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Land Degradation and Cotton Growing in Farming Communities in Benin

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Abstract: ***The municipality of Kérou is an agricultural community characterized by land impoverishment due to cotton monoculture and rudimentary agricultural technology[1]. Land degradation in the municipality of Kérou is therefore a worrying situation that has a negative impact on soil fertility, crop yields and can lead to long-term food in security and poverty[2]. The model developed by the soil scientists of the FAO [3]and the World Bank [4 and 5]isused to calculate from 2013-2014 the accumulated land losses (Pt) of 2.79 to 10.45 t/ha/year, following cotton growing in the municipality of Kérou.***

Keywords: Quantification, land degradation, cotton growing, Kérou

1. Introduction

Land degradation affects 33% of the world's land area, affecting more than 2.6 billion people in over 100 countries [6]. Developing countries are the most affected (90% of the world's affected population are in developing countries). Two (2) hectares of land were available per capita in 1900 worldwide compared to less than 0.5 hectares in 2010. Each year, an estimated 24 billion tons of fertile soil disappears (Adams and Eswaram, 2000).

Half of Africa's cultivated land is affected by soil degradation and erosion and up to 80 percent of pasture land is showing signs of deterioration. Of the 660 million hectares of forest in Africa, 3.2 million hectares are being lost annually, and the rate of deforestation is 29 times higher than that of reforestation. Arable land is declining at a rate of about 5-10 million hectares per year[7].

Five major soil types characterize Benin, 66% of which are degraded. Extremely degraded soils account for 16 percent, while moderately degraded soils account for 40 percent, of which 24 percent are in the extreme northern Sudano-Sahelian zone and 16 percent in the northern and north-eastern zone [8]. Soil erosion in Benin represents an annual loss of 30 million tons of soil[9]. This figure is well below the actual loss of land, and the Environmental Action Plan (PAE) needs to be updated. A simulation carried out by the Centre National d'Agro-Pédologie (CENAP), now the Laboratoire des Sciences du Sol, de l'Eau et de l' Environnement (LSSEE) of the Institut de Recherches Agricoles du Bénin (INRAB) confirmed the seriousness of the environmental problems foreseeable in the medium term. According to its conclusions, if nothing is done, soil erosion and degradation are likely to double in intensity and the availability of arable land will diminish faster than expected, depending on population growth[10].

In Atacora, soil degradation has reached an unprecedented level[11]. In a morpho-pedological study, Azontondé[10] showed that the observed loss of soil nutrients is largely due to soil erosion and overexploitation. Most of the Atacora is severely degraded and requires emergency intervention [9]. Land degradation and soil infertility affect 45% and 72% of households in the Atacora, respectively[12]. As for soil erosion, it represents an annual loss of just over 3 million tons of land in this department[13].

In Kérou, one of the nine (09) municipalities of the Atacora Department, there are moderately degraded tropical ferruginous and hydromorphic soils (degradation rate = 24%, [8]). With a population of 100197 inhabitants (or 1% of the population of Benin: RGPH4), and a land occupation of 374475 hectares, 91% of the population is agricultural, with cotton cultivation as its maineconomicactivity[14]. However, [15]foundthatcottoncultivation has negative effects on the environment and causes soil degradation. Indeed, the Municipality of Kérouis characterized by land impoverishment due to cotton monoculture and rudimentary agricultural technology[1]. Land degradation in the Municipality of Kérouis therefore a worrying situation that negatively influences soil fertility and crop yields and can cause food in security and poverty in the long term[2]. In fact, the decrease in food crops due to soil in fertility is a sign of the low food availability that is common in the municipality. The classification of the Food and Agriculture Organization of the United Nations The FAO (FAO), by the same logic, indicates that, if nothing is done in the next few decades, land degradation will become "very severe" in the municipality of Kérou[16]. This fact sheet consists of a quantitative assessment of land degradation through cotton cultivation in the municipality of Kérou in northwest Benin.

2. Experimental Section

2.1 Physical setting

Located in the North-East of the Atacora department, the Municipality of Kérouis bordered to the North by the Republic of Burkina Faso, to the East by the municipalities of Banikoara and Gogounou in the Alibori department, to the South-East by the municipality of Sinendé in the Borgou department and to the South by the municipality of Péhunco. To the west, it borders the commune of Kouandé and to the north-west it is bordered by the municipality of Tanguiéta. The municipality of Kérouis located between the Alibori valleys in the East, the Atacora mountain range in the West and the Pendjari river in the North-West. It is one of the nine (09) municipalities of the Atacora department. Comprising between 10° 15' and 11° 09' North latitude and 1° 43' and 2°

17' East longitude, the municipality of Kérou covers an area of 3,745 km². It has four (04) districts and twenty-eight (28) villages and city districts for a total population of 100,197 inhabitants[14]. The geographical and administrative situation of the municipality of Kérou is presented in figure 1.

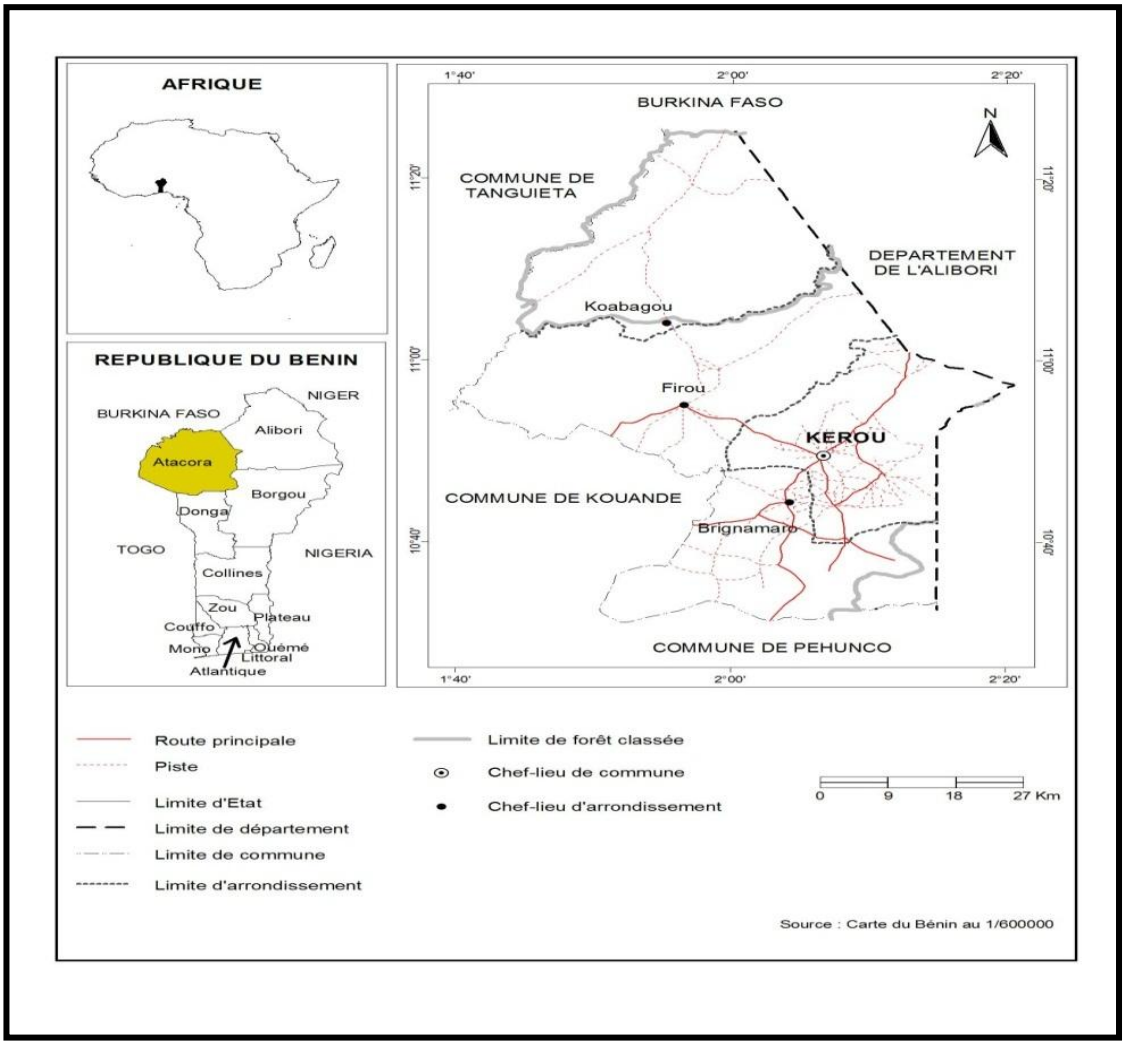

Figure 1: Geographic and administrative situation of the municipality of Kerou

2.2 Land use

The commune of Kérou has three types of soils, namely tropical ferruginous soils, ferralitic soils and hydromorphic soils found in swampy areas and lowlands. It also has very rich black soils found in the areas of classified forests such as the localities of Pikiré, Fêtêkou and Kaobagou. Apart from these localities invaded by cotton crops, the soils of the commune are very poor. Agriculture being the main activity in the commune with cotton as the predominant crop, a significant part of the territory is now sown for this activity. The areas under cultivation and the areas under agricultural control together occupy 23.13 percent of the territory of Kerou. It should be noted that in the 23.13 percent of the areas under agricultural control, 20 to 24 per cent are degraded[8]. Rock out crops occupies about 5.4 percent, while roads and towns occupy only about 0.48 percent. The total percentage of these completely bare areas is 29 percent. There is an intermediate zone represented by wooded and shrub by savannas that occupy the largest part of the territory, i.e. 46.56% (Table 1).

Table 1: Land use in the municipality of Kerou

Land use elements	Area	Percentage (%)
Forest gallery	13 034	3,48
Dry dense forest	1 433	0,38
Open forest and wooded savannah	77 021	20,56
Wooded and shrub by savannah	174 385	46,56
Saxicolous savannah / outcrop	20 209	5,40
Savannah with agricultural rights-of-way	56 987	15, 23
Mosaic of crops and fallow land	29 586	7, 9
Agglomerations and roads	1 820	0,49
Total	374 475	100,00

Source: PRODECOM, 2006

2.3 Land degradation quantification model

Generally speaking, the process of land degradation is carried out by decreasing selectivity of the richest soil elements. The model developed by the soil scientists of the FAO [3]and the World Bank [4 and 5]willbeused to calculate the accumulated land losses in the commune of Kerou.

$Rt = Ro.e^{aPt}$, and land losses: $(Pt) = \frac{Log\left(\frac{Rt}{Ro}\right)}{a}$;

$$Pt\ (Min) = \begin{cases} Pt\ (Max) = \frac{Log\left(\frac{Rt}{Ro}\right)}{0,04} = \frac{Log\ (Rt) - Log\ (Ro)}{0,04}; \\ \frac{Log\left(\frac{Rt}{Ro}\right)}{0,15} = \frac{Log\ (Rt) - Log\ (Ro)}{0,15}; \ \text{where,} \end{cases} \quad (1)$$

Rt: the yield of the year in tons per hectare (t/ha) ;
Ro: the initial yield in tons per hectare (t/ha);
a: a constant defined by the FAO (1994), varying from 0.04 to 0.15 ;
Pt: accumulated land losses per year in tons per hectare (t/ha). They are maximum
Pt (Max) or minimum Pt (Min).
Log = Nerianlogarithm (ln)

3. Results and discussion

Data of Support Programme for the starting-up of municipalities (PRODECOM) in 2006 [17]and from the Regional Action Centre for Rural Development (CARDER) of Atacora-Dongain 2014, on the evolution of the area, production and yield of cotton in the municipality of Kéroufrom 1998 to 2014 confirmed the problem of land degradation. In fact, the areas and production are in fact increasing over the period indicated, while yields are practically constant, even decreasing in places over the same period (Table 2).

Table 2: Evolution of cotton cultivation from 1998 to 2014 in Kerou

Cotton season	Area in hectare (ha)	Production in tonne (t)	Yield (kg/ha)
1997-1998	8 829	12 104	1 371
1998-1999	10 832	12 173	1 124
1999-2000	10 413	15 989	1 535
2000-2001	12 734	16 964	1 332
2001-2002	15 173	19 744	1 301
2002-2003	16 400	22 092	1 347
2003-2004	16 003	16 221	1 014
2004-2005	13 596	22 431	901
2005-2006	7 770	7 023	904
2006-2007	10 838	14 372	1 326
2007-2008	12 717	20 882	1 642
2008-2009	16 558	19 451	1 175
2009-2010	11 553	13 197	1 142
2010-2011	16 150	12 710	787
2011-2012	17 277	17 458	1 010
2012-2013	27 483	21 536	784
2013-2014	27 209	32 409	1 191

Source: PRODECOM, 2006, and CARDER Atacora-Donga, 2014

The soil scientist model of the FAO [3], the World Bank [4 and 5]and Table 2 are used to quantify land degradation. Thus, if: Rt = 1191 t/ha and Ro = 784 t/ha represent the yields of 2013 and 2014 respectively (see Table 2).

$$Pt\ (Max) = \frac{Log\left(\frac{Rt}{Ro}\right)}{0,04} = \frac{Log\ (Rt) - Log\ (Ro)}{0,04} = \frac{Log\ (1191) - Log\ (784)}{0,04} = 10,45$$

$$Pt\ (Min) = \frac{Log\left(\frac{Rt}{Ro}\right)}{0,15} = \frac{Log\ (Rt) - Log\ (Ro)}{0,15} = \frac{Log\ (1191) - Log\ (784)}{0,15} = 2,79$$

Thus, from 2013 to 2014, the municipality of Keroure corded a loss of accumulated land (Pt) of 2.79 to 10.45 t/ha/year, as a result of cotton cultivation. This result was earlier confirmed by research by [18] in his thesis entitled: "Cotton cultivation and soil degradation in Mouhoun (Burkina Faso)". Similarly, Brüntrup[15], in analysing the environmental effects of cotton production, wonders whether the replacement of cotton production by other crops would be a viable alternative to the production of cotton.

Will cash crop cultivation with food crops be part of sustainable agriculture? He notes, as in the framework of research in the commune of Kerou, that cotton cultivation has negative effects on the environment, promotes soil degradation and causes a drop in yields of food crops. The loss of accumulated land (Pt) of 2.79 to 10.45 t/ha/year obtained against1 to 12 t/ha/yeartolerated[3] shows that the commune of Kerouis not immune to severe land degradation. On the contrary, the process of severe degradation has begun. Moreover, Zinzindohoué[2] noted that this situation of land loss negatively influences soil fertility and causes food insecurity and poverty in the long term. The FAO [16] classification indicates that, if nothing is done in a few decades, land degradation will become "very severe" in the commune of Kerou, following a multiplier effect. Thus, land degradation is a problem that today compromises development and even the survival of the populations. It occurs in several forms and in different proportions in Benin. It has multiple consequences on agricultural and even economic development (reduced fertility and low soil yield, food insecurity, poverty). For Brüntrup[15], modernisation of cotton production is a medium-term development perspective and probably the surest way to achieve sustainable agriculture in northern Benin.

4. Conclusion

The 1/200,000-scale soil map of Benin was carried out between 1968 and 1969. Nearly half a century later, it is imperative to remake this Benin soils map in order to better determine their characteristics on the one hand, and on the other hand, circumscribe degraded soils in different agro-ecological zones in order to correct their nutrient deficiencies. To achieve this, an assessment of the loss of accumulated land in these different agro-ecological zones of Benin is required. The results of the evaluation of land degradation in the municipality of Kerou have determined a loss of accumulated land (Pt) of 2.79 to 10.45 t/ha/year. This loss is, however, lower than the soil loss tolerance set by FAO [3]. The tolerance for soil loss is erosion that does not cause a significant drop in land productivity. It varies from 1 to 12 t/ha/year depending on climate, rock type and soil thickness[3]. Despite this low tolerance in soil loss, the worst is to be feared because it takes 1000 to 100,000 years under

certain conditions to form one metre of soil[19]. Soil is therefore regarded as a non-renewable resource on a human scale.

References

[1] **Commune de Kérou (CK), (2010) ;***Plan de Développement Communal*. MDGLAAT. République du Bénin, 113 p.

[2] **Zinzindohoué, E., (2012) ;***Etat des lieux de la sécurité alimentaire dans le département de l'Atacora (au Nord-Ouest du Bénin) et analyse des politiques publiques*. Master of Advanced Studies en Action Humanitaire. Centre d'Enseignement et de Recherche en Action Humanitaire de Genève (CERAHGENEVE). Université de Genève. 46 p.

[3] **FAO, (1994) ;** *La dégradation des terres en Asie du Sud: sa gravité, les causes et les effets sur les personnes.*Soil World Ressources Rapports. Rome, 1994. 150 p.

[4] **World Bank, (2003a.) ;** Evaluation du coût de la dégradation de l'environnement. Royaume du Maroc. *Rapport METAP*. 40 p.

[5] **World Bank, (2003b); E**valuation du coût de la dégradation de l'environnement. République Tunisienne. *Rapport METAP*. 19 p.

[6] **Adams, C.R. et H. Eswaran (2000);** "Global land resources in the context of food and environmental security." In S.P. Gawande et *al.*,éd. "*Advances in Land Resources Management for the 20th Century," Soil Conservation Society of India, New Delhi;* pp.35–50.

[7] **Cleaver, K. M., (1993);** Existe-t-il une synergie entre croissance démographique, développement agricole et environnement en Afrique sub-saharienne ? *Congrès et Colloques* 13. Paris, INED, pp. 83-94.

[8] **République du Bénin, (2008) ;** Lutte contre la désertification et la dégradation des terres au Bénin. In *« Diagnostic de l'Auto-évaluation Nationale des Capacités à Renforcer pour la Gestion de l'Environnement Mondial du Bénin » (ANCR-GEM).* Rapport National. PNUD, CNDD, MEPN; pp.64-82.

[9] **Plan d'Action Environnemental (PAE), (1993);***Document final*, Cotonou, Bénin**,** 134 p.

[10] **Azontondé, H. A., (1990) ;** Effets de la culture attelée sur l'érosion et la conservation des sols au nord Bénin. *Centre d'Etude National d'Agro pédologique (CENAP)-SOLTROP 89- Cotonou – BENIN*, pp. 457-472.

[11] **Dossa, A., (2018) ;** Régression économétrique de l'influence de la population sur la dégradation des terres. *J. Rech. Sci. Univ. Lomé (Togo), 2018, 20 (3) ; pp. 105-117*

[12] **Dossa, A., Igué, A. M., Biaou, G. and *al.*, (2015) ;** Coût monétaire de la dégradation des terres dans la commune de Kérou, au Nord-Ouest du Bénin. *BenGéo / FLASH / UAC, N°17, juin 2015,* pp. 149 - 165.

[13] **Alinsato, A.S., (2006) ;** *Analyse des déterminants du consentement à payer pour la conservation des sols.* Unité de Formation et de Recherche en Sciences Economiques et de Gestion UFR-SEG/Cocody/Abidjan, Faculté des Sciences Economiques et de Gestion – Université d'Abomey-Calavi – Bénin. 25p.

[14] **INSAE (2015);***Quatrième Recensement Général de la Population et de l'Habitation (RGPH4) : Que retenir des effectifs de population en 2013 ?* Juin 2015, MDAEP/RB, 33 p.

[15] **Brüntrup, M., (1995);** La production du coton et l'environnement : quelques considérations pour les zones de savane dans le Nord du Bénin. *In* Leo De Haan et Peter Ton (eds), « *A la recherche de l'agriculture durable au Bénin ». Instituutvoor Sociale Geografie, UvA N°18,* pp. 94-103.

[16] **FAO, (2003) ;** *Economie de l'agriculture de conservation*. Service de la gestion des terres et de la nutrition des plantes. Division de la mise en valeur des terres et des eaux. Rome, 2003. 67 p.

[17] **Programme d'Appui au Démarrage des Communes (PRODECOM), (2006) ;***Schéma directeur d'aménagement de la commune de Kérou.* Département de l'Atacora et de la Donga, commune de Kérou, République du Bénin ; 103 p.

[18] **Hauchart, V., (2005) ;***Culture du coton et dégradation des sols dans le Mouhoun (Burkina Faso).*Thèse de Doctorat en Géographie. Ecole Doctorale des Sciences de l'Homme et de la Société, Université de Reims-Champagne-Ardenne, 467 p.

[19] **Lavelle, P. (2013) ;** Les sols. Livret sur l'environnement, *Académie des sciences*, pp. 1-3.