Research Journal of Applied Sciences 6 (4): 276-281, 2011
ISSN: 1815-932X

Effect of Vegetation Adjoining Tourism Facilities on Soil Properties in the Tourism Enclave of Cross River State

[1]A.I. Iwara, [3]F.O. Ogundele, [1]U.W. Ibor, [2]V.M. Arrey and [1]O.E. Okongor
[1]Department of Geography, University of Ibadan, Ibadan, Oyo, Nigeria
[2]Department of Hospitality and Tourism, Cross River University of Technology, Nigeria
[3]Department of Geography and Planning, Lagos State University, Nigeria

Abstract: The study examined the effects of vegetation on soil properties by comparing soil physical and chemical properties in an undisturbed secondary forest with those adjoining selected tourism facilities. The result obtained showed that the proportions of Organic Carbon (OC), Total Nitrogen (TN) and Cation Exchange Capacity (CEC) were significantly higher in undisturbed secondary forest soils than soils adjoining tourism facilities. The low nutrient status of soils adjoining tourism facilities was attributed to two factors: the sparse density of trees as well as low availability of plant residue (litter) which affected the buildup of top soil nutrient through the decay of biomass, accelerated soil erosion due to the absence of dense vegetation cover to protect the soil from direct rainstorm as well as suppress the movement of surface runoff. In order to improve soil structure for tourism and ecological sustainability, simple ecological land management principle of planting more perennial tree species along with grasses to control soil erosion by enhancing infiltration, other than stone pitching and concretizing the area was suggested. Stone pitching is cost-intensive and hinders ecological succession as well as increases the amount of surface runoff with degrading effects on adjoining facilities. It is therefore, considered ecologically unwise to completely eliminate trees during landscaping in the area as they help to improve soil structure.

Key words: Tourism facilities, vegetation, soil properties, undisturbed secondary forest, planting, Nigeria

INTRODUCTION

Vegetation, mostly forest supports critical functions in the biosphere at different spatial and time scales. Vegetation whether natural or man-made helps to regulate the flow of numerous biogeochemical cycles, most critically those of water, carbon and nitrogen the presence of vegetation in whatever environment (man-made or natural) is of great importance in local and global energy balances as well as in nutrient fluxes. Vegetation offers inestimable services on the earth's surface as it strongly affects soil characteristics including soil volume, chemistry and texture which feedback affects its productivity and structure (Lu *et al.*, 2002). It serves among many others as habitats for both micro and macro organisms and is of critical importance to the world economy, particularly in the production of food, wood, fuel and other materials. However, the clearing of forest vegetation for agricultural (cultivation of food crops and plantation agriculture) and non-agricultural (construction of roads, building of tourism infrastructures and residential structures) purposes is one of the significant causes of deforestation and modification of vegetation and soil nutrient fluxes in different parts of the globe.

The deforestation of forest especially for non-agricultural purpose affects soil nutrient cycling due to the conversion of vegetated surfaces to non-vegetated surfaces making ecological succession and nutrient cycling difficult. This process affects the buildup of nutrients through the decomposition of organic matter as well as the sequestration of CO_2. Tourism and the environment have a very complex and interdependent relationship; tourism is one of the largest industries in today's world economy and a great source of foreign exchange for many developing countries whose major assets are their natural resources (Kozyr, 2000; UNEP, 1998). As one of the world's largest industries and fastest growing economic sectors, tourism has multiple impacts both positive and negative on people's lives and on the environment. Tourism development usually starts with the construction of hotels, resorts and other facilities for tourists to stay and take delight in. These facilities require space to accommodate them, the construction of these facilities result in soil erosion, loss in biodiversity and habitat increase in the level of surface run-off and unprecedented change to the natural environment (UNEP, 1998; Umoh and Etim, 2008) due to the destruction of vegetation.

Corresponding Author: Anthony Inah Iwara, Department of Geography, University of Ibadan, Ibadan, Oyo, Nigeria

However, with the emergence of Tinapa business and leisure resort in 2002 and subsequent construction of facilities, the vegetation of the area has been drastically modified such that in some areas, scanty stands of perennial trees/shrubs say 3-4 are allowed to grow adjoining tourism facilities while in other areas, woody perennial trees/shrubs are completely cleared and replaced with grasses. This pattern of vegetation especially its sparse density and cover abundance has tremendous impact on the soil as a result of the inability of the vegetation to suppress the movement of surface runoff, protect the soil from the direct impact of rainwater and subsequent loss of nutrient. The environmental impacts of the construction of facilities needed to support the tourism industry are both immediate and gradual. Cumulative effects over time are particularly problematic because the developers in question are often out of the picture before impact becomes obvious (Gratner, 1996; Davis and Cahill, 2000). An example is the leaching of nutrients from bare surfaces as well as areas with low vegetation cover thereby resulting in the eutrophication and sedimentation of water bodies and river channels.

Nevertheless, other gradual impacts include soil nutrient elements loss caused by accelerated soil erosion and loss in biotic diversity. This if not well managed, degrades the environment in different ways such as infrastructural collapse through gradual loss and exposure of soil beneath as well as making soil unproductive for ecological sustainability (loss in soil nutrient and on-site destruction). Studies on tourism have focused more on the socio-economic impacts (Ojo, 1978; Lee, 1988; Appeal, 2008; Ige and Odularu, 2008; Ayeni and Okwuemesi, 2002; Eze, 2008; Esu and Etuk, 2007; Akpabio *et al*., 2008), others focused on the theoretical and perceptual aspects of tourism (Awaritefe, 2004; Bankole and Odularu, 2006; Njoku, 2003; Esu, 2008). More so, qualitative information abounds on the environmental impacts of tourism/ recreation (Jones, 2003; Brown, 1998; Chokor, 1993; Umoh and Etim, 2008; Pickett and White, 1985; Williams, 1992; Zedan, 2004; Kreag, 2001), there is however no documented accounts on the effect of vegetation adjoining tourism facilities on soil properties in the tourism enclaves of Cross River State and Nigeria in particular. It is however, against this background that this study is carried out. The study therefore, seeks to examine the ecological consequence of eliminating woody and perennial trees/shrubs on soil fertility.

MATERIALS AND METHODS

Study area: This study was carried out in Tinapa business and leisure resort in Cross River State, Nigeria. Tinapa business and leisure resort lies between longitudes 05°02' and 05°04'N and on longitude 08°07 and 08°22'E. The area falls approximately along the coastal fringes of Cross River State where the rainy season lasts for about 10 months with dry months having <60 mm of rainfall. The nearness of the area to the Atlantic ocean has a moderating effect on its temperature with highest average daily maximum of 35°C and recorded mean actual temperature of 26°C (Akpabio *et al*., 2008). The area has an average relative humidity of 80-90% at 10 am during the wet season and is so well drained that storm water disappears 30 min after a typical rainstorm (Eze, 2008). The soils in Tinapa are ferrallitic with dominant colour of yellowish-brown and are generally deep, porous and weakly structured and well drained. The vegetation of the area is a mixture of mangrove and tropical rainforest. The rainforest is further subdivided into the lowland rainforest and the freshwater swamp forest. The mangrove swamp is found in the southern fringe of the area and stretches from the freshwater limits to the ocean beaches (Iwara, 2009). The present study was carried out in the lowland and upland rainforest zone due to its geographic extent. The rich and luxuriant vegetation of the area has been subjected to severe degradation for non-agricultural purposes such as the massive construction of tourism facilities like Studio Tinapa, recreational centre, shopping complexes and administrative blocks and roads among others in the past 8 years with the advent of Tinapa. These massive tourism facilities have drastically modified the vegetation of the area in the past 8 years. In order to maintain vegetation around these infrastructures, grasses and few perennial trees are planted or allowed to grow in the area.

Soil sampling: This study evaluated the effect of vegetation adjoining tourism facilities on soil physico-chemical properties in Tinapa Resort by comparing soil properties adjoining tourism facilities (notably studio and hotel Tinapa, roads, administrative blocks, recreational parks and shopping complexes) in the area with those of undisturbed secondary forest. Thirty sample quadrats of size 10×10 m were established in the study sites using the grid method of sampling (15 in vegetation adjoining tourism facilities and another 15 in the undisturbed secondary forest). In each quadrat, 5 surface (0-10 cm) soil samples were randomly collected with a soil auger and then composited. The soils were put in polythene bags with labels they were thereafter air-dried and taken to the laboratory at the Department of Agronomy, University of Ibadan, Ibadan for analysis of soil physical and chemical properties. Particle size composition was determined using the hydrometer method (Bouyoucos, 1965) organic carbon by the Walkley and Black (1934) method, total nitrogen by the Kjeldahl method (Bremner and Mulvaney, 1982), available phosphorus was determined by the method of Bray and Kurtz (1945). The soils were leached with 1 M neutral ammonium acetate to obtain leachates used to determine exchangeable bases and soil cation exchange capacity while pH values were determined potentiometrically in distilled water using a soil: water ratio of 1:1.

RESULTS

Physical properties of soils: The soil particle size composition of soil adjoining tourism facilities and undisturbed secondary forest is shown in Fig. 1-3. The soils are principally sandy with sand constituting >70% of the inorganic mineral fragment in the soil. The proportion of sand is higher in the undisturbed secondary forest soils than in soils adjoining tourism facilities. The amount of silt and clay in the two soil communities is small compared to that obtained for sand the mean values of silt and clay are higher in soil adjoining tourism facilities than those in the undisturbed forest with mean values of 3.47 and 4.60% for silt and 10.93 and 18.63% for clay, respectively. The particle size composition of soils in both communities is not significant as soils in the area are texturally similar being loamy-sand and having been derived from the same parent material (granite) under the same climate and topography.

Chemical properties of soils: The chemical properties of the two sampled soils are shown in Table 1. The proportion of Organic Carbon (OC) is significantly higher in the undisturbed secondary forest than in soil adjoining tourism facilities with mean values of 1.73 and 0.87%, respectively. Also, the proportions of Total Nitrogen (TN) and Cation Exchange Capacity (CEC) are significantly higher in the undisturbed secondary forest than in soil adjoining the road with mean values of 0.40 and 0.22%, respectively for TN and 10.05 and 8.94 Meq/100 g, respectively for CEC. The high proportions of SOC, TN and CEC recorded for soil in the undisturbed forest are due to the rate of nutrients returned to the soil through the fall and subsequent decomposition of litter. However, the accumulation of organic matter and nutrients in the soil under tree canopies in the undisturbed secondary forest is not unique to the study area alone as the soil under tree canopies in the forest and savanna generally tends to have enhanced organic matter and nutrient levels compared to soil outside their influence (Aweto and Dikinya, 2003). There is no significance difference in the proportions of Av. P and exchangeable bases in both soil communities. The low contents in exchangeable bases in both soils necessitated the application of inorganic fertilizers by farmers in the past to augment the soil for agricultural production.

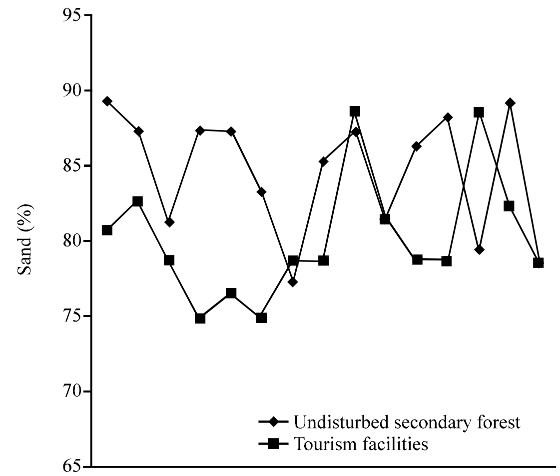

Fig. 1: Proportion of sand

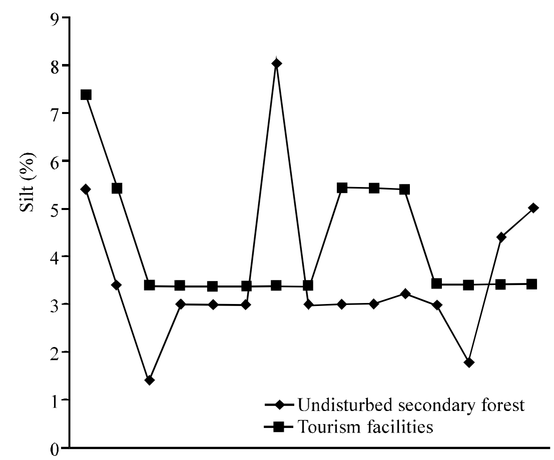

Fig. 2: Proportion of silt

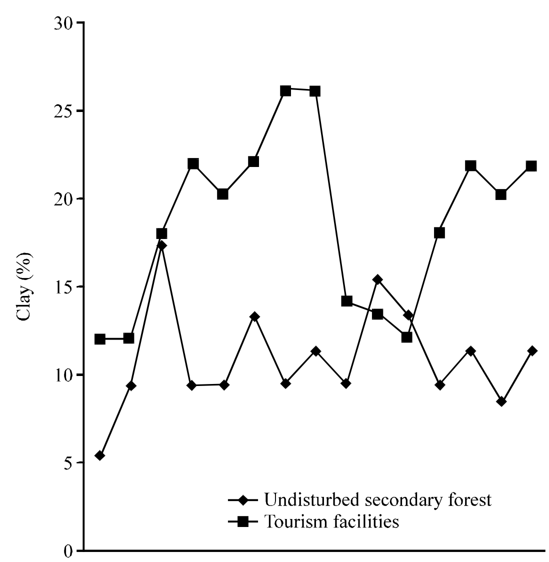

Fig. 3: Proportion of clay

Table 1: Chemical properties of soils adjoining tourism facilities and undisturbed secondary forest[a]

Soil properties	Secondary forest	Soil adjoining facilities	t-values
Organic carbon (%)	1.73±0.08	0.87±0.06	8.71*
Total nitrogen (%)	0.40±0.02	0.22±0.02	6.46*
Exch. calcium (M eq/100 g)	1.38±0.05	1.41±0.05	0.37^{NS}
Exch. magnesium (M eq/100 g)	0.74±0.01	0.73±0.01	0.58^{NS}
Exch. sodium (M eq/100 g)	0.09±0.00	0.10±0.00	0.71^{NS}
Exch. potassium (M eq/100 g)	0.17±0.00	1.05±0.60	1.46^{NS}
CEC (M eq/100 g)	10.05±0.59	8.94±2.25	3.71*
Ava. P (Mg kg)	68.80±4.26	60.31±6.38	1.11^{NS}
pH	3.15±0.07	5.11±0.20	9.14*

[a]Values are means±standard errors. *Difference between means is significant at the 5% confidence level. NS: Difference between means is not significant

DISCUSSION

The results obtained suggests that the transformation of vegetation to non-agricultural purpose like the construction of tourism facilities substantially reduces the proportion of Soil Organic Carbon (SOC), possibly due to the low density of trees which affects the accumulation of biomass. Also, the low proportion of SOC is attributed to accelerated soil erosion which is high around soils adjoining tourism facilities because of the absence of dense vegetation canopy (mostly composed of grasses) to protect the soil from direct rainwater as well as suppress the movement of surface runoff. However, the proportion of SOC varies significantly between the two communities. The high proportion of SOC recorded for soil in the undisturbed forest is due to the rate of nutrients returned to the soil through the fall and subsequent decomposition of litter. This agrees with the assertion of Aweto and Dikinya (2003) that SOC accretion in the soil is mainly due to the accumulation of litter which decomposes in situ to form organic matter; through this, the mineralisation of organic matter releases nutrients into the soil. However, SOC proportions of 1.73 and 0.87% obtained for soils in the undisturbed secondary forest and those adjoining tourism facilities are within the values of 0.23-1.8% reported in Sigdel (1994) but below the ranges of 1.74-2.33% reported by Suoheimo (1995).

The decline in proportion of total nitrogen in soils adjoining tourism facilities is also attributed to the low density of trees. This low density of trees impacts negatively on the quantity of litter produced as well as nutrient returned to the soil also the predominance of grasses around the facilities is ecologically satisfactory to prevent the continuous loss of litter and nutrient through leaching and run-off (Paudel and Sah, 2003; AREP, 2008). The proportion of Cation Exchange Capacity (CEC) just like those obtained for SOC happen to be higher in soil of the undisturbed secondary forest than in soils adjoining tourism facilities. This significant variation in the proportion of CEC is ascribed to the rate of nutrients returned to the soil through the fall and decay of litter. The low proportions of other nutrients, particularly exchangeable bases in the two sampled soils are possibly because of low levels of organic matter in both soils and leaching by the high rainfall in the area (Foth, 2006). These basic cations according to Foth (2006) become insufficient in the soil for plant uptake as a result of continuous leaching caused by increase precipitation. This condition necessitated the application of inorganic fertilizers by farmers in the past (before the acquisition of the area by the Cross River government in 2003) to improve soil fertility for improved agricultural productivity.

Furthermore, the proportions of Av. P in both soils are considered high presumably because of the application of fertilizers to improve the soil nutrient by farmers prior to the acquisition of the land by the Cross River State government in 2003. Cruickshank obtained similar result as noted by Aweto and Ogurie (1992) when he observed that substantial amounts of phosphorus accumulated in British soils as a result of long-term application of inorganic phosphate fertilizers. In addition, the same result was reported by Chidumayo and Kwibisa (2003) when they equally observed higher Av. P in cultivated plots than in mature woodland and fallow plots and attributed the increase to the application of P-fertilizers to crops by farmers. Furthermore, the proportion of pH is more in soil adjoining tourism facilities and less in the undisturbed secondary forest soil. The high pH value of 5.11 recorded for soils adjoining tourism facilities is accredited to the high rate of soil erosion, leaching and loss of soil nutrient elements caused by accelerated soil erosion as a result of its low density (few tree stands) and absence of dense vegetation cover to control surface runoff. The low value observed for soils in undisturbed secondary forest is probably due to the ecological effect of its dense canopy cover which helps to protect the soil from direct rainfall and maintain soil structure by holding back the movement of surface runoff. Generally however, the acidic nature of soils in the area may also be attributed to the high rainfall which is sufficient to leach basic cations especially calcium from the surface horizons of the soils (Miller, 1965; Paudel and Sah, 2003; Foth, 2006).

CONCLUSION

The result of this study has shown apparently that the clearing of forest for the construction of tourism facilities as well as other related non-agricultural activities like residential areas and industries not only modify the vegetation of the area but causes drastic and unprecedented changes in the physical and chemical properties of soil. Deforestation for whatever purposes results in soil nutrient loss caused by accelerated soil erosion basically as a result of sparse vegetation cover and tree density. This process of nutrient loss if not properly managed would increase soil pH which in the long-run affects the availability of soil fertility due to the leaching of essential soil cations. The continuous transformation of vegetation in the area into tourism facilities irrespective of the planting of grasses and few tree stands is ecologically adequate to prevent the soil from harsh climatic conditions and subsequent loss of nutrients thereby hindering ecosystem sustainability. However with the conversion of Tinapa's rich and luxuriant forest vegetation into tourism facilities, the proportions of Organic Matter (OC), Total Nitrogen (TN) and Cation Exchange Capacity (CEC) have been adversely affected and acidity increased which affect the availability of nutrient in the soil.

RECOMMENDATIONS

Nevertheless, to control soil erosion which is prominent in the area and capable of damaging available facilities, there is need therefore for government, stakeholders in tourism business and land planners to adopt sound ecological principles which will not only conserve and protect the soil but also promote sustainable environmental and tourism development (conservation of soil nutrient to enhance land productivity and limit land degradation for effective tourism objectives and ecosystem continuity).

For instance, the planting of improved tree varieties whose heights are controllable will go a long way in beautifying the area as well as render numerous ecological services. Furthermore in places where the land is slopy, simple ecological land management principle of planting more perennial tree species along with grasses can be applied to control soil erosion. The planting of trees along with grasses will not only loose the soil and improve its structure but will make it possible for rainwater to easily infiltrate the soil instead of stone pitching and concretizing the entire area. Stone pitching is cost-intensive and hinders ecological succession as well as increases the amount of surface runoff with degrading effects on adjoining facilities. Planting of trees along with grasses will help to suppress the movement of surface runoff. The attendant effect is reduction in the amount of storm water that would have reached surrounding water bodies, resulting in eutrophication and sedimentation. Indeed, the application of eco-friendly principles such as the planting trees along with grasses other than planting grasses only as well as stone pitching will not only protect the soil and control antecedent soil erosion but will ensure tourism sustainability by reducing facilities collapse and on-site destruction.

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