ASSESSMENT OF THE LEVEL AND IMPACTS OF ANTHROPOGENIC ACTIVITIES IN ECOTOURISM SITES USING SOIL BACTERIA PREVALENCE AND ABUNDANCE: AWBA DAM AS A CASE STUDY

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ABSTRACT

The extent of human impact on sensitive ecosystem is now so profound that there is currently much discussion about Anthropocene. Massive tourists' influxes to a relatively small area often have a huge impact. The direct local impacts of tourism on soil microbes and ecosystem at destinations are strongly affected by concentration in time and space. The diversity and abundance of soil microorganism can be influenced by tourism activities. Hence, this is a good means of evaluating the extent and the quality of the environment of tourists' destinations. This study used soil bacteria count at different activity areas in Awba dam to assess impacts of human activities. Anthropogenic activities in the dam were determined through direct observation. Two replicates of soil samples were randomly collected from construction site, residential area and farm land. Samples were taken to analytical laboratory for bacterial count using Serial Dilution Techniques to determine the count and the types of bacteria. *Bacillus sp* and *Pseudomonas sp* were the most prevalent bacteria occurring in all the samples (100%) and then *Micrococcus sp* (60%). The highest total bacteria count was obtained in the samples collected in the forested areas (7.3×10^6) followed by disturbed forest (6.1×10^6) and in samples collected in the residential areas (5.5×10^6). The bacteria count of each area differs depending on the kind and level of activities carried out in those areas. Construction sites have the highest level of disturbance but the least number of bacteria while forested areas have the lowest level of disturbance and the highest number of bacteria. The assessment of microbial biodiversity has the potential to provide useful insight into the health and functioning of a good environment. The analysis carried out on the soil samples collected revealed a variation in abundance of bacteria composition in accordance with the level of activity carried out on the land.

Keywords: Anthropogenic activities, Awba dam, microorganism abundance, ecotourism site, ecosystem.

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INTRODUCTION

An ecosystem is a natural unit consisting of biotic factors (animals, plants and microorganisms) in an area functioning together with all of the abiotic factors (non-living physical components) of the environment. Central to the concept of ecosystem is the idea that living organisms are continually engaged in a highly interrelated set of relationships with every other components of the environment in which they exist. Any unit that includes all of the organisms (community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (exchange of materials between non-living and living components) within the system is an ecosystem (Christopherson *et al.*, 1996).

A greater variety of species or biological diversity of an ecosystem may contribute to high resilience of an ecosystem because there are more species present at a location to respond to change and cushion, absorb or reduce its effects. This reduces the effect before the ecosystem's structure is fundamentally altered to a different state. Soil, a component of the ecosystem, may be characterised by the thin upper part of the Earth's crust where air (atmosphere), rock (lithosphere), water (hydrosphere) and living organisms (biosphere) interpenetrate, is a more complex medium than water and air. They may indeed be the most complex systems known to science. Composed of organic and inorganic matter, and with solid, liquid and gaseous components, they contain large numbers of living organisms and are the medium that supports life in its broadest sense (Yassoglou, 1992).

Human impact on ecosystem

Human or anthropogenic impact on the environment includes impacts on biodiversity, biophysical environments and other resources. The term anthropogenic designates an effect or object resulting from human activity. In the mid-1970s, atmospheric scientist, Paul Crutzen, introduced the term anthropocene. The term is sometimes used in the context of pollution emissions resulting from human activities but applies generally to all major human impacts on the environment (Kay, 2002).

Humans have significantly altered nearly all of Earth's systems, including its atmosphere, hydrosphere, biosphere and lithosphere. Human populations and their land use patterns have

already transformed most of the terrestrial biosphere directly (Turner, *et al.*, 2007). The effects of human activities vary with land use, ranging from agricultural wastes such as animal, farm, sewerage and fertilizer runoff, to industrial and commercial wastes of every conceivable type and magnitude. According to Ezenwa and Ayila (1993), over the years, the list of toxic contaminants has also increased so that it not only includes heavy metals, radionuclides, and organic compounds of anthropogenic origin, but also pharmaceuticals, explosives, and previously unknown biological pathogens.

Humans alter ecosystems both by introducing novel processes and by altering pre-existing ones, producing a wide variety of archaeological and geological evidence including changes in and altered spatial patterns of soil and sediment chemistry, soil erosion, sedimentation rates, isotope signatures, artificial substances, and plant and animal remains (Foley, 2005). As stated by Rockstrom (2009), ecosystem variables chosen for evaluation produce geologically stable records within landscapes of novel anthropogenic processes or anthropogenic changes in pre-existing processes, potentially enabling spatially explicit quantitative evaluation of the scale and extent of anthropogenic transformation of the terrestrial biosphere. Relative changes in plant community structure indicate anthropogenic changes in biodiversity caused by grazing, habitat loss and fragmentation, wild fire regimes and other disturbances leading to local and global extinctions of native species (Dale,1997), and invasions by exotic species facilitated by ecosystem alteration, disturbance and human transport of propagules (Thomas, 2004).

Changes in net primary production (NPP) are a classic general indicator of human alteration of ecosystem processes. Organic carbon accumulation, like NPP, is a good indicator of the state of ecosystem and its alteration by humans (Sherratt and Wilkinson, 2009). Reactive nitrogen availability in ecosystems is a strong indicator of ecosystem disturbances including fire and the rise of intensive agricultural practices, such as tillage, use of manure and synthetic nitrogen, though its alteration is not always detectable in the geological record. Soil phosphorus is often used in archaeology as an indicator of human settlements. It tends to accumulate over time as a result of consumption and combustion by concentrated livestock, food and biomass harvest and the use of manure and, most recently, fertilization of agricultural fields with mined phosphorus fertilizers (Ambrose, 2001). Other potentially useful indicators of changes are direct human

alterations of geomorphology and hydrology, changes in taxa besides plants, and other biogeochemical and residual traces (Kirch, 2005).

Tourism activities in aquatourism site

The extent of human impact on sensitive ecosystem is now so profound and pervasive that there is currently much discussion about Anthropocene (a new geologic era characterized by anthropogenic disturbances of the geologic record). Disturbance is any relative discrete event in time that disrupts community, ecosystem or population structure and changes substrate availability, resources or the physical environment (Fernando *et al*, 2012).

Mukherjee (2008) stated that the damages cause by tourism development does not end with the construction of tourist infrastructure. Some tourist resorts empty their wastes and sewage directly into water body and its surrounding which have effects on aquatic and soil organism. Most of Lagos Island, Lekki, Victoria Island, Ogudu and part of the riverine areas of Cross River, Rivers, Akwa Ibom and Delta state have been reclaimed to accommodate housing units, bridges, roads, resort centres, agriculture etc. In most cases, these reclaimed areas contain no provision for the development and protection of natural areas while scenic resources are adversely destroyed through reclamation activities (Egborge, 1993).

Massive tourists' influxes to a relatively small area often have a huge impact. They contribute to the pollution, waste, and water needs of the local population, putting local infrastructure and habitats under enormous pressure (Eugenio, 2001). Change in land use pattern and land cover can often change the environmental factors that control functions within an environment (Fernando *et al.*, 2012). The direct local impacts of tourism on soil microbes and ecosystem at destinations are strongly affected by concentration in time and space (seasonality). They result from the delivery and use of energy, the intensive use of water and land by tourism and leisure facilities, changes in the landscape coming from the construction of infrastructure, buildings and facilities, air pollution and waste, the compaction and sealing of soils (damage of vegetation) and the disturbance of indigenous people and local fauna (EPA, 2003).

Human activities along lagoons, coastline, estuaries, creeks, major rivers and tributaries have upset the ecosystem and its biodiversity (Ezenwa, 1993). According to Marschner *et al.* (2001) bacteria community composition results from the interaction between plant species, soil types

and their abundance on the level of soil degradation. One of the greatest changes with respect to tourism impact is the one caused by visitors' activities generating waste which must be discharged. The diversity and abundance of soil micro and micro invertebrate can be influenced by tourism activities.

Disturbances to ecosystems are commonly perceived negatively as a disruption of equilibrium in any given ecosystem. A growing knowledge based on non-equilibrium theory, however, indicates that disturbances are an essential ecological process. They are crucial at some level of intensity and periodicity for the long-term maintenance of most, if not all, ecosystems. The average frequency of a particular disturbance is inversely proportional to its intensity. Large intense disturbances are not common and small ones frequent. Ecosystems have evolved in response to specific regimes of disturbances that have recurred over millions of years. The disturbances caused by humans, however, often differ from naturally occurring ones. They occur at different scales, intensities and geographic locations. As a result, ecosystems tend to respond in unexpected ways to anthropogenic activities and many functions that ecosystems provide change or are diminished (Dale, 2000).

Diversity and roles of Soil Microbes

Microorganism numbers vary in different soil types and conditions with bacteria being the most numerous. Bacteria and fungi, among soil organisms, actively participate in the decomposition of organic matter liberating chemical nutrients and furthering plant growth (Whitman *et al.*, 1998). Microbial activity, measured in terms of respiration and biomass, reflects the flux of carbon through biotic systems. Microbes are critical to the world's ecosystems being integral parts of the nitrogen and carbon cycles and affecting plant growth and survival. Microbes, like all other organisms, are affected by a variety of factors which includes; chemical factors such as soil pH, oxygen level, cation exchange capacity (CEC); physical factors such as soil texture, soil water, temperature, light and; biological factors such as soil fauna, bioavailability and interactions of soil organisms Scow (2008).

Soil microbial diversity is important because it is often regarded as an important index of the health of the ecosystem. The role of microorganisms in maintaining the dynamic equilibrium and integrity of the biosphere is so vital that the continued existence of life is dependent on the

sustained, microbial mediated transformation of matter in both aquatic and terrestrial environments. Almost all biological processes in the ecosystem involve microorganisms. The potential benefits of optimizing, regulating and exploiting microbial activity are largely unexplored (Hooper *et al.*, 2000).

Species composition and activity of microorganisms are largely regulated and influenced by soil physico-chemical properties, climatic factors and composition of vegetation. Estimates of microbial diversity in natural ecosystem must accommodate temporal and spatial variability in microbial populations. Temporal shifts in microbial diversity are brought about by changes in the environment of the microorganisms and may be caused by the organisms or inflicted on the community from outside. Spatial effects include an evaluation of the relationship that exists between community composition and scale. A prerequisite to quantifying diversity in natural species is an understanding of the level and magnitude at which such changes operate. The patterns of microbial populations in soils vary temporally and spatially according to factors such as availability of carbon resources, the nature of the soil, parent material, seasonal and diurnal variations in temperature, porosity, water holding capacity, changes in pH, electrolyte concentration, redox and oxygen availability. Soil type and spatial distribution of resources have been found to be key drivers in the organization of soil communities (Fierer and Jackson, 2006).

The diversity and abundance of soil microorganism can be influenced by tourism activities. Hence, this is a good means of evaluating the extent and the quality of the environment of tourists' destinations. This study used soil bacteria count at different activity areas in Awba dam to assess human activities and its impacts on environmental productivity.

MATERIALS AND METHOD

Description of study area

The study area is a water reservoir called Awba dam, located in the University of Ibadan campus, Oyo state, Nigeria. Geographically, the site is located in the southwest area of the campus at an altitude of 209m above sea level. It lies between latitude 7^0 26' North and longitude 3^0 53' East. This water-based tourism site has an area of more than 6 hectares.

Awba dam is surrounded by modified tropical rainforest vegetation and aquatic macrophytes, *Eicchorniacrassipes, Marsilesquadrifolia, Nymphae lotus, Pistiastratiotus.* Awba dam environ was upgraded in 2003 to accommodate ecologically based tourism. Presently, construction works is on-going to improve the outfit of the place. Parts of the land mass surrounding the site are used for farming by member of University of Ibadan community.

Anthropogenic activities in Awba dam

This was determined by direct observation during visitation to the site. The site was visited twice in a month between June 2013 and May 2014 with a total of 24 visits basically for activities observation. This was done to cut across a complete cycle of climatic and tourism season as recommended by EEA, 2003. Recorded major human activities on the site are given in table 1.

Table 1: Sample collection points and their location

POINTS DESCRIPTION	SAMPLE CODE	POINTS COORDINATE	ELEVATION (ASL)
Farmland	A1 and A2	7°26.658'N and 3°53.311'E	206m
Constructed area	B1 and B2	7°2.455'N and 3°53.233'E	202m
Residential area	C1 and C2	7°26.587'N and 3°53.278'E	204m
Forest areas	D1 and D2	7°26.568'N and 3°53.228'E	205m
Disturbed forests	E1 and E2	7°26.558'N and 3°53.232'E	201m

Soil samples collection

Six soil samples were randomly collected from construction site, residential area and farm land. These were areas where major human activities are carried out. Two samples were collected from each area for replication. Four samples were randomly collected from the forest area with little or no disturbance. The samples were collected at the depth of 10cm into the soil (Saadoun, 2002).

Soil Bacterial counts

Soil samples were collected and taken to analytical laboratory in the Department of Agronomy, University of Ibadan for bacterial count using Serial Dilution Techniques as described by Jackie (2013) to determine the count and the types of bacteria in the samples.

RESULTS

Anthropogenic activities at Awba dam

Human activities were determined by direct observation. Recorded major human activities on the site during the 24 times visits are given in table 2.

Table 2: Recorded anthropogenic activities and their frequencies during 24 visits

Anthropogenic activity	Frequency (during 24 visit)
Crop cultivation	All through the year/visit
Construction (site upgrade)	15
Student field trips and research	3
Boat cruising	5
Fishing	3
Water extraction for supply	12
Human activities in residential areas	All through the year/visit

Bacteria count

Soil bacteria counts from soil samples collected in the site is given in table 3.*Bacillus spp*and *Pseudomonas spp*were the mostprevalent bacteria occurring in all the samples (100%) and then *Micrococcus spp*(60%). Bacteria prevalence is the same for farmland, forested areas and disturbed forest (samples A, D and E respectively). The highest total bacteria count was obtained in the samples collected in the forested areas (7.3×10^6) followed by disturbed forest (6.1×10^6) and in samples collected in the residential areas (5.5×10^6).

Table 3: bacteria counts from soil samples

BACTERIA ISOLATED	BACTERIA COUNT (cfus/g) $\times 10^6$		
	SAMPLE A1	SAMPLE A2	TOTAL
Bacillus spp	0.9	0.3	1.2
Pseudomonas spp	0.8	0.5	1.3
Micrococcus spp	0.7	0.4	1.1
TOTAL	**2.4**	**1.2**	**3.6**
	SAMPLE B1	SAMPLE B2	TOTAL
Bacillus spp	0.3	0.6	0.9
Pseudomonas spp	0.4	-	0.4
TOTAL	**0.7**	**0.6**	**1.3**
	SAMPLE C1	SAMPLE C2	TOTAL
Bacillus spp	1.3	1.2	2.5
Pseudomonas spp	2.0	1.0	3.0
TOTAL	**3.3**	**2.2**	**5.5**
	SAMPLE D1	SAMPLE D2	TOTAL
Bacillus spp	1.5	1.0	2.5
Pseudomonas spp	1.6	1.1	2.7
Micrococcus spp	1.0	1.1	2.1
TOTAL	**4.1**	**3.2**	**7.3**
	SAMPLE E1	SAMPLE E2	TOTAL
Bacillus spp	1.0	1.3	2.3
Pseudomonas spp	1.2	1.4	2.6
Micrococcus spp	1.0	0.2	1.2
TOTAL	**3.2**	**2.9**	**6.1**

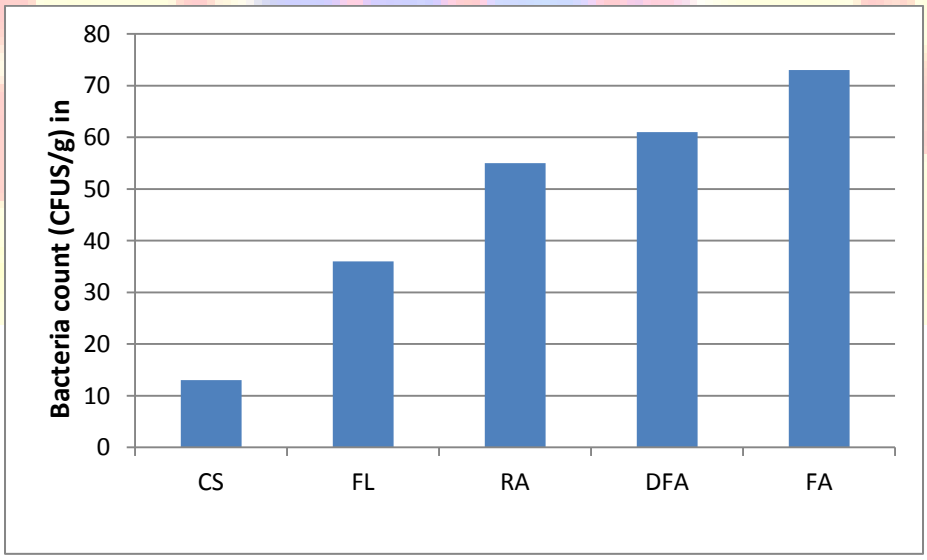

Figure 1: Comparison of soil bacteria count in the soil samples (%)

DISCUSSION

The bacteria count of each area differs depending on the kind and level of activities carried out in those areas. Using the same quantity of soil sample at the same depth into the soil (10cm) from different sample area, the highest number of bacteria count was recorded from sample from the forest soil decreasing in number down to the count from sample from the construction site. This is in accordance with the result of the experiment carried out by Vieira and Nehas (2005) comparing microbial number in soil of different agricultural use in which there was highest record in sample from forest soil. The research study revealed the same trend. Construction sites have the highest level of disturbance but the least number of bacteria while forested areas have the lowest level of disturbance and the highest number of bacteria.

Construction work: Awba dam was undergoing construction work during this study. This is to enhance areas suitable for ecotourism. Majority of these activities involves the use of heavy machines for removing forest trees and soil surfaces exposing. Construction works expose soil organism at both outer surface and sub-surface to direct sunlight and soil erosion. Some were destroyed during the operation of construction machines. The environmental impact of fuel used for running these machines is often negative on the living of soil microbes as discovered by Huesemann and Huesemann (2011) because of its toxicity. The cement content of concrete also has some toxic content that has adverse effects on soil bacteria.

Farming activities: Basically involve tilling of the soil thereby exposing the soil bacteria to excessive sunlight, erosion etc. Their destruction by tilling activities depends on the depth of till into the soil and the size of tilling area. This study revealed that *Pseudomonas* was the most abundant bacteria in farmland. This in line with a study carried out by Ana (2000) when it was reported that *Pseudomonas* strive well on cultivated soil.

Residential area: the environmental impacts caused by people residing around Awba dam include the effects that result from the use of toxic materials and other additives sources that are detrimental to soil microbes. According to Reynoids (1997), over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target. Pesticide contaminates land and water when it escapes from production sites thereby affecting the lives of soil bacteria. Pharmaceuticals and personal care products (PPCPs) often find their way into the soil (US EPA,

2009). However, some bacterial can withstand these substances. For example, pseudomonas has been reported to have high resistance to some chemicals in their environment (US EPA, 2009). This is consistent with the outcome of this study as pseudomonas was the most abundant bacteria in residential area.

Disturbed forest: This area still retains the nature of forest as there was present of trees with grasses and liters covering the soil. The result revealed the presence of *Bacillus spp, Pseudomonas spp* and *Micrococcus spp* very similar to result obtained in forested area. The species of bacteria obtained was also similar to that discovered from farmland but with different count.

Forest area: in this area of the study site, no activity was recorded as the area is still very much covered with vegetation with non-conspicuous human activities. The soil is covered with leaves litters. The soil in this area is shielded from direct sunlight and minimized from erosion activities with the help of the vegetation and litters on the ground. The result of the research showed the highest bacteria count in this area. Bacteria are known to be very diverse and prevalent in forest ecosystem. They function as a benefactor to plants by attaching to roots and assisting in the efficiency of nutrient uptake, as well as expanding the rhizosphere. Flavobacterium species is usually common in the forest soil because of its low temperature loving nature. The overwhelming majority of carbon and nutrients that support soil bacteria is in the vegetation and dead wood of the rainforest, not the soils (Bamforth, 2007). Because of high water content, hence acidic nature of the soil which favour higher counts of bacteria.

CONCLUSION

A biological indicator could be an organism, part of an organism, or a community of organisms, used to obtain information about environmental quality. The assessment of microbial biodiversity has the potential to provide useful insight into the health and functioning of a good environment. The analysis carried out on the soil samples collected revealed a variation in abundance of bacteria composition in accordance with the kind of activity carried out on the land. Land degradation occurs when preparing land for activities like tourism, carrying out construction works, building and farming.

This study revealed that human activities carried out on soil around the dam have impacts on the soil microorganism. It also revealed that soil microorganisms could serve as impacts indicator and be used to assess the level of impacts of human activities on ecotourism sites to monitor environmental impacts.

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