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Tea land degradation in Rwanda: Case study of Gicumbi District

MUPENZI Jean de la Paix, Li Lanhai
Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences; Key laboratory of oasis ecology and desert environment, 818 Beijing Road, Urumqi, Xinjiang, 830011, China
E-mail: lilh@ms.xjb.ac.cn

MUPENZI Jean de la Paix, Jiwen Ge, Gabriel Habiyaremye, Tanga L .Nadege, Nzayisenga Theonest
China university of Geosciences, Institute of Ecology and Environmental Sciences
School of Environmental Studies, 388 Lumo Road, Hongshan Administrative District, Wuhan, Hubei 430074, China

***Abstract*—This paper presents the results of the Study taken in Gicumbi District, Rwanda. It showed that Tea agriculture have degraded the environment through different types of Fertilizers used in tea plantations. The soil in tea plantation is acidic where the pH is less that 5; the Environment has been considerably degraded and water in river steams near to the tea plantation was polluted by agrochemicals used.**

Keywords: Environment, pollution, Tea land, Rwanda

I. INTRODUCTION

Tea is the agricultural product of the leaves, leaf buds, and internodes of the *Camellia sinensis* plant, prepared and cured by various methods. "Tea" also refers to the aromatic beverage prepared from the cured leaves by combination with hot or boiling water, and is the common name for the *Camellia sinensis* plant itself. In Rwanda, Two principal varieties are used: the China plant (*C. sinensis sinensis*), used for most Chinese, Formosan and Japanese teas (but not Pu-erh); and the clonal Assam plant (*C. sinensis assamica*), used in most Indian and other teas (but not Darjeeling). Within these botanical varieties, there are many strains and modern Indian clonal varieties. Leaf size is the chief criterion for the classification of tea plants[1,2]; tea is classified into (1) Assam type, characterized by the largest leaves; (2) China type, characterized by the smallest leaves; and (3) Cambod type, characterized by leaves of intermediate size[3-7]. Tea agriculture requires a large area, in 1999 the total area for tea cultivation in Rwanda was 12,541 ha and 14,394 ha in 2008 with 1,407ha not exploited [8-12]. Although Rwanda had made modest attempts to grow tea since the Second World War, it was only in the 1960's that the industrial cultivation of tea was really established. The *History of Tea* is long and complex, spreading across multiple cultures over the span of thousands of years. Although tales exist in regards to the beginnings of **tea** being used as a beverage, no one is sure of its exact origins. Through genetic studies of tea plants the geographic origins of species is believed to be located around the point of confluence of the lands of northeast India, north Burma, southwest China and Tibet. Mass cultivation and trade of tea was begun by the Chinese. Through Buddhism the beverage was spread to Korea and Japan. Trade of tea by the Chinese to Western nations in the 1800s the spread of the tea and the tea plant to numerous locations around the world [13-15].

II. MATERIALS & METHODS

A. The study area:

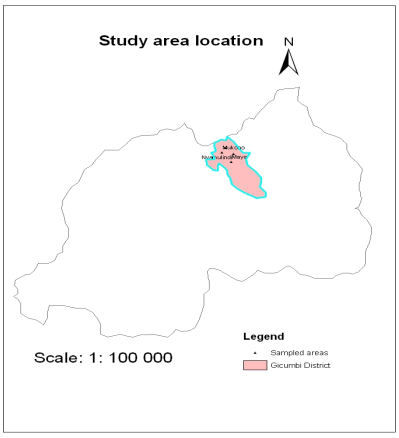

Figure 1 Study Area locations

Mulindi tea plantation is located in Gicumbi district a hilly district in Northern Province and is divided into 21 sectors called Imirenge in local language. Tea plantations are located in eleven Administrative sectors among 21 sectors of Gicumbi district. Mulindi tea factory is located at 14km to Gatuna board and at 1 hour journey from Kigali and at 5 km from Kigali-Gatuna road in Kaniga Sector[15-18]. The factory is the biggest in terms of production but as it does not have its own plantations; it depends on COOPTHÉ and Village's Tea which is called COOTHEVM for its green leaf supply. The COOPTHÉ constitute 35% with 585 ha exploited, and Villagers' Tea;which constitute 55% with 1150 ha. The industrial block has only 174.4045ha; this means a total of 1909.4045 ha. All these tea plantations are distributed around ten agriculture sectors. About 90% of this area is located in valley or swamp and 10% only is located on versants of mountains. The factory was built in 1962 with capacity of 3200T. During 1994-1996 the factory and tea plantations were rehabilitated following the war. The factory only has 224 ha of woodlands that are not sufficient to provide the energy necessary, the

reason why the factory is obliged to buy the firewood from the population around.

B. METHODS

At Mulindi tea plantation, we took soil samples by dryer on three locations which are Nyamulindi, Maya and Mukono for getting information relating to soil degradation through laboratory analysis using pHMeter. We also took water samples by tank in polyethylene and we put it in very cleaned bottles for a good transportation from three locations of Mulindi streams (Nyamulindi, Maya and Mukono). We analyzed both qualitatively and quantitatively water pollutants resulting from tea preparation activities in laboratory. These water samples were acidified with purified nitric acid and were analyzed through atomic mass spectroscopy. The measure of pH in the solution used the following elements: ammoniumacetae ammonia (pH 6-8), sodium acetate-acetic acid (pH 3-6), and hydrochloric acid-glycine (p h 1-3). The water samples taken in three streams of Mulindi River using the tank in polyethylene beforehand rinsed with ultra pure water and it was taken 1L by location. RESULTS AND DISCUSSIONS

III. RESULTS AND DISCUSSIONS

TABLE 1 PRODUCTION, WOOD FUEL, FERTILIZERS, AREA IN MULINDI TEA PLANTATIONS FROM 1996 TO 2008

Years	Green leaves/kg	wood fuel used/T	fertilizers/kg	Area/ha
1996	3282152	3090	0	921.4
1997	3241815	9115	0	921.4
1998	4757300	11300	0	1026.9
1999	8853154	6847	165662	1614.7
2000	9238657	7732	153413	1642.2
2001	13750123	14406	450000	1772.5
2002	10072611	10629	370800	1762.5
2003	9286082	10896	166850	1770
2004	8731340	10581	470700	1909.4
2005	11271253	12492	470800	1909.4
2006	11148716	11945	235574	1909.4
2007	13904538	15836	514616	2298
2008	13678308	12774	370385	2298
Total	121216049	137643	3368800	

During 13 years from 1996 to 2008, the production of green leaves at Mulindi tea plantations increased by 10396156kg (316.74816%). During that period the using of wood fuel had an increase of 9684tones or 313.39806% while the use of fertilizers increased from 0 kg in 1996 to 370385kg in 2008. The total area was around 1900ha in 1996 but only 921.4ha were rehabilitated, and it was 2298ha in 2008 including the young tea and empty area inside of tea plantations but only 1909.4045ha give a production.

A. Agrochemical

The use of chemical fertilizers led to the decline of soil fertility [19]. To determine the impact of fertilizers in addition to laboratory experiment, in this study, we tried to use previous studies carried out in other study areas. For example, studies in India have shown that as much as 70% of soil biota has been lost on tea plantations

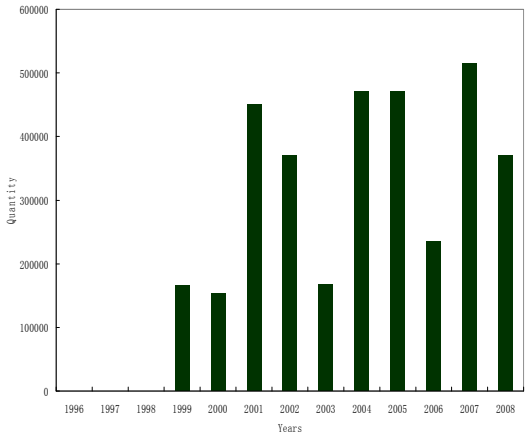

Figure 2 Fertilizers (NPK) used at Mulindi Tea Plantations from 1996 to 2008

The Figure 2 shows that the use of fertilizers at Mulindi Tea Plantation was not regular; this can be explained by the following factors: Some farmers cannot afford the cost of fertilizers while others lack knowledge about the importance of fertilizers to nearby natural habitat, especially in areas that workers and machinery pass over (Senapati et al. 2002). In general, Rwanda tea plantations and at Mulindi in particular, they use NPK 25-5-5 +1Mg and NPK 26-6-8 +2Mg very frequently as fertilizers. Other pesticides which are used in different tea plantations are rounded up for elimination of weed; urea, methane and dime thane for young tea or in nurseries.

B. Soil Degradation

Soil Degradation at Mulindi was among the Main objectives of this study; for its measurements, we used pH as indicator. For that case pHMeter was used to analyze the soil acidity. It was found that the pH of soil samples collected on three locations of Mulindi valley was 5.2 at Nyamulindi, 4.8 at Maya and 4.6 at Mukono. This means that the pH of soil in all Mulindi valleys is less than 7 and all soils are classified among the acidic soils. This acidity of soil can be explained by the following factors. First, the rock in which the soil came from, Mulindi valley belongs to the sedimentary rock. The second is the use of fertilizers with NO_3^+ and finally an augmentation of aluminiums ions and H^+ in soil [20,21].

C. Analysis of Pollution

TABLE 2 Concentration of H^+, Cu, H_2NO_3, Al^{3+}, NO_3, NO_2, Mg, Ca, Fe, K, P, and S in Mulindi streams (mg/L) in 2008

Samples no	Na	H+	cu	H_2NO_3	Al^{3+}	NO_3	NO_2	Mg	Ca	Fe	K	P	S
1.Nyamulindi	31.85	26.4	13.2	13.1	2.06	1.14	20.3	12.2	46.1	0.18	3.8	0.26	20.2
2.Maya	28.3	38.6	6.3	11.6	3.15	1.64	19.6	13.1	51.9	0.14	9.3	0.65	18.9
3.Mukono	33.3	21.9	8.4	10.8	4.04	0.96	26.4	14.5	41	0.09	8.1	0.48	19.3

The concentration of major elements in water at Mulindi valley varied by site. The result in table 2 showed that the concentration of Na, H^+, H_2NO_3, Al^{3+}, No_3, NO_2, Mg, Ca, Fe, K, P, and S were important in all sites with 31.85, 26.4, 13.2, 13.1, 2.06, 1.14, 20.3, 12.17, 46.12, 0.18, 3.8, 0.26, 20.18 respectively at Nyamulindi, with 28.3, 38.6, 6.3, 11.6, 3.15, 1.64, 19.6, 13.05, 51.87, 0.14,9.3, 0.65, 18.9 respectively at Maya, and with 33.3, 21.9, 8.4, 10.8, 4.04, 0.96,26.4, 14.46,41.04, 0.09, 8.1, 0.48, 19.3 respectively at Mukono. The study also showed that the concentration of Fe, NO_3, K, Al^{3+} were not important than other elements in all Mulindi valley, but the concentration of Ca, Na, H^+, NO_2, S, H_2NO_3 and Cu were highest in all valley. These concentrations indicate that the water in Mulindi Valley are acidic and the pollution has its origin from oxide of nitrate (NO_2) and the use of many fertilizers with high level of MPK^+ Mg . Note that this instrument (experimental) technique has been used by many researchers in environmental studies such as [22-27] and several schemes are existing.

IV. CONCLUSIONS

The fertilizers used in the tea plantations were the cause of soil degradation and through those fertilizers the water was polluted. Also the deforestation resulted in soil erosion which led to floods and the deposit of sediments on the valley.

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