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Research Article

Local Perception of Vegetation Dynamics and Its Drivers in Community-Managed Forest: A Case Study from Senegal

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Abstract:

Knowledge on deforestation and forest degradation (DFD) in managed forest is widely available. However, the way local people perceive DFD and its drivers are not well understood. This study aimed at assessing local perception of vegetation dynamics and factors driving DFD in a community-managed forest. Data were collected by means of interviews conducted with 136 respondents from 5 communities. Non-parametric tests were used to analyze the data. The results show that 67% of respondents perceived DFD to be occurring in the forest. The perception of the level of forest degradation among the age groups in the communities was significantly related. The tree species cited as declining were those used for fuelwood and food as well as (*Sterculia setigera* Delile *and Parkia biglobosa* Jacq. R. Br. ex G. Don) and species of high timber value (*Pterocarpus erinaceus* Poir and *Cordyla pinnata* Lepr. ex A. Rich). An overlapping was found between local estimate of species decline and those found to be decreasing with vegetation inventory confirming the reliability of local knowledge. Charcoal production, bush fire, seasonal migration of cattle, and illegal logging, were identified as the main drivers of vegetation dynamics by more than 50% of the respondents. Main economic activities and community location significantly affected the ranking of the perceived drivers of vegetation dynamics, while age group did not.

Keywords: Deforestation, Forest degradation, Drivers, Community-managed forest, Senegal.

Introduction

The ongoing process of DFD observed is linked to environmental and biophysical drivers as well as man-made disturbances (Damnyag *et al.*, 2013; Geist & Lambin, 2002; Sassen *et al.*, 2013). Human disturbances result from cropland expansion, shifting cultivation, urban growth, population increase and wood extraction. Human activities not only impact directly, forest formations but are also expected to influence extreme weather events (Guariguata *et al.*, 2008; Salinger, 2005). Environmental and biophysical drivers embody many factors as indicated in Geist and Lambin (2002). However in the Sahel, rainfall represents a determinative factor of vegetation health explaining the correlation established between the decrease in rainfall observed (Hulme *et al.*, 2001; Nicholson, 2000) and vegetation degradation (Gonzalez, 2001; Gullison *et al.*, 2007; Ji & Peters, 2003).

In Senegal the driving factors of DFD from literature are almost the same (Girard, 2002; Mbow *et al.*, 2008; Sankhayan & Hofstad, 2001). Nevertheless, some factors are more specific to some areas. For example in the peanut basin region, cropland expansion and shifting cultivation have been identified as the main drivers of DFD (Tappan *et al.*, 2000a). In the southern part of Senegal namely in Tambacounda and Kolda which are the main charcoal supply areas of the country, DFD are correlated with wood extraction (Tappan *et al.*, 2000b). These are the common drivers that usually explain land use and land cover change. However, beyond this obvious fact are more complex and hidden mechanisms that drive the process summarized in two major points: policy and institutional factors (Lambin *et al.*, 2001; Mbow *et al.*, 2008; Mortimore *et al.*, 2005). Indeed, implemented policies favour local adaptation strategies which in return impact the environment.

In Senegal, this situation has led to a succession of policies relative to natural resources management in some sectors like, the forestry, to control the continual DFD observed. The evolution of forest management can be summarized in three stages: the colonial period, from independence to the promulgation of the decentralization law, and after decentralization. The first stage was marked by quasi-patrimonial regulations and management that in most cases were communities' rights to exploit natural resources. The policy of natural resource conservation was enforced through repressive methods. In the second period after

independence, the colonial legislation was revised but was still based on centralized state management. The latter, however, did not provide the expected outcomes in terms of sustainable management. On the one hand, this experience resulted in a situation of opposition and conflict between state agencies and local communities raising the issue of local communities' lack of participation in natural resources management. On the other hand, forests still experienced a negative trend. The third stage marked by the involvement of local populations in the management of the natural resources was reinforced by the decentralization law which transfers the management of natural resources to local communities. However, in managed forest for charcoal production where there is co-management between local communities and state agencies, the dynamics of vegetation still show a negative trend (Faye *et al.*, 2016). Consequently, the wish to curb DFD due to charcoal production is threatened by panoply of factors that continue to drive the process. There is however lack of information on these drivers of DFD in managed forest where rules are set in a collaborative manner for a sustainable production of charcoal. It is this knowledge gap in the information on the drivers of DFD that this paper sought to fill. The specific objectives were to: determine the local perception of DFD and to identify the drivers of DFD and their relative importance.

1. Materials and methods

1.1. Study area

Missirah Forest is located in the south-eastern part of Senegal between latitudes 13°26'N and 13° 43'N and longitudes 13°29'W and 13°10'W (Figure 1). The forest covers an area of 63,121.54ha and it is located between the rural communities of Missirah and Kothiary. Topographical map of Missirah Forest shows that the relief is flat with altitudes that vary from 27 to 67 m above sea level. Based on data collected from 1984 to 2014, the mean annual rainfall is estimated at 731mm. The region is characterized by high temperatures of up to 40°C. Missirah Forest harbours several land use actors who until 2004 used the land with no formal regulations. However in 2004 the land came under a regime of community-forest management scheme with a World Bank project. Before the introduction of charcoal production, economic activities were based on a mixture of crop and livestock production.

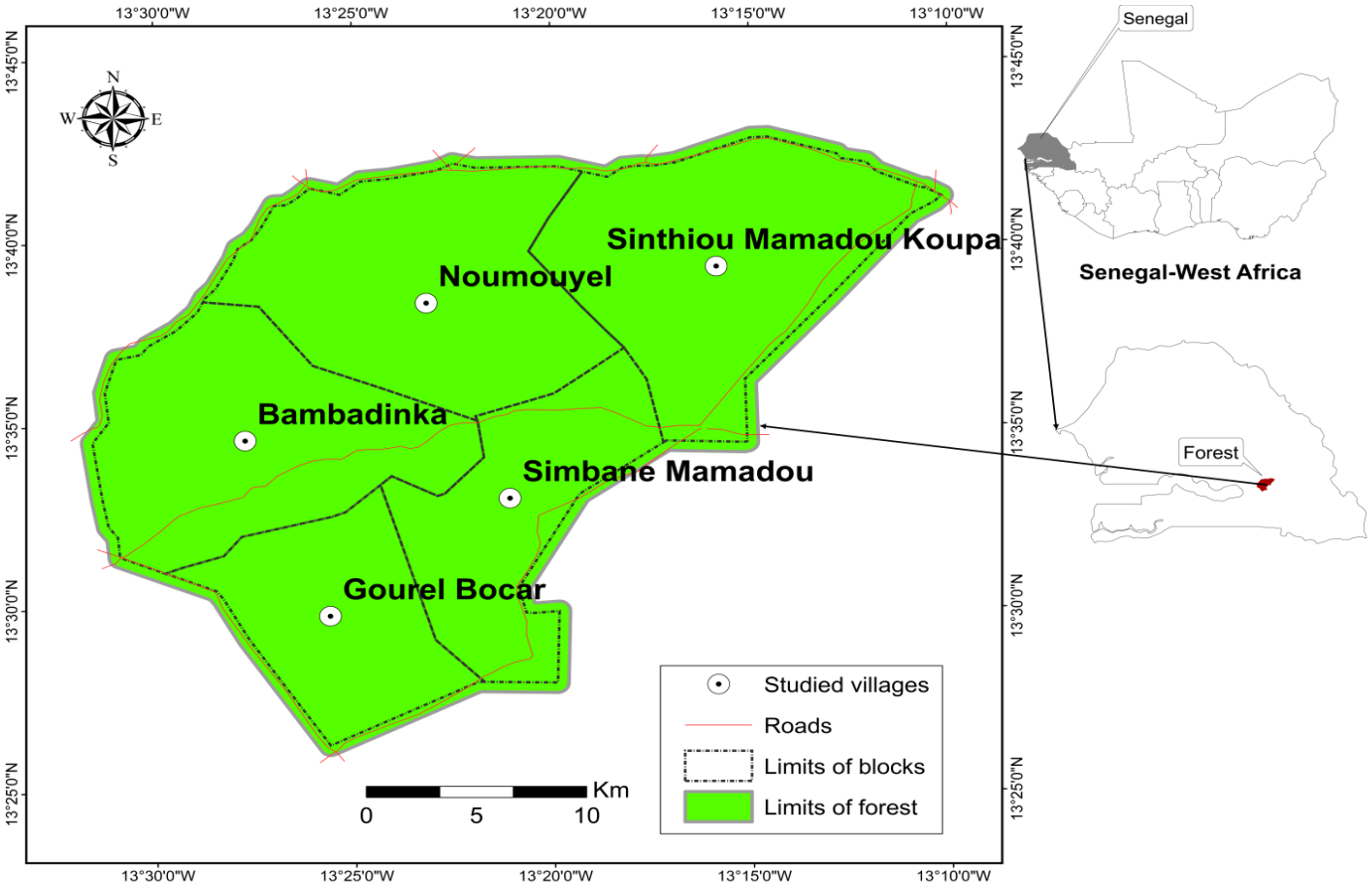

Figure 1. Location of Missirah Forest

1.2. Sampling design and data collection

The choice of the studied villages was made using a multi-stages sampling. Firstly, villages were selected based on their location in the five blocks of the forest. Secondly, villages were chosen according to their main economic activities. The third criterion for the choice of villages was the ethnic grouping. Five villages were selected Noumouyel, Sinthiou Mamadou Koupa, Simbané Mamadou, Gourel, and Bambadinka. Qualitative and quantitative data were collected through focus group and structured interview respectively.

For the questionnaires, the total number of households of the five villages estimated at 217 constituted the population size. The sample size was computed using the table of Krejcie and Morgan (1970). From this table, the sample size of the population ought to be 132 households for the five villages but 136 households were interviewed. The number of households interviewed in each village was determined proportionally to their respective total number of households. Five focus group discussions were organized in all the villages chosen. Information collected from the focus group discussions was used to prepare the questionnaire. Before executing the questionnaire, it was pre-tested in three communities for improvement. The main emphasis of the questionnaire was the perception of local population on the current state of the vegetation compared to the past. They were also asked to give an estimate of the observed changes in the vegetation on a scale of 0-10 unit and to give a list of woody species that are declining. The respondents were also asked to list the drivers of vegetation dynamics and to rank them according to their importance between 1 and 5 in a decreasing scale of severity (1 - most severe and 5- least severe).

1.3. Data analysis

Data were analyzed using the Statistical Package for Social Sciences. Frequency tables and graphs combined with non-parametric statistical techniques were employed in this study. Spearman's rank correlation was used to determine if there is statistically significant relationship between the perception of forest change and the level of forest change among the different categories of respondents. Kruskal-Wallis H Test was conducted to estimate significant difference in the ranking of drivers of vegetation between the categories of respondents. Mann-Whitney U was applied to determine between the categories of respondents among which the difference is observed.

2. Results and discussion

2.1. Socio-economic characteristics of respondents

Interviewees were mostly men, constituting 87% of the sample. Most of the respondents did not receive formal education (Table 1) and about 79% of the educated people had only basic education. The age group of 36-55years was the most represented. Majority of the respondents were engaged in agriculture as their main activity, followed by charcoal production. However, in Noumouyel and Sinthiou Mamadou Koupa communities, charcoal production was the main activity. In Noumouyel, 76.47% of the respondents do charcoal production as their main economic activity and in Sinthiou Mamadou Koupa; all the respondents were charcoal producers. Most of the respondents were found in Bambadinka and Noumouyel with 25.7 % and 24.9% of the sample respectively. The Fulani represented the dominant ethnic group.

Table 1. Characterization of the respondents

Characteristic	Value
Total respondents	136
Gender	men (86.8 %); female (13.2%)
Age	17-35 years (19%); 36 - 55 years (45%) and 56-80 years (36%)
Education	formal education (10.3%); no formal education (89.7%)
Main occupation	agriculture (55.9%); charcoal production (43.4%); trading (0.7%).
Ethnic group	Fulani (62.5%); Diakhanke (19.1%); Sarakhole (8.8%); Manding (8.8%) and Bambara (0.7%)
Villages' respondents	bambadinka (25.7%); Noumouyel (24.9%); Simbane Mamadou (19.85%); Gourel Bocar (19.85%) and Sinthiou Mamadou Koupa (9.5%).

2.2. Local perception of vegetation dynamics

Majority of respondents (67%) in the surveyed communities described a negative trend of the vegetation change. This is consistent with majority of earlier research findings on local perception of vegetation dynamics (Damnyag *et al.*, 2013; Lykke *et al.*, 2004; Mertz *et al.*, 2009; Ouoba *et al.*, 2014; Sop & Oldeland, 2013). However, from one community to another, vegetation change was differently perceived. In Noumouyel, Sinthiou Mamadou Koupa, and Bambadinka respectively, 97%, 61%, and 77.1% of the informants described the change in vegetation as retrogressive while in Gourel and Simbané Mamadou majority of the respondents felt the vegetation had actually improved.

The location of communities and their perception on the level of change in vegetation of Missirah Forest were significantly related ($p < 0.02$). The perceptions of respondents were informed by the state of the coupes earmarked for charcoal production that are located close to them. Their perceptions of the state of plots under production were significantly related ($p = 0.001$). In Noumouyel, and Sinthiou Mamadou Koupa 75% and 90% respectively of the respondents considered the coupes of their blocks to be overexploited. Conversely, in Simbané Mamadou, people found the plots underexploited while respondents in Gourel found the exploitation of plots balanced. These differences in forest quality at various locations of the forest may be explained by differences in the level of human pressure. In Noumouyel and Sinthiou Mamadou Koupa there is a heavy pressure on the

vegetation because of the intense activity of charcoal production.

The rating of the level of change by respondents in different age groups was significantly negatively correlated (Spearman's rho r = -0.42, p <0.001). The older the respondent, the higher the rating of the level of degradation. Majority of respondents in 36-55 and 56-90 year groups rated the loss in the vegetation on a scale of 5-6, indicating a loss of 50 % and 40 % respectively, whereas most respondents in the 16-35 year group rated the loss in vegetation on a scale of 7-8, indicating a loss of 20 %. This is corroborated by Ayantunde *et al.* (2008) in south-western Niger and Sop and Oldeland (2013) in Burkina Faso who documented that local ecological knowledge was positively correlated with age. Both of these studies argued that the older the respondents, the more the number of species identified as declining are important. The economic activity of the respondents was not significant in explaining the perception of the level of degradation (p = 0.28).

A total of 24 species belonging to 10 families were cited by respondents who perceived degradation as species experiencing a decrease in numbers (Figure 2). Fifty percent (50%) of the species belong to the *Fabaceae* family and 12.5% to the *Moraceae* family. Each of the 8 remaining families contains only one species. About 58% of the species are commonly cited in the five communities. The unanimous recognition of the decline of these species may suggest that they are really threatened in the forest. Twelve (12) species cited as declined by populations were not found in the plots in 2013. Three species *Stereospermum kunthianum* Cham, *Sclerocarya birrea* (A. Rich) Hochst and *Ziziphus mauritiana* Lam were recorded in 2013 but only with one individual for each. Five species namely *Detarium microcarpum* Guill. & Perr, *Pterocarpus erinaceus* Poir, *Prosopis africana* Guill. & Perr., *Sterculia setigera* Delile and *Cordyla pinnata* Lepr. ex A. Rich showed various levels of decline in stem numbers between 2002 and 2013. According to the local communities, with the exception of areas surrounding the settlements, *Cordyla pinnata* Lepr. ex A. Rich populations in remote areas were decimated by loggers. The correlation between local knowledge and field data is confirmed by Lykke *et al.* (2004) and Hermann and Tappan (2013), who revealed an overlap between local estimates of species decline and those found to be decreasing with vegetation inventory. *Anogeissus leiocarpus* (DC.) Guill. & Perr is the sixth species cited as declining. This perception however, does not match with field data that revealed an increase. Its high score can be justified by the large numbers of respondents in Noumouyel and Sinthiou Mamadou Koupa which are areas of intensive charcoal production. Indeed, *Anogeissus leiocarpus* (DC.) Guill. & Perr is among the preferred species for charcoal and consequently is subjected to high rate of cutting (Furukawa *et al.*, 2011; Houehanou *et al.*, 2013). These authors highlighted that fuelwood extraction contributed to the reduction of adult individuals of preferred woody species.

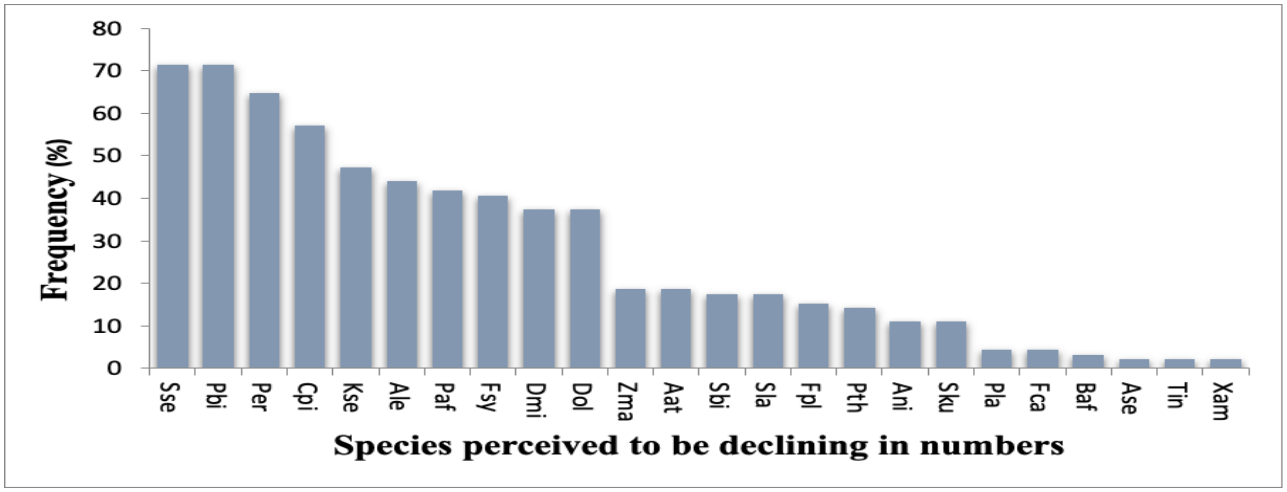

Figure 2. Respondent's perception of species experiencing decline in their numbers

Sse = Sterculia setigera; Pbi = Parkia biglobosa; Per = Pterocarpus erinaceus; Cpi = Cordyla pinnata; Kse = Khaya senegalenis; Ale = Anogeissus leiocarpus; Paf = Prosopis africana; Fsy = Ficus sycomorus; Dmi = Detarium microcarpum; Dol = Daniella oliveri; Zma = Ziziphus mauritiana; Aat = Acacia ataxacantha; Sbi = Sclerocarya birrea; Sla = Sarcocephalus latifolia; Fpl = Ficus platyphylla; Pth = Piliostigma thonningii; Ani = Acacia nilotica; Sku = Stereospermum kunthianum; Pla = Prosopis laxiflora; Fca = Ficus capensis; Baf = Burkea africana; Ase = Annona senegalensis; Tin = Tamarindus indica; Xam = Ximenia americana.

2.3. Drivers of deforestation and forest degradation

Panoply of vegetation dynamics' drivers (16) were identified by local communities. The most cited were charcoal production, bush fires, seasonal migration of cattle, illegal logging, population increase, and rainfall decrease (Figure 3). Charcoal production is widely acknowledged by the community of scholars to be a cause of deforestation (Chidumayo, 2004; Chidumayo & Gumbo, 2013) and forest degradation (Kouami *et al.*, 2009; Ribot, 1993). However, in this case charcoal is supposed to be produced sustainably following technical prescriptions. Therefore, if charcoal production still contributes to DFD, three main reasons can be evoked; the prescribed volume of trees recommended in the management plan exceeded the mean annual increment of the forest, producers are taking more than what is prescribed, and other prescriptions that are crucial for the recovery of the forest are not

being adhered to e.g. cutting height that should encourage the sprouting of the stumps. The recovery of the forest is mainly based on coppicing after cutting; hence, if stumps fail to coppice replacement of the harvested volumes cannot be achieved. Uncontrolled bush fire is a major driver of vegetation degradation in savanna woodlands (Mbow *et al.*, 2003) where fire is used as a management practice (Sawadogo *et al.*, 2002). Since the prevention of bush fires is one of the key objectives stated in the management plan, the high score of bush fires implies that the management plan is not being implemented well. Fire management requires a lot of commitment to be effective eg annual maintenance of fire breaks and proper resourcing of local committees to be able to suppress a bush fire when it starts. It appears these and other requirements for effective fire management are not being implemented.

The seasonal migration of cattle is a traditional management practice in the sahel to ensure natural regeneration of vegetation (Lykke *et al.*, 2004). However, in present times characterized by high human and livestock populations combined with the degradation of natural resources it becomes rather a cause of degradation and conflicts with communities receiving cattle herders. For instance, cattle herders cut almost every tree species and people believe that the way they cut the trees hampers easy regeneration. Furthermore, dead branches that remains after their passage, increases the fuel load making bush fires virulent. People engaged in illegal logging are mostly non-residents. Species concerned are especially *Pterocarpus erinaceus* Poir, *Cordyla pinnata* Lepr. ex A. Rich, and *Afzelia africana* Smith ex Pers. Despite its prohibition, logging is still going on in Missirah Forest escalating the removal of trees. This fact confirms that the management plan is not being effectively implemented. Population growth is positively correlated to vegetation cover clearance (Ouedraogo *et al.*, 2010) mostly in areas of extensive agriculture. In dry land areas land degradation combined with high level of poverty compel local communities to start new farms to increase their yields for food consumption and sale. Forest clearing is made easy by charcoal production especially in areas harvested frequently with grasslands becoming more prevailing (Braimoh & Vlek, 2004b).

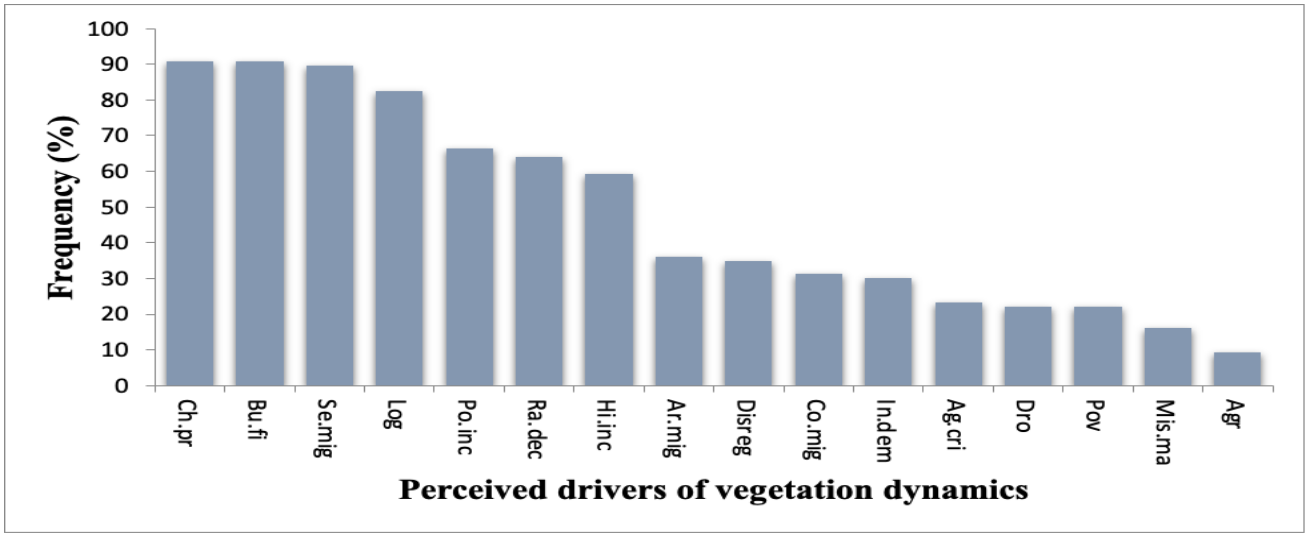

Figure 3. Respondent's perception of drivers of deforestation and forest degradation

Ch.pr= charcoal production; Agr. = agriculture; Se.mig= seasonal migration of cattle; Bu.fi= bush fire; Log.= logging; Dro.= drought; Ra.dec= rainfall decrease; Mis.ma= mismanagement; Disreg= disregard technical prescriptions; Po.inc= population increase; Ar.mig= arrival of migrants; Hi.inc= high income generated by charcoal; Co.mig= conversion of migrant into traders; In.dem= increase in charcoal demand from cities; Pov= poverty; Ag.cri= agricultural crisis.

The least cited driver of DFD was agriculture relating to forest clearance for the establishment of new farms or the expansion of old farms. However, 44% of the respondents asserted to establish new farms in the last 5 years and 48% to extend their old farms in the same period. On the other hand, agricultural crisis (lack of fertilizers, seeds and marketing of produce) was cited by 23.26% of the respondents. The crisis of cash crops such as cotton and peanut in the area would incite a good many people to convert into charcoal producers and by this way increase the pressure on the forest. The decrease in cotton production in the area was hastened by the introduction of the joint guaranty. Today few villages continue to produce cotton. Regarding peanut production, problems relating to seeds and fertilizer procurement combined with the issue of commercialization of the production, compelled majority of villagers to give up producing peanut, except for their own consumption.

Disregard shown towards technical prescriptions of the management plan, was indicated as driver by 35% of the respondents. Participation in PRODEGE training and the likelihood of acknowledging that a respondent had acquired knowledge on the technical prescriptions of the management plan were found to be significantly related ($p < 0.001$). The proportion of those who indicated participation in PROGEDE training and had some knowledge on technical prescriptions of the management plan was 89%. However, none of them was able to give all the right information about the species recommended, the diameter size of trees to be cut, areas restricted to charcoal production, the type of kiln, and the height from which trees should be cut to encourage a

good coppicing after exploitation. This was corroborated by field observations. The Casamance kiln, considered as one of the most successful improved kilns (Maes & Verbist, 2012) recommended, is not actually adopted by local communities who affirmed in their majority to use the traditional pit kiln. The bundle of firewood collected in the field contains wood from forbidden species like *Anogeissus leiocarpus* (DC.) Guill. & Perr, *Burkea africana* Hook and *Mitragyna inermis* (Willd) Kuntze. Furthermore, kilns were found in valleys where charcoal production is prohibited. The length of stumps measured in exploited plots was more than 20cm, which is at variance with the recommendations of the management plan. The disregard for the technical prescriptions is exacerbated by the laxity of rangers in charge of controls in the field. This finding is supported by Kaimowitz (2003) who found that the recommendations of management plans are not always applied correctly. The importance of this result for the continuation of the process is that the statute of managed forest alone does not guarantee a sustainable production of charcoal (Fandohan *et al.*, 2011). Indeed, a rigorous enforcement of technical prescriptions built on reliable ecological bases is one of the pillars for a sustainable management.

The perceived causes of DFD were observed to be different from one community to another. The results showed that the most cited drivers in Gourel, and Simbané Mamadou, are respectively charcoal production, seasonal migration of cattle and bush fire. The arrival of migrants for charcoal production was frequently quoted as driver by 70% and 35% of the respondents in Simbané Mamadou and Gourel, respectively. They attract immigrants because local people are not really engaged in charcoal production, as such their lands have better tree stocks and it is easier to get a license for commercialization. In Bambadinka also these three factors were the most enumerated except the fact that bush fire comes before seasonal migration of cattle.

The perception was different in Noumouyel and in Sinthiou Mamadou Koupa. In Sinthiou Mamadou Koupa the three most cited were in the order of: bush fire, seasonal migration of cattle and logging whilst for Noumouyel logging was the most cited, followed by seasonal migration of cattle and charcoal production. These two localities are mostly where the disregard for the technical prescriptions occurred. It constituted a major problem in these zones because of large presence of people from Guinea that are not conversant with the technical prescriptions. The mismanagement relative to corruption was also more quoted in these two communities where the number of charcoal producers was quite high. There, they were more confronted with the issue of license which according to them was the subject of a nebulous management. Looking generally at the distribution of the 31 licenses reported, Gourel got the highest share (35%) followed by Noumouyel (23%) and Bambadinka (23%), Simbané Mamadou (16%), and Sinthiou Mamadou Koupa (3%). However, the comparison of the number of charcoal producers who had license and the total number of charcoal producers in each village showed that in Noumouyel and Sinthiou Mamadou Koupa the ratio was very low. The proportion of charcoal producers that had license was estimated at 9% in Sinthiou Mamadou Koupa and 26% in Noumouyel while it reached 58% in Bambadinka, 63% in Simbané Mamadou and 73% in Gourel Bocar.

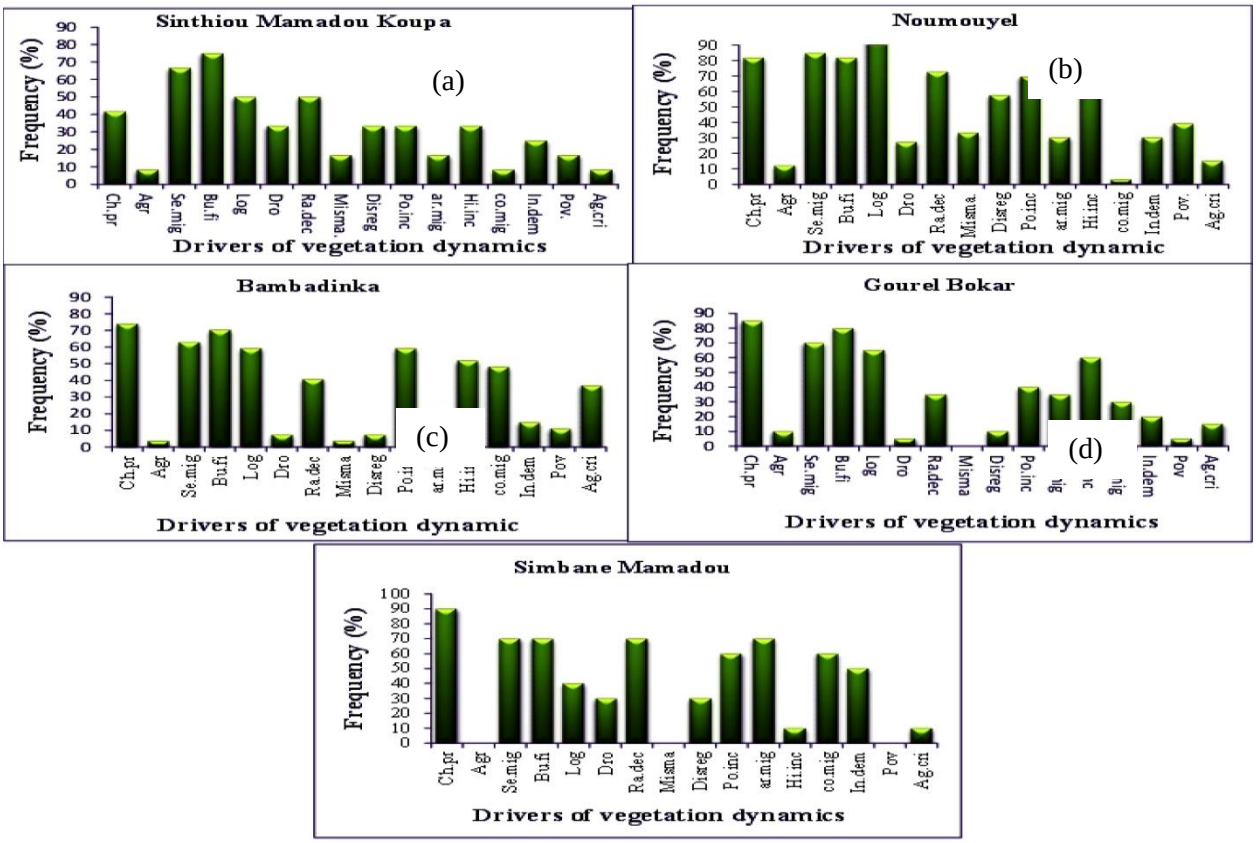

Figure 4. Drivers of vegetation dynamics in the different communities

Ch.pr = charcoal production; *Agr* = agriculture; *Se.mig* = seasonal migration of cattle; *Bu.fi* = bush fire; *Log* = logging; *Dro* = drought; *Ra.dec* = rainfall decrease; *Mis.ma* = mismanagement; *Disreg* = disregard technical prescriptions; *Po.inc* = population increase; *Ar.mig* = arrival of immigrants; *Hi.inc* = high income generated by charcoal; *Co.mig* = conversion of migrant into traders; *In.dem* = increase in charcoal demand from cities; *Pov* = poverty; *Ag.cri* = agricultural crisis.

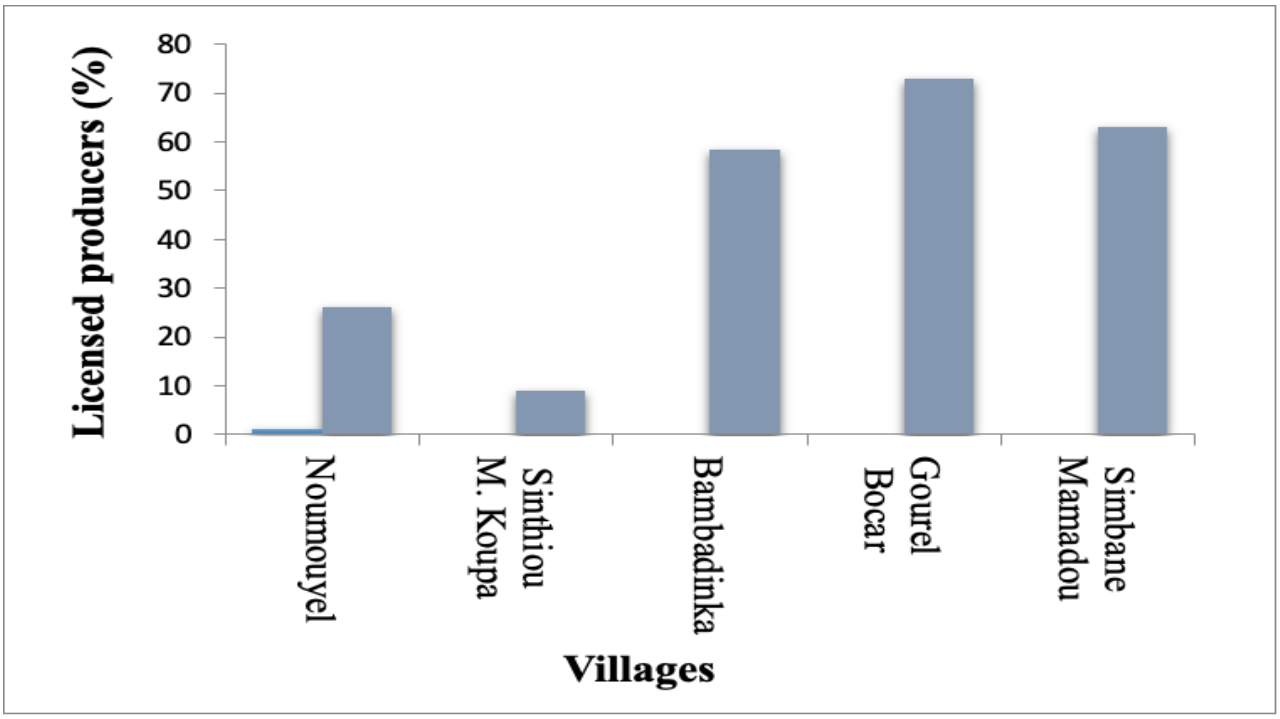

Figure 5. Percentage of licensed charcoal producers in the various communities

Mismanagement as a factor of forest degradation has also been reported from other parts of the country (Mertz *et al.*, 2009). Poverty is also more prevalent in the two localities as a driver of vegetation dynamics. The lack of other sources of income to meet basic needs is acknowledged to be correlated with vegetation dynamics (Damnyag *et al.*, 2013). People with low income have a higher level of dependency on natural resources (Qasima *et al.*, 2013) and consequently exercise more pressure on vegetation. This raises the issue of the need to balance conservation and local development (Hoang *et al.*, 2013).(Hoang *et al.*, 2013) Logging was cited by at least 50% of the respondents in each village except in Simbané Mamadou. This may be explained by the proximity of these villages to the main road and the main town (Avon *et al.*, 2013; Mon *et al.*, 2012; Newmana *et al.*, 2014). Population increase as a driver of DFD was often mentioned in Noumouyel, Bambadinka and Simbané Mamadou. Conversion of emigrants into operators of charcoal production was cited mainly in Bambadinka and Simbané Mamadou. This factor is more important in these communities because they are characterized by a high rate of immigration.

2.4. Ranking of vegetation drivers

To identify the drivers that contributed more to DFD, they were ranked between 1 and 5 in a decreasing scale of severity. The Kruskal-Wallis H test conducted on the ranking of causes of DFD showed a significant difference in the ranking of cattle rearing, charcoal production and illegal logging among respondents in the different communities ($p < 0.05$) whilst there was no significant difference in the medians of the remaining drivers of DFD (Table 2).

On the pairwise comparison of the ranking of the drivers of DFD between the five communities for cattle rearing, there was significant difference between Noumouyel and Simbané Mamadou communities, $p = 0.05$, mean ranks = 18 and 10 respectively; Sinthiou Mamadou Koupa and Simbané Mamadou, $p = 0.01$, mean ranks = 10 and 4 respectively; Sinthiou Mamadou Koupa and Bambadinka, $p = 0.03$, mean ranks = 25 and 17 respectively; and Simbané Mamadou and Gourel, $p = 0.04$, mean ranks = 5 and 9 respectively. It shows therefore the predominance of cattle rearing in Noumouyel, Sinthiou Mamadou Koupa and Gourel compared to Bambadinka and Simbané Mamadou.

The ranking of charcoal production as a driver of DFD, showed the prevalence of the activity in Noumouyel (Noumouyel and Bambadika, $p = 0.03$, mean ranks = 32 and 23 respectively; Noumouyel and Gourel, $p = 0.003$, mean ranks = 21 and 10 respectively) and in Simbané Mamadou (Simbané Mamadou and Gourel, $p = 0.01$, mean rank = 12 and 6 respectively). With regard to illegal logging as a driver of deforestation, there was significant difference for Noumouyel and Bambadinka, $p = 0.001$, mean rank =13 and 26 respectively; Sinthiou Mamadou Koupa and Bambadinka, $p = 0.01$, mean rank = 3 and 8 respectively. Therefore illegal timber logging appears to be more prevalent in Bambadinka.

Table 2. Ranking of causes of deforestation by importance on a scale of 1-5 and their significance among respondents in different study communities

Drivers of vegetation dynamics	n	Min	Max	Mean	H Test statistics and *p*- values in the 5 communities
Seasonal migration of cattle	75	1	4	1.80	H(4)=9.97, *p*=0.04
Charcoal production	75	1	4	1.99	H(4)=12.46, *p*=0.01
Illegal logging	37	1	4	2.41	H (4)=15.18, *p*=0.001
Bush fire	73	1	4	2.44	H(4)=5.34, *p*=0.25
Disregard for technical prescriptions	4	1	4	3.00	H(2)=2.67, *p*=0.26
Rainfall decrease	9	1	5	3.22	H(3)=5.52, *p*=0.14
Arrival of migrants for charcoal	4	2	4	3.25	H(2)=2.25, *p*=0.32
Increase charcoal demand from cities	5	3	5	3.80	H(2)=1.26, *p*=0.53
Conversion of immigrants	12	3	5	4.00	H(2)=0.87, *p*=0.65

For the ranking of causes of DFD by charcoal producers and farmers, there was significant difference only for illegal logging and rainfall decrease. For bush fire, charcoal production and seasonal migration of cattle there was no significant difference among them (Table 3). With regard to age groups, it was not significant in explaining the differences in the ranking of the causes of vegetation dynamic ($p > 0.05$).

Table 3. Ranking of causes of deforestation by importance on a scale of 1-5 and their significance among respondents in different main economic activities

Drivers of vegetation dynamics	N	Min	Max	Mean	H Test statistics and *p*- values among farmers and charcoal producers
Seasonal migration of cattle	75	1	4	1.80	H(1)=1.9, *p*=0.17
Charcoal production	75	1	4	1.99	H(1)=6.7, *p*=0.10
Illegal logging	37	1	4	2.41	H(1)=10.04, *p*=0.002
Bush fire	73	1	4	2.44	H(1)=0.91, *p*=0.34
Rainfall decrease	9	1	5	3.22	H(1)=5.21, *p*=0.02

Conclusion

This study has shed light on local populations' perceptions of vegetation dynamics as well as the factors driving the dynamics. Majority of respondents in the five communities describe a negative trend of the vegetation and identified 24 species as declining. Charcoal production, bush fire and seasonal migration of cattle that were identified as lead drivers of vegetation dynamics are confirmed by literature. This shows a high level of environmental awareness among the people that appears to improve with age. The main lesson to learn from this research is that the current management appears inadequate to uphold a rational use of natural resources and that charcoal production remains the main driver of vegetation change. This study showed also that local communities are not adhering to the technical prescriptions despite their awareness of the drivers of vegetation dynamics. Although in most cases there was consistency in the ranking of the perceived drivers, difference was observed for seasonal migration of cattle, charcoal production, and illegal logging. Respondents in villages where charcoal production is the main economic activity tend to consider illegal logging as the main driver whereas those in communities where agriculture is prevalent charcoal production is perceived as the most important.

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