



An assessment on the effects of road constructions on ecological biodiversity and livelihood in Bo City, Southern Sierra Leone

Mohamed Exton Zoker ^{1*}, Samuel Karim ², Alvin T Jones ³, Martin Williams ⁴

^{1, 2-4} School of Education, Mathematics and Integrated Sciences, Njala University, Freetown, Sierra Leone

² Faculty of Social and Management Sciences, Ernest Bai Koroma University of Science and Technology, Makeni, Sierra Leone

* Corresponding Author: **Mohamed Exton Zoker**

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Abstract

Ecological effects on roads construction include physical disturbance, habitats loss, extinction of populations of species near road edges, mortality of wildlife that are using roads edges as habitat, and the scattering of wildlife (including invasive species and alien species) along road network. In other words, roads construction contributes essentially to the socio-economic and cultural development of rural communities. Improved road infrastructure facilitates rural population to find work in and beyond their respective communities. Similarly, the city of Bo has been experiencing 21st Century massive asphalt roads construction. This research is to assess the effects of road construction on ecological biodiversity on the livelihood of the people in Bo City. Biodiversity is increasingly threatened by rapid infrastructure expansion and its associated ecological effects. Infrastructure such as roads, alter ecological conditions by cutting through habitats and consequently reducing populations of many wildlife species. As a result local species in abundance decline in the nearness of infrastructure and increase with distance from the infrastructure until leveling off at a certain threshold distance. This decrease in population density varies by taxonomic group, with mammals being affected over long distance than birds (Benitez, Lopez, *et al* 2010).

Keywords: ecological biodiversity, livelihood, habitats, people

1. Introduction

Roads construction in Bo city, southern Sierra Leone, is a new phenomenon which began more than two decades. These are Government of Sierra Leone projects being undertaken and implemented by various roads construction companies. The 21st Century technology of asphalt road construction and the usage of earth-moving equipments are hampering the livelihood of inhabitants of Bo City. These massive constructions of major roads through the city and other roads connecting some localities are therefore impacting businesses and destroying habitats of microorganisms and other organisms and thereby causing ecological effects of on biodiversity. Therefore, it's paramount to assess the effects of road construction on the ecological biodiversity and livelihood in areas where these constructions of roads are located.

1.1 Statement of the Problem

When the soil is impacted greatly, natural vegetation is cleared on account of road construction purposes; there are possibilities for species to become invasive and separated when they migrate to new habitats. These activities by humans are endangering and threatening wildlife and other organisms. The machineries use also emits carbon dioxide in the atmosphere therefore depleting the ozone layer, which if not handle correctly has the propensity to contribute massively to global warming. The relocation of people situated at or near these construction sites impedes economic balance as well as causes social disturbances. Sources of natural waterways use by people in Bo City are interrupted due to backfilling of wetland and mini valleys. When shop and store owners including other family businesses are removed and relocated on account of roads construction, it creates pressure on the livelihood of the people.

1.2 Aim of the Study

The aim of the study is to contribute to knowledge other researchers have coined about the ecosystem in an effort to create awareness about the potential roads construction plays. Humans' interactions with the environment are creating the loss of biodiversity. This research will provide education on the effects of road constructions on ecological biodiversity as well as its effects on the livelihood of the people of Bo City, southern Sierra Leone. The research is aimed to assess the level of destruction road constructions has caused since the asphalt pavements began in the City of Bo.

1.3 Objectives of the Study

This research will be conducted based on consideration of the following objectives:

- To identify the effects of roads construction on ecological biodiversity
- Provide insights on how roads construction contributes and impacts the economy
- To assess the effects of roads construction on the livelihood of the people in Bo City
- To evaluate government's policies on road infrastructure and its impact on the inhabitants
- To analyze causes of ecological degradation

1.4 Research Questions

These questions serve as the basis of this research. They are to be used in maintaining all ethical research considerations.

- Does road constructions impacts ecological bio-diversity and livelihood?

If yes, state the reason

- Are there any correlations of ecological conservation to livelihood?

If yes, state the reason

- What are the ominous activities of road construction that threatens ecology?
- Does ecological policies plays crucial role to conserving environment, and thereby enhancing livelihood?

If yes, state the reason

- What is the knowledge base of ecological conservation in Bo City?

I, Very strong, ii, Strong, iii, Fair, and iv, Poor

- Does climate change adaptation have the ability to strengthen ecological conservation?

If yes, state the reason

- Are there probabilities of species getting into extinctions as a result of threats to ecology in Bo City?

If yes, state the reason

- How can the ecology be conserved?
- Does modern techniques in ecological conservation proves efficient and effective to enhancing a balanced environment? If yes state the reason
- What are cost-benefits trade-off between road construction and ecological biodiversity conservation?

1.5 Significance of the Study

Believing that "knowledge is power", the researchers deem it fit to undertake this study to provide education to the

following people and institutions: the inhabitants of Bo City, city development council, policy makers, non-governmental organizations, future researchers, the government of Sierra Leone, Environmental Protection Agency, etc. Moreover, these groupings are key factors regarding conservation of wildlife as well as the protection of ecological biodiversity.

1.6 Scope and Delimitation of the Study

Whilst assessing the effects of roads construction on ecological biodiversity and livelihood in Bo City, researchers will be restricted to obtaining data from inhabitants of the city who are living closest to the road construction sites and who were directly affected by the actions of the construction companies. The criteria to becoming participants or respondents of the research work as well as the selection process, is aimed at establishing credibility during data collection process. Researchers will consider 50 participants in total covering the various locations of roads construction: the Tikonko Road, Matru Road, and various roads in the city center where construction is being carried out.

1.7 Limitation of the Study

Mobility, space and time might greatly impact the conduct of the research in term of data collection and analysis. The geographical location of Bo and its size, as it is being considered as the second biggest and populated city in Sierra Leone, might have influence and impact results as researchers may not cover Bo in its entirety. Language and cultural diversity in research area could contribute to inefficiency of data interpretation and analysis. Choosing 500 participants is an indication that the researchers cannot reach to as many as the thousands of people for interview

1.8 Definition of Key Terms

- **Cultural/language diversity**-differences of language & culture that affects understanding and analysis
- **Knowledge**-an information and education being provided
- **Mobility**-the inability to cover every area within research surroundings.

2. Review of Literature

2.1 Introduction

In reviewing previous works of researchers, focus on assessing the effects of road construction on ecological biodiversity on livelihood in Bo city remains vital phenomenon during the conduct of this research. Presentation of related research works, in-depth analysis as discussions on the following headings: theoretical framework, conceptual framework considering the topic and research objectives and questions basically about the research.

2.2 Theoretical Framework

Introduction of Research Article

Rural households in developing countries rely on surrounding ecosystems to provide a variety of services (incl. water, firewood, timber, medicine, grazing, and wild food) essential to sustain their livelihoods. Growing human populations, expected to quadruple this century, and their livestock in communities adjacent to protected areas increase the pressure on environmental resources, negatively affecting conservation objectives. The poor tend to rely more on ecosystem services and may thus suffer disproportionate deprivation from depletion of environmental resources. Infrastructural development extending roads into remote

rural areas is proposed to reduce poverty by facilitating market integration and growth of non-farm Micro, Small and Medium Enterprises (MSMEs).

Consequently, road expansion is occurring at an unprecedented pace in developing countries extending into remote areas harbouring ecosystems with high biodiversity conservation value. However, according to some observer's risks are often not adequately assessed and roads may instead cause environmental, economic and socio-political problems. A study estimates a drop in the wildebeest population by 35% assuming the road will constitute a barrier to migration, which on the other hand has been contested. Proponents argue that the road will facilitate national and local economic growth reducing poverty and improving the local quality of life, which is generally expected to lower pressure on ecosystems. A study of the socio-ecological feasibility of two alternatives to the Northern Serengeti all-whether road, one of which passes along the southern edge outside the Serengeti National park found that the Northern Serengeti all-whether road was associated with least improvement in children access to schools, fewest households with increased access to hospitals, least connection of labour force with small and medium-sized business and between markets and areas with high crop and livestock production. The Northern Serengeti all-whether road furthermore had the highest establishment costs and most negative impacts on conservation and tourism income potential. However, retorts that the improved social well-being expected from the Northern Serengeti all-whether road is a human right and a prerequisite for conservation because the adjacent communities are the custodians of migratory species. With the lines thus drawn up, it remains unclear how communities will adjust their livelihood activities in response to road improvement in general, reducing travel time to markets. Such information is needed to facilitate informed predictions about emerging and changing environmental pressure as a result of land use change.

General economic theory and empirical findings suggest diverging effects of roads that have opposing implication for conservation. We identify four simplified hypotheses based on the literature. Hypothesis 1 predicts that road improvement through increased markets access will enable people to earn a higher profit from their cattle and crops, leading to intensification of such activities facilitated by livestock and crop extension services and loans. Hypothesis furthermore propose that market access will facilitate the development of nonfarm MSME providing new livelihood opportunities (e.g. business income and wage employment). Consequently, ecosystem pressure will initially decrease and biodiversity conservation will improve.

Methodology

Data was collected in the GSE covering an area of about 18,000 km² in Tanzania on the border of Kenya. The topography of the ecosystem is dominated by plains hosting the greatest remaining wildlife migration in the world following seasonal variations in rainfall and the availability of grazing across the ecosystem. Outside the protected areas' boundaries lie agricultural and pastoral areas home to over two million people in the nearest seven districts. The Maasai inhabit the Loliondo Game Controlled Area and the Ngorongoro Conservation Area on the eastern boundary of the Serengeti National Park stretching to the southern edge of the plains where they meet the Sukuma agropastoralists as the

principal inhabitants of the area South and South-West of the Maswa Game Reserve up to Lake Victoria. North of the western corridor and West of Ikoma, Ikorongo and Grumeti Game reserve is densely populated agricultural land mainly inhabited by the Ikoma and the Kuria tribe further North. The human population in the ecosystem is growing at an alarming pace of 3.5% per year increasing the pressure on the ecosystem to meet demand for food, energy, construction material, water, and land with conversion of natural habitats to agriculture at a rate of 2.3% per annum. Conversion of land to agriculture is fastest along the western border of the park where human population growth rates are also highest. Although agriculture is increasing in the pastoralist areas east of the park, land-conversion is still minimal. Overall land use change appears driven by frontier engulfment by people being pushed towards park boundaries by resource scarcity in distant densely populated areas. Living close to the protected areas is characterised high levels of human-wildlife conflict lowering agricultural output. Poverty appears to be a key driver of bush meat hunting in the western and southern part of the ecosystem mainly for income generation through the bush meat trade. Estimates of the number of people hunting in the protected areas vary considerably from 32% of the population up to 52,000 people in Western Serengeti alone. The intensity of hunting is expected to increase because of the rising human population adjacent to the protected areas. An estimated 20% of households furthermore illegally graze livestock inside the protected areas. Hence, the GSE was selected for this survey because of the proposed infrastructure project but also due to the increasing pressure on ecosystems in this social-ecological system. The proposed Northern all-whether road involves upgrading an existing gravel road to a tarmac road connecting the Mara and Arusha regions and particularly the headquarter of Serengeti district, Mugumu, and the headquarter of Ngorongoro district, Waso. However, we take a broader look at preferences for livelihood activities in response to road development

Findings

We use a discrete choice experiment to explore the effect of road development on respondents ex-ante preferences for changes in livelihood activities-crop and livestock production, hunting and trading bushmeat, and business and wage employment-under different incentives-provision of loans, livestock and crop extension services—in scenarios with reduced travel time to nearest district town in the Greater Serengeti Ecosystem in Tanzania. We test four hypotheses about the effects of roads with opposing implication for conservation. Hypothesis 1 predicts that increased market access will lead to intensification of crop and livestock production activities (achieved through extension services and loans), and Hypothesis 2 that market access will facilitate the development of non-farm Micro, Small and Medium Enterprises (MSME) providing new livelihood opportunities (e.g. business income and wage employment)—both reducing environmental pressure. Hypothesis 3 on the other hand predicts that improved market access will lead to extensification and expansion of crop and livestock production activities, while Hypothesis 4 suggests that it will encourage exploitation of environmental goods (here in the form of hunting and trading bush meat and illegal grazing inside protected areas)—both increasing environmental pressure. We find increasing preferences for more cropland and more cattle as travel time to market is reduced but no preference for increased

allocation of household members to hunting and trading bush meat supporting hypothesis 3 while contradicting hypothesis 4.

However, second-order effects might support hypothesis 4 as we find aversion towards decreasing effort invested in hunting and trading bush meat. Preferences for increased cropland and livestock may furthermore interact to increase land use change and illegal grazing inside protected areas. Crop extension services had a negative modifying effect on preferences for more cropland (supporting hypothesis 1) while livestock extension services had a positive modifying effect on preferences for more cattle (contradicting hypothesis 1). Providing loans had a negative modifying effect on preferences for increasing cropland and number of cattle. Marginal rates of substitution suggest that 950,000 TSH borrowed at a 10% interest rate will reduce preferences for more cropland and cattle by 11.8 and 38.4% respectively. Crop extension services reduce preferences for more cropland by 27% whereas livestock extension services increase preferences for more cattle by 104%. Contradicting Hypothesis 2, we found no preference for increasing the number of households members engaged in business and wage employment in response to reduced travel time. Targeted efforts to increase the educational level as well as entrepreneurship skills in the GSE could promote engagement in the labour market and development of business enterprises diverting focus from traditional activities such as farming and livestock production and hence reducing pressure on the ecosystem.

Impact of road on biodiversity

Roads have become a prominent landscape feature that we use daily and in almost every environment imaginable (Forman & Alexander, 1998). Yet little attention has been paid to the associated edge effects of roads in the landscapes in which they are embedded. A major and increasing impact upon the environment is that of roads and their associated vehicular traffic. The effect of road upon the environment is complex, and includes disturbance during construction, and pollution both from the road material itself and from the traffic of an established road. Potential edge effects from roads range from erosion and sediment deposition during construction to pollution from the highway maintenance to traffic.

Forest roads can be defined as ecosystems because they occupy ecological space (Hall et al., 1992). They have structure, support a specialized biota, exchange matter and energy with other ecosystems, and experience temporal change. Forest road ecosystems are built and maintained by people (Haber, 1990). Forest road ecosystem includes both the paved and unpaved rights of way and adjacent structure, including other infrastructure, ditches, drainage features, and other components that provide the means for vegetation to establish and provide habitat for associated plants and animals (Lugo & Gucinski, 2000). Edge effects (alternations to habitat quality due to proximity to the edge) are central influence over local biotic and abiotic processes in the forested area. Furthermore, edge effects can reduce the area of interior habitat by changing species composition, temperature, moisture, light availability and wind speed (Gysel, 1951; Chen et al., 1992, 1995; Euskirchen et al., 2001). Edges often have higher species richness and greater numbers of exotic species (Ranney et al., 1981; Brothers & Spingarn, 1992)^[11], potentially altering ecosystem processes

and functions such as productivity near the edge (Laurance et al., 1997). 18 Changes in plant and animal diversity occurring up to 30 m from the road edge into the adjacent forest (Mader, 1987). Roads cause both a direct and an indirect loss of habitat. The direct loss refers to the reduction of the total area of an ecosystem caused by the presence of the road and its verges, i.e., by the conversion of the original land cover (e.g. wood land, grassland, wetland, etc.) into an artificial surface. The indirect loss refers to effects such as the fragmentation (i.e., the portioning of an ecosystem into smaller and more isolated patches) and the degradation of ecosystems (i.e., the biophysical alteration of an ecosystem induced by noise, air and water pollution, artificial light, etc.). These effects cause an indirect loss of habitat in that they reduce the capability of an ecosystem to sustain its original biodiversity.

Research Methodology

3.1 Description of study Area

The research was carried out in Bo city, the second capital city of Sierra Leone. Bo city is situated in the southern province of the country. It is the second capital city of Sierra Leone. The landscape was once cover with rainforest but due to deforestation exercises for far too long, it is now predominantly form bush with characteristics of scrubs and trees. The western part of Bo city covers New London, Kande Town, Torwama, Njajboima and New York. The inhabitants are predominantly Mendes, Temnes, Libas, Fullahs, Mandingoes and Lokors. There is a rapid construction of settlements and this makes the city expanding at a faster rate. The high way passes on the outskirts of the city of the west and east to Kenema.

There are also other networks of roads such as the Mattru Road, Tikonko Road, and the Torwama Road which head up to Mattru on the Jong. Mattru Road and Tikonko Road converge at Dambala Road which leads to the city center. Some of the above mentioned roads like the Torwama Road, the highway and others like Menhieboima Road and Sewa Road provide access to other towns and villages in the interior and also the capital city.

Commercial activities within the City of Bo include the selling of food stuffs, clothes and other items, and also bike riding. Infrastructure includes town councils, both district and city councils, town hall, coronation field, Ministry of Tourism and Culture, Police Station, both central and eastern police station, telecommunications, electricity, government hospitals and many other private health centers, prison, government reservations, banks, shops supermarkets, drugstores, photo studio, clock tower, radio stations, churches and mosques and also university. The sources of usable water in the township are mainly dug wells and streams. But few pipe bond water supply around the highway especially the central part of the city.

3.2 Population of the Study Area

Bo city is an urban center, and lays approximately one hundred sixty (250 km) east southeast of Freetown which is the capital city and about forty miles (71 km) to Kenema. It has a land area 23.50 km² and a population of about 233,684 (based on 2017 census estimate). Components of the population are children, youth and the aged.

3.3 Sample and Sampling Procedure

The sample size was taken from five hundred people where the road constructions are going on. And this sample (500

people) include bike riders, vehicle drivers, business people and shops and stores as well as those selling on tables, pedestrians and even residents along the roads that are undergoing construction. These are the ones the researchers will interview. The roads that are undergoing construction include the Torwama Tikonko Road, Mattru on the Rail, Ngyia Road and Mission Road.

3.4 Data Collection

For data collection oral interviews are conducted in order to obtain desired result from the participants in all the areas where road constructions are taking place. For this study, primary data is used. In this case data was obtained by interviewing selected people orally. Participants will be recorded through tape recorder with the consent of the interviewees. Interviewers will also use handwriting or note pads to take information as the participants respond to research leading questions.

3.5 Reliability of Instrument

In this research work, researchers guarantee factual and dependable information. This is to ascertain adequate and accurate data which will be reliable. The use of tape recorder and notepads during interview is intended to employ coding techniques for correct data recording. Both the recorder and notepads are sufficient indications that data from the interviewees are checked before being recorded. All data collection procedures and processes are set to be proven worthy of research and for future reference for other researchers.

3.6 Method of Data Analysis

The data was analyzed based on the objectives set for the study. Data analysis was descriptive and obtained from sources including presenting questions to participants, either a focused group or single individual for their responses respondent's results or answers will be organized in chart form. This qualitative research is aimed at presenting data in descriptive manner.

Data Analysis, Findings and Discussion

4.1 Demographic Characteristics of Respondents

This chapter includes the analysis of data that was collected, findings obtained from interviews conducted and significant research discussions. The purpose of this chapter is to also provide demographic profile of the women's age 18 – 68 and men's age 18 – 68, that were interviewed and responded to questions during interview. This information is important to understanding and assessing the effects road constructions have on the biodiversity and livelihood of people in Bo city, southern Sierra Leone. The age range and age interval as indicated and displayed is necessarily mentioned to gather information from respondents who attained the age of consent and are not minors or under aged.

Some of the respondents are engaged in various economic activities which include but not limited to bike riders, vehicle drivers, pedestrians, shop and store owners and residents along various roads (Torwama-Tikonko road, Ngyia road, Mattru on the rail and Mission road) under construction and some of the ones already completed. The tables below show the demographic characteristics of respondents' age in the city of Bo, Southern Sierra Leone by category. These tables contain both males and females respondents in total. Demographic characteristics of respondents' gender and age

increased by 10, who participated and responded and they are found in various locations in the city of Bo as per road under construction or completed. Each age group responded to interview questions as indicated on the tables.

In table 1 there are satisfactory responses obtained from the respondents at the location of the road indicated below. Researchers have gathered that such turnout is predicated upon being residents at this location and talking with respondents on regular basis. Out of the total number of 125 interviewees targeted on the Torwama-Tikonko road, there were 100% respondents reported. The age range from 28 to 48 received high responses and elaborated on the effects of road constructions on ecological biodiversity and the livelihood of people in Bo City, especially at this location.

Table 1: Torwama-Tikonko Road Participants/Respondents

Gender	Males	Females	Total Number	% of Respondents
Age Group				
18-28	15	10	25	20%
28-38	18	12	30	24%
38-48	30	15	45	36%
48-58	10	5	15	12%
58-68	6	4	10	8%
Total	79	46	125	100%

Table 2: Mattru on the Rail Road Participants/Respondents

Gender	Males	Females	Total Number	# of Non Respondents	% of Respondents
Age Group					
18 – 28	13	8	21	1	16.8%
28 – 38	21	15	36	3	28.8%
38 – 48	30	13	43	Nil	34.4%
48 – 58	10	3	13	2	10.4%
58 – 68	4	1	5	1	4%
Total	78	40	118	7	94.4%

Table 3: Ngyia Road Participants/Respondents

Gender	Males	Females	Total number of Respondents	% of Respondents
Age Group				
18-28	16	5	21	16.8%
28-38	20	10	30	24%
38-48	35	13	48	38.4%
48-58	12	4	16	12.8%
58-68	8	2	10	8%
Total	91	34	125	100%

Table 4: Mission Road Participants/Respondents

Gender	Males	Females	Total # of Respondents	% of Respondents
Age Group				
18-28	14	9	23	18.4%
28-38	19	13	32	25.6%
38-48	25	14	39	31.2%
48-58	15	6	21	16.8%
58-68	7	3	10	8%
Total	80	45	125	100%

4.2 Findings

Does road constructions impacts ecological bio-diversity and livelihood?

If yes, state the reason

Road constructions have impacts on ecological biodiversity and livelihood in diverse ways. There is total destruction of

plant species and the loss of habitats of many animals both vertebrates and invertebrates that reside in areas where roads construction is taking place. During this process, microorganisms as well as wildlife lost their habitats and go in extinction. Taking Torwama-Tikonko road as an example, had swamps, creeks, streams which have been covered and this led to the destruction of aquatic animals such as crabs, fishes, frogs as well as snakes. The backfilling of wetland can also lead water pollution which makes water impure for domestic purposes such as bathing, laundering, drinking, etc. There is also an interruption on food chain and food web in the ecosystem. Roads construction also leads to air pollution on people that are living along the road and it has the tendency of increasing road accidents. Paved roads ease movements of vehicles, bikes and pedestrians and also improve the livelihood of people. It also improves businesses, less cost of transport fare, and reduces maintenance cost on vehicles and motorbikes.

Are there any correlations of ecological conservation to livelihood?

If yes, state the reason

Plants and animals depend on each other in order to survive; therefore the destruction of one will affect the life of the other. Hence, we should conserve biodiversity to prevent these species to become extinct and to maintain a balance in nature. When the ecosystem is not destroyed or not tempered with by human activities such as deforestation, road construction, burning, the use of chemicals, and conservation of resources become a guarantee to sustaining livelihood. Sustainable livelihood can provide sustenance, economic viability, a sense of identity, social status and the means to produce and distribute resources and services. Biodiversity conservation protects plants, animals, microbial and genetic resources for food production, agriculture, and ecosystem functions such as fertilizing the soil, recycling nutrients, regulating pests and diseases, controlling erosion and pollinating crops and trees.

What are the ominous activities of road construction that threatens ecology?

During road construction the ecology is impacted immensely. Road construction and excavation lead to soil exposure and erosion caused by changes in ground runoff conditions; destroys surface vegetation, resulting in a decrease in plant species and ecosystem structure and function; road construction destroys wildlife habitat, and cause changes on the surface of the earth. Roads can also cause habitat fragmentation by breaking up tracts of forest into smaller areas. Habitat fragmentation can lead to forest die-off by altering forest conditions like humidity levels, wind, temperature, and exposure to invasive species and fire. One of the key findings of the study is that the construction of roads in Bo City causes landscape scarring, soil erosions and landslides, wildlife habitat fragmentation and sedimentation of water channels.

Does ecological policies plays crucial role to conserving environment, and thereby enhancing livelihood? If yes, state the reason

Yes, the fact is ecological policies are the major reasons why we still have some plant and animal species in existence. Plants provide us with food, fiber, shelter, medicine, and fuel. The basic food for all organisms is produced by green plants.

In the process of food production, oxygen is released. This oxygen, which we obtain from the air we breathe, is essential to life. Provides source of energy to all living beings. Plant converts carbon dioxide into oxygen necessary for survival. The vegetation provides habitat or source to build habitat for all animals. Prevents soil erosion, brings rains to be used as drinking water all through the year. Conservation of vegetation refers to the process of ensuring that native plants, trees, and grasses are protected in certain areas. This helps to ensure that the various types of wildlife that live in an area have food and shelter, and also helps to protect biodiversity.

What is the knowledge base of ecological conservation in Bo City?

i. Very strong, ii. Strong, iii. Fair, and iv. Poor

The ecological conservation in Bo city is poor based on human activities for economic purposes. These included cutting down of trees for burning charcoal for sale, burning of bushes for the cultivation of crops and this lead to the killing and destruction of habitats of both macro and microorganisms and also plants. Bo City as a whole consists of swamps and streams holding a lot of aquatic organisms such as fish of different species toads frogs, crabs, prawns, etc. and even microorganisms. Some of these swamps and streams are backfilled for the construction of roads, bridges and houses which lead to the destruction of the habitats of these organisms. Wastes such as plastic bottles and containers, refuse, fascas, are dumped into swamps and streams that lead to the suffocation of these organisms dwelling their and die. Most of these trees that are cut down are responsible for the reduction of carbon dioxide concentration and replenishes the lost of oxygen in the atmosphere. High concentration of these gasses can lead to Green House effect when the ozone layer is depleted.

Does climate change adaptation have the ability to strengthen ecological conservation? If yes, state the reason

Human can adapt to climate change by using their vulnerability to its impact. Activities such as moving to higher growing to avoid rising sea level, planting new crops that thrive under new climate condition or using new building technology represents adaptation strategies. Climate change can alter where species live, how they interact and the timing of biological event, which could fundamentally transform current ecosystem and food webs. Climate change can overwhelm the capacity of ecosystem to mitigate extreme events and disturbance, such as wildfire, floods and drought. Beyond doing everything we can't cut emission and slow the pace of global warming, we must adapt to climate consequences the fallout variation depending on where we live.

Are there probabilities of species getting into extinctions as a result of threats to ecology in Bo City? If yes, state the reason

The probability of species getting into extinction as a result of threats to ecology in Bo City is very high. Species become endanger for two main reasons. These include loss of habitat and loss of genetic variation. In Bo City there is a loss and degradation of habitats, such as deforestation, over exploitation of the natural habitats of species which lead to their extinction. More recently, habitat destruction and degradation by the construction of roads, bridges and

building of houses, which have become primary causes of endangerment and extinction of animals and plants. Invasive species, pollution and diseases are also major threats, while over exploitation of animals and plants continues.

How can the ecology be conserved?

We can protect ecology by improving water quality, reducing biodiversity and limiting the destruction of natural resources. Ecology can be saved by protecting more trees, recycling, reusing, reducing pollution, creating awareness through environmental programs. Ways of protecting ecology are as follows: reduce refused disposals in the environment and recycling plastic containers. Cutting down on what you throw away, volunteer for cleaning up in the community, conservation of water, reforestation, use long lasting light bulbs, etc.

4.3 Discussion

Road constructions in Bo City, southern Sierra Leone, have impacted the environment and livelihood of the citizens positively and negatively. There are indications, clearer evidence and observable information which came from respondents during interviews regarding the massive destructions caused by road constructions. It has been reported that countless fruits bearing trees which were owned and controlled by family members from whom they survived were removed by heavy equipments or by the use of power saws. Families, who were depending on the fruits from these trees as a means of earning livelihood, were left with little or nothing. Market tables along these roads were removed which caused setbacks to petit business people.

It is also been observed that several water sources and water ways are redirected and interrupted due to backfilling and cutting through wetlands. It is biologically proven that wetlands are saver terrains for a variety of aquatic animals and several plant species. Cutting through wetlands for road construction purposes has caused environmental irregularities considering the use of wetland. These are the reasons why water sources are contaminated due to over flooding therefore making water unsafe for its traditional uses. Wastes have taken over wetland and lowland communities where road constructions have taken place in Bo City. Major trees were cut down. Trees have vast importance to humans and the environment, which include but not limited to: protection against stormy winds, medicinal uses, domestic purposes, recreational purposes, etc. were destroyed. As a result of the removal of those perennial trees, heavy storm removed the roofs of nearly 20 homes along the Torwama-Tikonkon road, Torwama village, Bo City. The incidence also damaged several light poles and electric cables along the old Torwama road village. The debris landed on the main road and caused traffic congestion on that day.

There are indications that the soil has been degraded massively. Soil degradation has affected both private land owners and public land along areas where roads have been constructed. Several homes whose entrances and fences were lower prior to the construction of these roads are no longer convenient for use. Some of these entrances are abandoned because vehicles cannot use them. Those entrances and other mini roads are useful due to soil degradation, which makes accessibility to some houses difficult and has affected several homes, businesses, market grounds, etc. Soil degradation caused lost of habitats of microorganisms, insects species, reptiles and other animals. Several species of all kinds have

been endangered due to the loss of habitats and several species presumably killed by heavy machines.

Road constructions speed up infrastructural development. It contributes and facilitates rapid changes in areas where the construction was carried out. There are positive and rapid changes in areas such as transportation, business, individual infrastructural development, national development of government projects, which lead to the beautification of the landscape and cities. Bo City is not exempt from these qualities as a result of road constructions. The city of Bo is more accessible than ever before due to paved roads some of which are still ongoing. The asphalt road pavement his increased the number of motorbike rider in the city. There are more businesses being operated in several locations by people who can easily navigate through far-to-reach areas. When the roads are in good shape, vehicles movements are without any hindrances. Vehicle and motorbike owners do not visit garages frequently. The issue of inaccessibility is out of question.

Summary, Conclusion and Recommendations

5.1 Summary

The researchers targeted 500 people for interview in the city of Bo and considered four separate roads under construction which include the Torwama-Tikonko Road, Mattru Road on the rail, Ngyai Road and Mission Road. The demographic characteristics are discussed in chapter four. The age range of the respondents covers from 18 to 68 years. During data collection, it is indicated that majority of the respondent's falls between ages from

28 to 48 years, some of whom were motorbike riders, vehicle drivers, store and shop owners, marketers, owners of houses along the roads and pedestrians. Bo city is an urban center, and found approximately one hundred seventy four (174 km) east southeast of Freetown which is the capital city and about forty miles (71 km) to Kenema. It has a land area 23.50 km² and a population of about 233,684 (based on 2017 census estimate). Components of the population are children, youth and the aged.

5.2 Conclusion

During the assessment of the effects of road constructions on ecological biodiversity and livelihood in BO City, below are some the finding: there is more business people located on Ngyai Road since it is found in the city center. At this you find more shops, stores, parks, market tables which were destroyed during the road construction. And this brought setbacks to business people as well as pedestrians. The situation created road congestion for users and traffic jam. Bike riders were forced to be relocated as well as vehicle parks. Respondents on Ngyai Road were mainly people between the ages 28 to 48 years which amounted to the total of 62% of the respondents When the soil is impacted, natural vegetation is cleared on account of road construction purposes; there are possibilities for species to become invasive and separated when they migrate to new habitats. These activities by humans are endangered and threatened wildlife and other organisms. The machineries used also emitted carbon dioxide in the atmosphere therefore caused problems the ozone layer. The relocation of people situated at or near these construction sites impeded economic balance as well as caused social disturbances. Sources of natural waterways use by people in Bo City are interrupted due to backfilling of wetland and mini valleys. Other family

businesses are removed and relocated on account of roads construction; it created pressure on the livelihood of the people. At Matru on the rail, is not as congested as other roads therefore the researchers obtained less number of the respondents.

5.3 Recommendations

With regards to the above conclusion of this research the following recommendations are made.

- Government should inform people who have businesses along ahead of time to relocate their businesses before the commencement of road constructions.
- After road construction let there be replanting of trees in strategic areas where several trees were cut down
- There must be no-go-zone in fragmented habitats around which roads were constructed to provide stability for invasive species
- Government should train people in ecological conservation before road constructions and even after the construction of roads
- Government should actually provide pipe borne water since several water sources were contaminated due to road constructions

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