognized as a phenomenon which affects the sustainable management of the plant resources in particular the survival of the young seedlings which have important needs of pedological, ecological and climatic suitable conditions (IGMVSS, 2015). Thus the ANR is practiced for the ligneous species conservation in the fields. Nevertheless negative aspects of this practice are indexed by the farmers of Gampela. The difficulties of progression of the seeders; the control of the ploughings by the plough; the reduction of the cultivable surfaces when the densities of the ligneous species are badly managed are many constraints which reduce the effectiveness of the ANR. According to some previous authors, actually the producers are reticent to the practice of the ANR because of these negative effects (Camara et al., 2017). However it is important to note that the results of this work indicate that the practice of the ANR is a way of protection and conservation of woody diversity. An examination of the 28 species inventoried and the farmers perceptions on the ANR attest that they are in general multi-purpose species which present socio-economic and ecological interests for the rural populations and soils (Kindt et al., 2008; Lawarnou et al., 2012; Camara et al., 2017).

The ANR is particularly a source of supply of woody energy for the rural households and monetary incomes for the farmers. The ANR is perceived to have several positive impacts. Some of them evoked the restoration of the fertility of the degraded lands and the availability of forest products (Thiobane, 2013). When the densities of the ligneous species are well managed, the ANR improves soil moisture and creates a microclimate which influences the soil fertility. All these advantages are materialized by the best performances of the crops as perceived by the producers (Yameogo et al., 2006). In one hand due to its capacity to restore the soil and preserve the ligneous species it is important to note that the ANR practice offers the opportunities to combat the harmful effects of the climate change. But in

another hand it is a practice whose efficacy is slowed by the events related to the climate change. As mentioned in the results of this work, the droughts, the strong winds, the floods, the strong heats and the prolonged cold existed in recurring ways in Burkina Faso (Dipama, 2016). The researches of Durand et al. (2013) corroborate the results that climatic factors affect the development and the physiology of the seedlings in ANR, their seeds and their aerial parts, their roots. The climate change involves the mortality of the seedlings even the disappearance of useful woody species. To cope with the constraints of agricultural and woody productions, the farmers have endogenous strategies and the technologies advised by the technicians of rural development (COGEL, 2013).

The developed strategies aim to preserve the species usually exploited by the rural people and especially those which resist the climatic conditions and ecological forged by the climate change. *Vitellaria paradoxa*, *Parkia biglobosa*, *Eucalyptus camaldulensis* are some of them. The seedling watering especially done in dry season is a strategy which allows the reduction of dryings and the mortality of the seedlings. Although being a good measure taken by the farmers, they themselves are confronted with the lacks and insufficiencies of water for the various uses. Sometimes the waste waters of the households are used for the watering of the seedlings, which involves also the mortality of the seedlings taking into account that these waste waters contain of the detergents and oils (Dovonou et al., 2011; Drabo, 2015). In the same optics to minimize water problems, the farmers dig basins around the seedling to improve soil moisture as well as the soil fertility. Protection by the protective grids although effective presents insufficiencies according to the nature of the grid: the use of the grids woven with Combretaceae meets some constraints related to the slowness of their weaving and the availability of *Combretum micranthum*. Their artisanal weaving requires at least two days per grid. There is also the need for renewing them after two rainy seasons. Thus they are not very advisable for a sustainable management of *Combretum micranthum* species (MCA/BF-AD10, 2014). The metal or plastic grids are usually carried by robbers. The effectiveness of the spiny grids being limited, its association with the metal or plastic grids reinforces the capacity of protection.

Conclusion

It appears clearly that the practice of the ANR is an excellent mean of restoring woody cover and preserving species with socio-economic and ecological interests for rural populations. It reveals that the producers themselves have local knowledge in the sustainable management of woody resources. These local knowledges must be taken into account and, if necessary, be improved in the programs of the rural people development.

Nowadays the practice of the ANR is confronted with the harmful effects of climate change, which reduces its efficiency and requires that the farmers invest themselves more in the assistance of the plants in regeneration. Some technical, material and financial supports to farmers from rural developers is essential to increase the performance of RNA practice. For effective support it would be important to categorize the farmers and consider for each group of actors the woody species that constitute their centers of interest.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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References

A/Tipaalga, 2015. Cartography using the gps statements of the fences of setting in defens and installations in the fields under Natural Assisted Regeneration (RNA) except fence realized by

the people of the province of the Soum. Burkina Faso. 53p.

Arbonnier, M., 2000. Tree, Shrubs and Lianas of the Dry Zones of West Africa. Burkina Faso. 573p.

Belem Ouédraogo, M., Yaméogo, J., Guinko, S., 2010. The ligneous edible plants of gallerie forests of the Biosphere Reserve "de la Mare aux Hippopotames". Fruit, Veg. Cereal Sci. Biotechnol. (Spl. issue). 4(1), 10-17.

Berhaut, J., 1988. Illustrated flora of Senegal. Volume IX. Senegal. p.485.

Camara, B.A., Drama, M., Sanogo, D., Ngom, D., Badji, M., Diop, M., 2017. Local people's perceptions on Farmer Managed Natural Regeneration and agro-ecological effects of the practice on millet's yield (*Pennisetum glaucum* (L.) R. Br.) in the groundnut basin of Senegal. J. Appl. Biosci. 112, 11025-11034.

COGEL, 2013. Exploratory investigation on traditional knowledge and local knowledge related to the Climate and the Environment in the four (04) common targets. Project "Consolidation of the Governance of the Local Environmental. Ministère de l'Environnement de l'Economie Verte et du Changement Climatique. Burkina Faso. 162p.

Dipama, J.M., 2016. Climate change and sustainable agriculture in Burkina Faso: strategies of impact strength based on the local knowledge. Ied AFRICA/PRESSED. 36p.

Dovonou, F., Aina, M., Boukari, M., Alassane, A., 2011. Physicochemical pollution and bacteriological of a watery ecosystem and its ecotoxicological risks: case of the lake Nokoue in the Southern Benin. Int. J. Biol. Chem. Sci. 5(4), 1590-1602.

Drabo, K., 2015. Analysis of the protection measures of the riverbanks of the lake Bam in the north central Burkina Faso. Master II, Senghor University, Ouagadougou Campus, Burkina Faso. 60p.

Durand, J.L., Lorgeou, J., Cochard, P., Volaire, F., 2013. Ecophysiology of the adaptation of the fodder plants and meadow. Fodder. 214,111-118.

IGMVSS., 2015. State of implementation of the Great Green Wall in Burkina Faso. Ministère de l'Environnement de l'Economie Verte et du Changement Climatique. Burkina Faso. 4p.

Kindt, R., Kindt, A., Larwanou, M., Belem, M., Dakouo, J.M., Bayala, J., Kaire, M., 2008. Species accumulation within Land uses and tree diameter categories in Burkina Faso, Mali, Niger and Senegal. Biodiversity Conservation. p.8.

Larwanou, M., Moustapha, A.M., Rabe, M.L., Iro, D., 2012. Sylvicultural and cultural practices in agroforestry parklands according to a North-South rainfall gradient in Maradi Region, Niger. Int. J. Biol. Chem. Sci. 6(1), 24 - 36.

MCA/BF-AD10, 2014. Establishment of life-fencing and windbreakers. Millenium Challenge Account Burkina Faso, p. 23.

Quinn, L., Coombe, M., Millets, K., Daish, T., Colussi, P., Kumar, S., Richardson, H. 2003. Buffy, a Drosophila Bcl-2 protein, has anti-apoptotic and cell cycle inhibitory functions. EMBO J. 22(14), 3568-3579.

Sampony, W., 2016. State and factors of degradation of the woody species of the agroforestry parklands in the rural district of Saaba, Central Burkina Faso. Memory of Forestry ad Environment Engineer. ISEDR/University of Dédougou, Burkina Faso. p. 89.

Smith, J., Lavender, B., Smit, B., Burton, I., 2001. Strategies of adaptation in order to reduce the Canadians vulnerability to the climate changes. Canada. p.13.

Thiobane, M., 2013. Combat the desertification: good points of the ANR and the agroforestry. In: Natural Assisted Regeneration to Green the Crop Soils. Rev. The Books of GREP. pp.8-9.

Von Maydell, H-J., 1983. Trees and shrubs of the Sahel. 531p.

Yameogo, J., Ouedraogo, S.J., Bayala, J., Ouedraogo, M.B., Guinko, S., 2006. Soil microvariations and their impacts on the performance of maize (*Zea mays* var *FBC6*) in parklands of *Borassus akeassii* Bayton,

Ouédraogo, Guinko and *Faidherbia albida* (Del.) A. Chev. Cameroon J. Exp. Biol. 2(2), 53-61.

Yaméogo, J., Ouédraogo, S.J., Bayala, J., Belem/Ouédraogo, M., 2010. Medicinal and food potentialities of seventeen favorites tree species in the agroforestry parklands in the southwestern Burkina Faso. Fruit Veg. Cereal Sci. Biotechnol. (Spl. issue). 4(1), 55-61.

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