Factors Influencing the Conservation of Tropical Forest Resources in West Africa

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Abstract:

In this paper, we measure the degradation of the W Reserve in West Africa using the number of cases of illegal farming and illegal cattle grazing recorded and analyze the factors influencing such degradation using nonlinear Seemingly Unrelated Regression (SUR) model. Our results indicate that the Reserve degradation was negatively correlated with the average income level, the number of financial institutions, and the distance while a positive correlation with the average farm areas in the villages. The institutional characteristics of the villages, namely the number of non-governmental organizations promoting nature preservation, and the existence of check points between the Reserve and the villages in its periphery were negatively correlated with its degradation. Keywords: W Reserve, West Africa, illegal farming, illegal cattle grazing

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Keywords: W Reserve, West Africa, illegal farming, illegal cattle grazing

INTRODUCTION

We analyzed the factors that influence the degradation of tropical forests resources in West Africa using illegal farming, and illegal cattle grazing with the W Reserve as study area. Indeed, natural resources play a key role in the production of market commodities for society (Zhang and Pearse, 2012). They represent important resources for society particularly, not because of their existence but much more for the usefulness they provide to the human society as inputs in the production of goods and services. Although several combinations of inputs (such as labor, capital, etc.) can be used to increase production in the short run, production can be compromised in the long run when the resources are not exploited efficiently. Such situations could result from the overuse of non-renewable natural resources.

One such resources whose exploitations are raising concerns are tropical forests resources. According to FAO (2016) although the degradation of forests resources has slowed down globally, tropical forests resources degradation is still important with one of the highest rate observed in Africa. Indeed, the conservation of tropical forest resources is vital because although they provide 25% of our medicines worldwide, and inhabit over 50% of the planet biodiversity, they cover less than 10% of earth (Lasco, 2008). They sustain millions of people life worldwide and contribute directly and indirectly to countries' economies. Culture provisions include their use as places of recreations, education, ceremonies, etc. (Musyoki et al., 2013) while environmental services encompass biodiversity conservation, soil erosion control, water cycle regulation, carbon sequestration with effects global warming reduction, etc. (FAO, 2016).

In tropical regions, most forests resources are conserved as protected areas dedicated for the maintenance of biological diversity and managed through legal or other effective means (IUCN, 1998). Protected areas in general are created to meet three goals: (i) ecosystem preservation, (ii) local development, and (iii) environmental education (Barbero et al., 2011). Therefore, the persistence of their degradation in these areas implies the non-consideration of some important factors that could explain the pressure from the communities around them through illegal activities (e.g. poaching, illegal farming, illegal cattle grazing, etc.).

Although several studies have investigated the factors that influence forest resources conservation in general, and particularly tropical forests resources, their degradation persists indicating incomplete understanding of the drivers of the phenomena. The rationale of this study comes particularly from the existence of several uncertainties in the literature on the

identification of the factors that determine the degradation of forest resources because of their proxy for these resources degradation. Indeed, the studies on forest resources conservation measured the degradation of these resources using individually deforestation (e.g. Culas, 2014; Chaudhary et al., 2016) or cattle grazing (Barona et al., 2010; Walker et al., 2000), or poaching (Piel et al., 2015; Knapp, 2012) but no study to our knowledge considered together illegal farming, and illegal cattle grazing as a proxy of these resources degradation. Accordingly, this study appears as the first study to investigate the factors influencing forests resources degradation, and particularly tropical forests resources degradation considering together illegal farming and illegal cattle grazing as measurement of these resources degradation.

In addition, while the existing literature on forests resources conservation has focused mainly on countries (Chaudhary et al., 2016; Culas, 2014; Diarassouba and Boubacar, 2009; Yiridoe and Nanang, 2001) and individual households (Lovera, 2014; Dolisca, 2005) as study units, very little is known on the relationships between the characteristics of the villages in the peripheries of forests resources, and their degradation. Indeed, while country level studies as well as individual household level studies provide useful information in the understanding of forests resources degradation, considering villages as study units will provide additional information in the understanding of the phenomenon. Particularly in tropical regions, villages represent the first administrative units around forests resources whose characteristics may influence the behaviors of utility maximizing individuals toward these resources. Consequently, whether the characteristics, namely the socioeconomics characteristics and institutions of the villages in the peripheries of forests resources influence their degradation is unclear.

Several factors can be associated with the degradation of forests resources in tropical regions such as the high population growth observed in these regions. Indeed, while an increase of the population results in the increase in the demand for food, lands for habitations, and infrastructures, the size of the land areas available to meet these needs is constant. Hence, to reach these goals, the exploitation of forests resources as well as the conversion of forests lands into alternative uses by the population in their peripheries appear as inevitable. However, although population in tropical regions could explain in part the pressure on forests resources, a range of other socioeconomics characteristics and institutions can strongly influence their degradations. A clear understanding of the linkages among forests resources degradation, and the socioeconomics and institutional characteristics of the villages in the periphery of these resources is still elusive.

Sustainable uses and conservation of tropical forests benefit not only tropical regions but the whole planet. Indeed, tropical forests degradation through deforestation in recent years is considered as one of the major causes of greenhouse gas flux from land use changes (Lasco, 2008). Forests resources are natural sink for carbon due to their carbon fixation capacity during photosynthesis and their conversion into biomass (Nowak et al., 2013). Consequently, because carbon influences global temperature and energy use, it appears that forests resources influence the global climate essential for human activities. Although efforts are made worldwide to reduce forests resources degradation in general and particularly tropical forests resources through the funding of several mitigation projects, important amount of resources and costs can be saved through the improvement of the understanding of the phenomenon.

Our general hypothesis was that both socioeconomics characteristics, namely population, average level of income, number of financial institutions, average farm areas, distance, and

institutional characteristics namely, participatory management of forests resources, environmental non-governmental organizations, check points influence tropical forests resources degradation through illegal farming, and illegal cattle grazing. Indeed, as population increases, there will be an increase in the number of cases of illegal farming and illegal cattle grazing in the Reserve. Second, as the number of financial institutions, and non-governmental organizations promoting nature preservation increase, the number of cases of illegal activities in the Reserve will decrease. Third, the increase in the distance, and the existence of check points between the Reserve and the villages in its periphery will be associated with the decrease in the number of cases of illegal farming and illegal cattle grazing in the Reserve.

Although several authors have investigated the factors that influence forests resources degradation using deforestation or cattle grazing individually, uncertainties remain on the explanatory factors. As example, while some authors observed that population has little influence on deforestation (Ali, 2005; Westoby, 1989), the results of other studies (e.g. Laurance, 1999; Diarassouba and Boubacar, 2009) suggested that population pressure influence significantly and positively forests cover loss. Moreover, while some studies (e.g. Culas, 2014; Kirby et al., 2006) suggested that deforestation is influenced by domestic consumption of woods as well as forests products exports, other authors (e.g. Southgate, 1994) identified farm products exports as factors influencing deforestation. In addition, while institutions are expected to influence forests resources degradation, the extent of their effects is still unclear.

There are indications that distance influence the behavior of utility maximizing individuals toward natural resources in general, and forests resources. Distance provides incentives in the exploitation of resources since it reduces the private costs associated with the activities such as transportation costs, loss of time, efforts, etc. (Barlowe et al., 2013). Giliba et al. (2011) observed a significant and negative correlation between the degradation of forests resources, and the distance between them and homesteads. Similarly, Kirby et al. (2006) noted that proximity of households to previous degraded forests areas increases the likelihood of the sites to be degraded.

2. STUDY AREA

The W Reserve was chosen as the study area because it is one of largest reserve in West Africa and crosses three (3) countries, namely Benin, Burkina-Faso, and Niger with a wide range of villages in its periphery. Covering an area of 1,024,280 hectares with 563,280 hectares in Benin, 235,000 hectares in Burkina-Faso, and 226,000 hectares in Niger, the Reserve is located between 11º and 12º35 North latitude and 2º and 3º50 East longitude (Mahamane, 2005).

Its fauna is one of the richest on the continent and includes emblematic species such as the lion (*Panthera leo*), the Giraffe (Giraffa Camelopardalis), the Gazelle (*Gazella rufifrons*), the Buffon's kob (*Kobu kob*), and reptiles (Rabeil, 2003). Moreover, it is one of the rare place in Africa where endangered species (species on the red list of International Union of Conservation of Nature (IUCN) such as cheetah, lycaon, African elephant) are living, and a unique bird area. Its vegetation comprises savannah, gallery forests, and grasslands.

The periphery of the W Reserve comprises about 210 villages with a human population estimated at 405,000 people (ECOPAS, 2003). This population belongs to different ethnic groups who share several ties and cultures. The Bariba, Mokolle, and Dendi represents the main ethnic groups in Benin while the Gourmantche are the most dominant group in Burkina-Faso. In Niger, the Zarmas, Haoussa, Foulmaganis are the main ethnic groups while the Fulani are

present in the three countries (Barbero et al., 2011). The human population in the periphery of the Reserve has a long history of relationships with their natural environment with farming, hunting, extensive cattle grazing, and wood and non-wood resources exploitation as their main source of livelihood. Although, there are collaborations and concertation in the management principles of the Reserve, each country managed the areas of the Reserve on its territory based on its national legislation. Figure 2.1 presents the study area

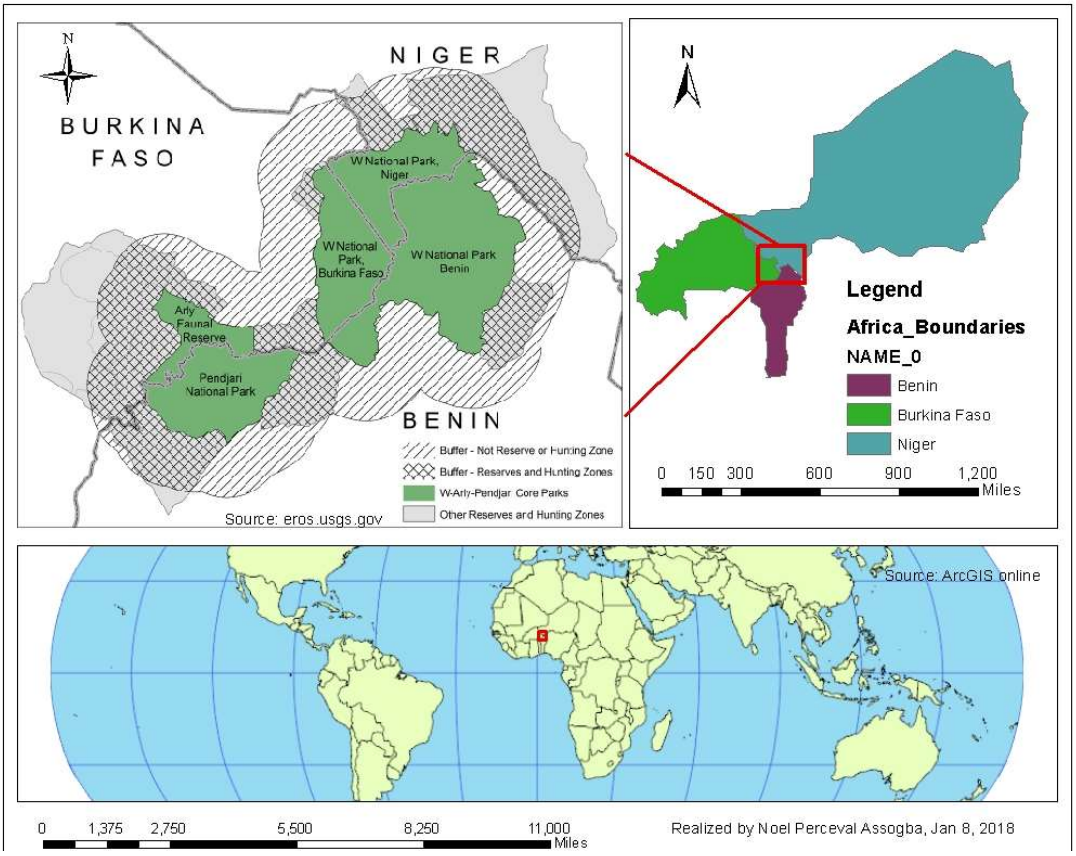

Figure 2.1: Study area

3. METHODS

3.1. Theoretical model

In the literature, several models have been proposed to analyze the factors that influence natural resources conservation. One such model is the livelihood framework (Babigumira et al., 2014; Allison and Horemans, 2006; Campbell et al., 2001). Within this framework, actions resulting to natural resources degradation come from the links that exist between these resources and the livelihoods of the households in their periphery. The livelihood framework considers essential the understanding of the livelihood strategies as well as the contextual realities in a specific place for the explanation of the interactions between the communities and the natural resources in that place. It comprises 5 major factors, namely, external uncontrollable factors (e.g. employment opportunities), livelihood assets (e.g. human capital, natural capital), transforming

structure (e.g. enforcement system, education, market), livelihood strategies (e.g. cattle grazing, farming, hunting), and livelihood outcomes (e.g. income, food) (Babigumira et al., 2014; DFDI, 1999). This model takes a wholistic approach, and because of its structure is considered as a more general model used for the derivation of specific models in understanding interactions between rural households and natural resources.

A specific model used in the literature particularly to identify the incentives to illegal use of natural resources under protection is the open access model proposed by Sutinen and Anderson (1985) and modified by Charles et al. (1999) to analyze the behavior of fishers in three regulatory contexts, namely, unregulated, imperfectly enforced inputs controls, and imperfectly enforced. The open access model is a short run profit maximizing model consisting of a specification of a production, and a cost functions which forms depend on the type of resources being modeled. It can be used to analyze the incentives to the degradation of natural resources on which the actors whose actions are responsible of the degradation have no control on the access to these resources (Bulte and van Kooten, 1999; Poudyal, 2005).

Hence, following this model, profit maximizing individuals in the villages in the periphery of the W Reserve carry out illegal activities (illegal cattle grazing, illegal farming) to maximize short-run profit. Let's denote by p the unit price of output, f the quantity of output, z the quantity of input, and d the unit price of input. The optimization problem of the individuals can be expressed as follow:

$$Max_z \{pf - dz\} \quad (1)$$

Solving for the First order condition, equation (1) yields to following marginal conditions:

$$pf = d \quad (2)$$

Equation (2) indicates that the individuals maximize their profit at the condition where marginal revenue, and marginal cost are equal.

Illegal activities imply the existence of law enforcement system or mechanism to prevent or reduce the activities. In the case of the W Reserve, the law enforcement system consists of the surveillance units and checkpoints between the Reserve and some villages in its periphery. Hence, the implementation of these activities is associated with some risks. These risks can be measured by the probabilities of being detected, and or being punished (e.g. prisons, fines, etc.). Considering the risks associated with the activities the optimization problem in equation (1) becomes:

$$Max_z = \{pf - dz - \Omega R\} \quad (3),$$

where Ω is the probability associated with being detected, R the level of fine, and ΩR the expected value of the fine. The output f is assumed to be a function of input level, and of the biomass available for exploitation; Ω is a function of enforcement and the output; and R a function of the output. Accordingly, solving (3) the marginal condition for profit maximization is as follows:

$$pf_z = w + f_z [\Omega_z R + R_z \Omega] \quad (4)$$

Equation (4) indicates that profit is maximized when the marginal revenue equals the input cost per unit plus the marginal change in the expected fine with a change in output (Milner-Gulland and Leader-williams, 1992). The optimum output is expressed as:

$$f^* = f(z^*, H) \quad (5)$$

where H is the biomass of the goods (e.g. fodder) removed by the individuals from the Reserve.

The explicit form of the profit maximizing output can be obtained by defining the form of the production function. Following Charles et al. (1999), let's define the *f* linear production function as:

$$f = \mu z H \quad (6)$$

where μ is a catchability coefficient species specific. The probability of being caught is assumed to be proportional to the input:

$$\Omega = \alpha z \quad (7)$$

where $0 < \alpha < 1$.

The penalty or fine is assumed to be proportional to output:

$$R = \eta f + p \quad (8)$$

Substituting equations (6), (7), and (8) in equation (3), the optimization problem is:

$$Max_z = \{p(\mu z H) - dz - \alpha z (\eta \mu z H + p)\} \quad (9)$$

Equation (9) implies the following condition:

$$p\mu H - d - 2\alpha z\eta\mu H - \alpha p = 0 \quad (10)$$

Rearranging equation (9), we obtain:

$$z^* = \frac{(p\mu H - d - \alpha p)}{2\alpha \eta \mu H} \quad (11)$$

Substituting equation (11) in (6) the quantity of output harvested is:

$$f^* = \frac{(p\mu H - d - \alpha p)}{2\alpha \eta} \quad (12)$$

Equation (12) suggests that the quantity of output harvested through illegal activities are functions of the unit prices of the inputs and output, the stock of the biomass (or goods) in the Reserve, the penalties (or fines) and the probability of being caught.

Due to data limitation, we used the number of cases of illegal activities (e.g. illegal farming, illegal cattle grazing) as measurements of output harvested. On the markets of input and output, their unit prices are determined by demand factors (e.g. population, income level, etc.), supply factors, policies, and the existence or not of substitutes on these markets (Zhang and Pearse, 2012). We considered as measurements for their effects, the variables such as population, average level of incomes, the existence of financial institutions etc. Finally, we considered the variables such as the existence of checkpoints for the measurement of the effects of the stock of biomass in the Reserve, the probability of being caught, and the penalties.

3.2. The nonlinear SUR model

Dependent variables characteristics determine model specifications. In this study, we measured the W Reserve degradation using count data, namely the number of cases of illegal farming and illegal cattle grazing.

While illegal activity cases in the Reserve may be correlated within village *i* because individuals can be involved in both illegal activities, no correlation in these activities between separate villages can be fairly assumed. Consequently, nonlinear SUR model can be used to analyze the factors influencing both illegal activities (Cameron and Trivedi, 2010). nonlinear SUR is particularly recommended when error terms of system of nonlinear equations are expected to be contemporaneously correlated (Gallant, 1973). The model gains in efficiency over single equation regression by considering cross-equations correlations. The nonlinear SUR model used in this study can be specified using the following system of two equations:

$$f_j = \varphi(X_j\beta_j), \quad j = \text{number of cases of illegal farming, number of cases of illegal cattle grazing} \quad (13)$$

where f_j is a T X 1 vector, X_j is a T X K_j matrix of explanatory variables, and T the totoal number of observations. The model can be rewritten in the following general form:

$f = \varphi\ (X\beta)$ (14)

where f is a 2T X 1 vector; X is a 2T X ($K_{ill\_farm} + K_{ill\_cat}$) matrix, and β is a ($K_{ill\_farm} + K_{ill\_cat}$) X 1 vector of parameters.

The choice of the variables was based upon previous empirical literature on the factors influencing forests resources conservation. The variables are defined in table 3.1.

3.3. Empirical specification and variables

The following two equations were used to identify the factors influencing the W Reserve degradation:

$ill\_farm = \delta_0 + \delta_1\ pop + \delta_2\ incom + \delta_3\ credit + \delta_4\ farm\_area + \delta_5\ cash\_cr + \delta_6\ env\_ngo + \delta_7\ part\_mana + \delta_8\ check\_p + \delta_9\ dist$ (15)

$ill\_cat = \omega_0 + \omega_1\ pop + \omega_2\ incom + \omega_3\ credit + \omega_4\ env\_ngo + \omega_5\ part\_mana + \omega_6\ check\_p + \omega_6\ dist$ (16)

The variables are defined in table 3.1.

Table 3.1. Variables definition

Variables	Description
ill_farm	Number of cases of illegal farming in the Reserve
ill_cat	Number of cases of illegal cattle grazing in the Reserve
pop	population
income	Average level of income in a village (FCFA)
credit	Number of financial institutions in a village
farm_area	Average farm area in a village in hectares
cash_cr	growing of cash crop in the village (yes/no)
env_ngo	number of non-governmental organizations promoting nature preservation in a village
part_mana	Implementation of participatory management of forests resources policy (yes/no)
check_p	Existence of checkpoints between the Reserve and the villages (yes/no)
dist	distance between the Reserve and the villages (kilometer)

3.4. Data

Data used in the identification of the factors influencing the degradation of the W Reserve covered the period January 2016 to May 2017, and include the data on illegal activities in the Reserve (number of cases of illegal farming, and illegal cattle grazing), and the socioeconomics and institutional characteristics of the villages in the Reserve periphery. Data on illegal farming and illegal cattle grazing were obtained from the Reserve surveillance administrations in Benin, Burkina-Faso, and Niger. The socioeconomics and institutional characteristics of 93 villages in the periphery of the W Reserve were obtained, and used for the study. Particularly, the average income level, population, number of financial institutions, and number of non-governmental organizations promoting nature preservation were obtained from the administrations of the municipalities in the periphery of the Reserve. Finally, the data on the existence of checkpoints, and the distance between the Reserve and the villages were obtained from the W Reserve administrations in the three countries.

4. RESULTS AND DISCUSSION

4.1. Descriptive statistics of illegal farming and illegal cattle grazing in the Reserve

Table 4.1 presents the statistics on the number of cases of illegal farming and illegal cattle grazing recorded by the Reserve surveillance administrations in the three countries during the period January 2016 to May 2017.

Table 4. 1: Descriptive statistics on the number of cases of illegal activities

variables	Total number	Mean	Standard deviation	Min	Max
Illegal farming	35	0.3763441	0.8712058	0	4
Illegal cattle grazing	161	1.731183	2.414358	0	9

Illegal cattle grazing is the most important case of infraction recorded. The predominance of illegal cattle grazing cases could be explained by the important role that cattle play in the economy of the local communities, and the extensive mode of animal husbandry in place in the region. Indeed, the natural fodders and water streams being the main source of food and water for the livestock, the W Reserve due its abundant resources of plants, and water resources (e.g. Niger river) represents an ideal place for grazing.

The distribution of the infractions was not uniform across the three countries. While the cases of illegal farming in the Reserve were only recorded in Benin, illegal cattle grazing cases were observed in the three countries. Figure 4.1 presents the distribution of cattle grazing cases in the region.

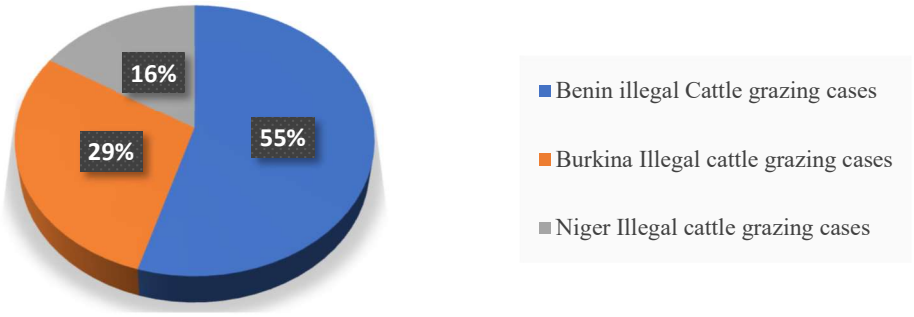

Figure 4. 1: Repartition of number of cases of illegal cattle grazing in the region

The highest number of illegal cattle grazing cases was recorded in Benin, representing 55% of the total number of cases followed by Burkina Faso with 29% of the cases. The lowest number was recorded in Niger, 16%.

4.2. Socioeconomics, and institutional characteristics of the villages in the periphery of the Reserve

Table 4.2 presents the socioeconomics, and institutional characteristics of the villages in the periphery of the W Reserve. The average population in the villages in the periphery of the Reserve was 1577 people. The lowest population in the villages was 55 people while the highest population was 10315 people. The average income level in the region was 16,715 FCFA. The

average farm areas in the region was 2.14 hectares. The average number of financial institutions in the villages in the periphery of the Reserve was 1 with 2 as their maximum number. Similarly, the average number of non-governmental organizations promoting nature preservation is 1 with their maximum numbers being 2. Finally, the average distance between the villages and the Reserve is estimated at 15.32 kilometers.

Table 4.2. Socioeconomics, and institutional characteristics of the villages in the periphery of the W Reserve

Variables	Mean	Standard deviation	Min	Max
pop	1577.235	1679.487	55	10315
incom	16715.05	6440.952	10000	30000
farm_area	2.141129	1.088044	1	4
credit	1.043011	0.8197823	0	2
env_ngo	1.204301	0.7598504	0	2
dist	15.31799	16.0764	0	66.3843

4.3. Identification of the factors influencing the Reserve degradation

The nonlinear SUR estimation results are presented in table 4.3. The results indicated that the villages in the periphery of the Reserve socioeconomics characteristics namely the average level income, the average farm areas, the number financial institutions, and the distance, and institutional characteristics namely the existence of check points, and non-governmental organizations promoting nature preservation influence its degradation.

Particularly, illegal farming activities were statistically significant (at 5% significance level), and positively correlated with the average farm area in the villages in the region. The positive correlation between the average farm area in the villages with the number of cases of illegal farming could be explain by the farming system in the region. Indeed, farming in the region is still traditional with low use of technology and inputs such as fertilizers. Hence, farmers to increase the production of their farm tending to increase their farms areas to compensate for the low use of fertilizers could find the W Reserve fertile lands as attractive. However, negative correlation and statistically significant (at 10% significance level) was found between illegal farming activities in the Reserve and the number of financial institutions, and number of non-governmental organizations promoting nature preservation. Indeed, the increase in the number of financial institutions in the villages in the periphery of the Reserve is associated with the decrease in the number of illegal farming activities by 22.07%, holding all the other factors constant. The negative correlation between the number of financial institutions in the region and illegal farming activities may be explained by the fact that the increase in the number of financial institutions increases credit access to farmers. Consequently, rather than increasing farms areas, farmers with credit access improve their farms performances using improved technology, and production inputs such as fertilizers. Another explanation could be that access to credit through financial institutions provides the means to farmers to undertake non-farming income generating activities. Similarly, the increase in the number of non-governmental organizations promoting nature preservation in the villages is associated with the decrease in the number of illegal farming cases by 20.57%, holding the other factors constant.

Illegal cattle grazing activities in the Reserve were statistically, and negatively correlated with the average income level (at 5% significance level), the existence of checkpoints (at 5% significance level), and distance (at 10% significance level) between the Reserve and the villages in its periphery. The existence of checkpoints is associated with a decrease in the number of illegal cattle grazing in the Reserve by 94.83% holding all other factors constant. This negative correlation between the existence of checkpoints, and illegal cattle grazing cases in the Reserve could be explained by the risks it raises for the cattle to be caught by the Reserve surveillance units. Particularly, the penalties associated with illegal activities include fines, and or jails times for the herders whose cattle are found in the Reserve. Similarly, the increase in the distance between the Reserve and the villages in its periphery by 1 kilometer is associated with a decrease in the number of cases of illegal cattle grazing by 2.07%, holding all other factors constant. This result may suggest that while the distance between the Reserve and the villages in its periphery increases, herders may resort to other places less far for grazing.

Table 4.3. Nonlinear SUR results of the factors influencing the W Reserve degradation

Variables	ill_farm	Ill_cat
Socioeconomics characteristics		
pop	0.0000319	0.0001834
	(0.0000492)	(0.0001312)
incom	0.000036	-0.0000761 **
	(0.0000231)	(0.0000385)
credit	-0.2207234 *	0.3760662
	(0.1132547)	(0.3444783)
farm_area	0.2474279 **	-
	(0.1060452)	
cash_cr	0.0231202	-
	(0.1537562)	
dist	-0.0106615	-0.0207407 *
	(0.007606)	(0.0125015)
Institutional characteristics		
env_ngo	-0.2057144 *	0.5237849
	(0.1138778)	(0.3505083)
part_mana	0.2523515	-0.1505792
	(0.1747832)	(0.4269536)
check_p	-0.0296449	-0.9483337 **
	(0.1601898)	(0.4151667)
Constant	-0.2987169	2.466668 ***
	(0.361621)	(0.7261106)
Observations	93	93
R-squared	0.3520	0.1678

CONCLUSIONS

The main contribution of this paper to the literature on forests resources conservation is the use of both illegal farming and illegal cattle grazing as a proxy for forests resources degradation, and the villages in the periphery of forests resources as study units. Our results

using nonlinear SUR reinforced the conclusion that socioeconomics and institutional characteristics of the regions in the periphery of forests resources influence their degradation. Particularly, we found that the W Reserve degradation was negatively correlated with the average income level, the number of financial institutions, and the distance while a positive correlation with the average farm areas in the villages was observed. The institutional characteristics of the villages, namely the number of non-governmental organizations promoting nature preservation, and the existence of checkpoints between the Reserve and the villages in its periphery were negatively correlated with its degradation.

Acknowledgements

We thank Auburn University for providing funding support. We are also grateful to the administrations of the W Reserve in Benin, Burkina-Faso, and Niger for the provision of some of the data used in the study as well as to the municipalities in the periphery of the Reserve.

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