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# Impacts of road constructions on ecological biodiversity and livelihood in Sierra Leone

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## Abstract
Humans are key players for the current unprecedented rate of biodiversity loss across the globe with climate change, pollution and the loss, fragmentation, and degradation of habitat (VITOUSEK *et al* 1997).
According to convention on biological diversity (C B D) in 2019, defines biodiversity as "the variety of life on earth, including plants, animals and microorganisms, as well as the ecosystem of which they are part. Biodiversity includes genetic differences within species, the diversity of species and the variety of ecosystem.
The development and presence of roads infrastructures is the major indicator of economic growth. Research has shown that several important indicators of economy like trade, electricity, communication, health are positive correlated with the road infrastructure. Therefore any government of a country considers it important to invest in road infrastructure for feature prospect of the country with the best possible ways.
However, consequences of road construction cannot be neglected. Roads construction for mobility and accessibility of people inevitably transforms natural habitat in to a sealed and highly disturbed environment which always implies net loss of wild life habitat. The physical encroachment on the land, gives rise to disturbance and barrier effects that contribute to the overall habitat loss, fragmentation and degradation in Sierra Leone. Humans are changing the original structure of ecological communities by roads infrastructure which increases the death rate of species. This modification in earth ecological communities causes a compelling concern for ecosystem diversity loss Sierra Leone, like most developing countries trying to construct roads for mobility and accessibility.
Road construction projects undertaken by government or NGOs in Sierra Leone can reduce landscape permeability. Therefore the fundamental changes in landscape structure have both direct and indirect impacts on the conservation of species and biodiversity. The direct loss refers to the reduction of the total area of an ecosystem caused by the presence of roads and its verges, i.e. by the conversion of the original land cover into artificial surfaces. The indirect loss refers to the effects such as the fragmentation (portioning of an ecosystem in to smaller and more isolated patches), and the degradation of ecosystem induce by noise, air, water pollution, artificial light. These effects cause and indirect loss of habitat in that, they reduce the capacity of and ecosystem to sustain its original biodiversity.
It is explicit that, in Sierra Leone, most of the species are endangered as a result of road constructions the use of bulldozers and other machines in the operation to level the land, clear trees, and flatten the ground will destroy and displace many living organisms from their natural habitat and change their entire ways of living. The process will unable organism to adapt to drastic changes in their natural habitat.

**Keywords:** ecological biodiversity, livelihood, constructions, organism

## Introduction
Biodiversity can refer to many things, and has many specific definitions. Convention on Biological Diversity (CBD) defines biodiversity as " The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexities of which they are part, this includes diversity within species, between species and of ecosystem" (Article 2 CBD, 1992).

Government of sierra Leone considered it important to undertake Roads construction project in Bo city owing to the fact that Bo is the second largest city in sierra Leone by landscape/geographical location. It is the capital and administrative Centre of Bo District. However the ongoing Roads construction by FRIST TRICON LTD and SALCOST at some routes in Bo city such as Mattru road, baima road, stock road, Bo Tinkonko road and Njala university toawama compus main road has major effects on ecological biodiversity and livelihood of people found along those routes as it causes disturbance during construction and pollution both from the road materials itself and from the traffic of an established roads. Potential edge effects from roads range from erosion and sediment deposition during construction to pollution from the high way maintenance to traffic. The physical presence of roads in the landscape creates new communities, alter hydrological and dynamics, and disrupts natural processes. The various biotic and abiotic factors operate in synergetic way across several scales, and cause not only an overall loss and isolation of plant community, but also split up landscape in a literal sense. The construction of roads will change natural habitats into a sealed and highly disturbed environment.

**Statement of the problem**

The current loss of biodiversity and the related changes in the environment are now faster than ever before in human history and there is no sign of this process slowing down. So the potential threats should be identified and their extent of impact should be studied with it. In context of Sierra Leone, lots of environmental problems can be cited out that emerged out of developing transport infrastructures by neglecting the environment. Biodiversity conservation mechanisms are concentrated to reduce poaching, hunting and other illegal activities and other threats are usually overlooked i.e. rural road projects. Also the information known about the impacts of road projects on biodiversity is very low. Gautam *et al*. (2012). Road construction projects in Bo city are causing biodiversity loss and environmental degradation. So it is necessary to analyze the impact of these development projects on biodiversity. The research attempts to investigate the causes of ecological degradation, the effects of road construction on ecological biodiversity and livelihood in Bo city and finally to point out the national and international ecological and biodiversity policies.

**Aim of the study**

The aim of this research work is to assess the effects of road construction on ecological biodiversity and livelihood in Bo city, southern Sierra Leone.

**Research objectives**

In order to achieve the general aim of this work, the researcher will however needs,

- To investigate the causes of ecological degradation.
- To determine the effects of road construction on ecological biodiversity
- To find out the effects of road constructions on livelihood on the residence of Bo city.
- To point out the national and international ecological and biodiversity policies.

**Research Questions**

1. What are the causes of ecological degradation?
2. Are there any effects of road construction on ecological biodiversity?
3. What are the national and international ecological and biodiversity policies?

**Significance of the study**

The study is relevant for a number of reasons. First it will serve as a source of information for further research and to other researchers who are into similar or related studies of roads construction. The study will also expand knowledge on impact of road construction on ecological biodiversity. Finally, the research would be useful to the ministry of transportation and infrastructure, NGOS, and other international organization in developing ecological biodiversity policies.

**Scope and Delimitation of the study**

Even though the assessment on the effects of road construction on ecological biodiversity and livelihood involved the whole Bo city, researchers will be limited to obtaining data from people who are staying closer to the construction routes and who are directly affected by the construction projects. Therefore searchers will focus on 500 respondents along the various routes in which construction is ongoing, such as Baima road, Mattru road, Stock road and Njala university Toawama compus main road.

**Limitation of the study**

As the research progressed, the researchers encountered several challenges in the entire process. One of the limitations of the study was the difficulty in acquiring data from respondents due to the fact that they held a belief that researchers were trying to make money.

There was also a problem of time in administering the questionnaires to the respondents owing to the fact the researchers considered 500 respondents in different locations in which construction of roads is ongoing.

**Definitions of Terms**

1. Habitat- is the natural home or environment of an animals, plants,or other organisms.
2. Biodiversity is the biological variety and variability of life on earth.
3. Land degradation- the deterioration or loss of the productive capacity of the soil for present and future.
4. Land fragmentation is a process by which large and contiguous habitats get divided into smaller, isolated patches of habitats.

**Research questionnaires**

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

If yes, state the reason

2. Are there any correlations of ecological conservation to livelihood?

If yes, state the reason

3. What are the ominous activities of road construction that

threatens ecology?
4. Does ecological policies plays crucial role to conserving environment, and thereby enhancing livelihood?

If yes, state the reason
5. What is the knowledge base of ecological conservation in Bo City?
6. Very strong, ii, Strong, iii. Fair, and iv. Poor
7. Does climate change adaptation drive has the ability to strengthen ecological conservation?

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

If yes, state the reason
9. How can the ecology be conserved?
10. Does modern techniques in ecological conservation proves efficient and effective to enhancing a balanced environment?

If yes, state the reason
11. What are the cost-benefit trade-off between road constructions, and ecological bio- diversity conservation?

## Literature Review

### Introduction

This chapter will be a review to assess the effect of road construction on ecological biodiversity and livelihood in Bo city. This section will also flow on the effort that has been made by other scholars towards giving the causes of ecological degradation, national and international ecological biodiversity. It is also focused on published work from journals, text books and e-books.

### Causes of ecological degradation.

Ecological degradation refers to the loss of biodiversity through depletion of resources such as air, water, soil, habitat destruction, pollution, the destruction of ecosystems, the extinction of wildlife, etc. The causes of degradation in human-environment according to Ezeaku and Davidson (2008) [28] could be attributed to a single or complex mix of causes. While there are nature-induced factors, there are also human-induced factors that contribute to environmental resources degradation. According to the duo, the causes include biogeophysical (natural) such as climate vagaries of water and wind erosion; poor land use, inadequate land and water management policies, deforestation/over-exploitation of forest ecosystem services; socio-economic factors as it relates to burgeoning human population in our contemporary times (Ray and Ray, 2011) and also pollution/contamination of land resources and institutional factors in the areas of deficiency and/or inadequate land policies. Generally, the anthropogenic causes of environmental degradation according to Adejumobi (2017) [2] are increased urbanization and population explosion, inadequate environmental education, poverty and industrialization Other causes include extensive and intensive mechanized and commercial farming and salinization of agricultural land, indiscriminate harvest of forest resources, excessive uses of natural resources, poor urban planning, uncare attitude towards the environment and its resources, incessant bush burning and so on (Jiboye and Ogunshakin, 2011; Adeboyejo, 2017) [47, 2]

### Natural causes of ecological degradation

Natural causes include those factors relating to climate change vagaries and surface erosion. According to Issaka and Ashraf (2017) [37], having established that there is a relationship impact of soil erosion and degradation on water quality indicating the source of pollutants as anthropogenic and industrial activities has concluded that erosion causes both on-site and off-site effects on land and water bodies thereby affecting its quality.

Land degradation is a major problem facing developing countries and is projected to become an even more severe constraint into the future (Chisholm and Dumsday, 1987; Eckholm, 1976; USAID, 1979; Ward, 1979; Brown and Wolf, 1984; Bennett, 1931; Barbier and Burgess, 1992; Pimentel *et al*., 1995) [17 26, 10, 8, 4]. Some studies show that nearly 80% of rangeland and dry land forest areas, 30% of tropical forests and around 50% of all irrigated cropland in developing countries are classified as degraded (Leonard *et al*., 1989 [53]. Other studies also show that much existing (as much as half) as well as potentially productive agricultural land in developing countries is being lost through the processes of land degradation and abandonment (Cleaver and Schreiber, 1992; Barbier, 1997) [3, 5].

### The effects of road construction on ecological biodiversity

### Effects 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.

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), potentially altering ecosystem processes and functions such as productivity near the edge (Laurance *et al*., 1997).

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.

**Ecological Conditions and Scale**

Roads interact with ecosystems across a wide range of scales. For example, at small scales, heavy metal molecules accumulate in soils adjacent to roads. At intermediate scales, roads disrupt soil structures and hydrological pathways and alter plant and animal communities. At large scales (regions to nation), roads alter migration patterns and increase spread of exotic organisms. Many effects can occur at more than one spatial scale (for example, effects on migration patterns). The literature review in the next section documents effects of roads on ecological conditions at three scales. Every aspect of roads (as with many human activities) has some interaction with the surrounding environment, including road construction, operation, and maintenance. However, the researcher's review focuses on the construction that is, the effects of roads and their structures (for example, culverts) and vehicles that uses them.

**Abiotic consequences on road construction**

Abiotic conditions that can be influenced by roads include hydrological, geomorphological, and chemical characteristics and such disturbances as landslides, noise, and light. In this section, the committee considers only changes to the abiotic conditions themselves, and examples of each are provided below. How these abiotic changes affect the biota is considered in later sections.

**Hydrological and Geomorphological Changes**

Landscape changes result when roads alter the hydrological and geomorphological aspects of watersheds and landscapes. They can cause important changes (some for short periods, others for longer periods) in fluvial dynamics, sediment production, and chemical balances, which can adversely affect floodplain functioning and alter ecological conditions in aquatic and riparian areas. Roads also affect water movements, sedimentation, and transport of pollutants. Because they often interrupt or otherwise alter sheet flow and runoff patterns, roads can affect the amount and quality of water that goes to recharging groundwater (Forman *et al*. 2003; NRC 1996, 2004), and they can affect surface waters in many ways. Because road embankments trap dust and dirt and they face the low winter sun at an angle, they can accelerate snowmelt (NRC 2003). Roads and associated ditches can become part of hydrological networks (Forman *et al*. 2003).

**Chemical effects of road construction**

- **Water quality**

The most observable abiotic environmental consequence of roads is the contribution of motor vehicles on paved roads to water pollution. However, this contribution cannot be disassociated from the surrounding land use. The largest number of studies reporting on the chemical characteristics of road effects focus on the chemical effects arising from rainfall events at the single-segment scale (FHWA 1981; Asplund *et al*. 1982; Gjessing *et al*. 1984; Kerri *et al*. 1985; Lord 1985; Yousef *et al*. 1985; Barrett *et al*. 1995, 1998; Sansalone *et al*. 1995; Lopes and Dionne 1998; Wu *et al*. 1998). Water quality is adversely affected by pollutants present in surface runoff and the atmosphere. Pollutants that accumulate on roadways from spills, wastes generated during vehicle use, litter, and adjacent land uses enter waterways via surface runoff.

(Forman *et al*. 2003, Hahn and Pfeifer 1994, Buzas and Somlyody 1997, Ball *et al*. 1998) (Figure 3-2). Shaheen (1975) examined urban roadway runoff and found that although the more hazardous constituents in highway runoff come directly from motor vehicles, they constitute less than 5% of the total solid pollutant load in highway runoff. These components include organic materials, such as petroleum and n-paraffin found in lubricants, antifreeze, and hydraulic fluids; lead; copper; chromium; zinc; nickel; and asbestos. Asbestos in brake linings was banned in 1989 (Shabecoff 1989), so vehicular sources of asbestos are minuscule, although resuspension of previously deposited asbestos is still a concern. In spite of the low contribution of constituents originating from the vehicle itself, vehicular traffic volume was identified as the principal factor influencing pollutant mass in highway runoff. That might be because vehicles are a transport mechanism as well as a source of pollution (Asplund *et al*. 1982).

- **Air Quality**

Some studies also focused on the impact of vehicular chemical pollutants on local air quality. The majority of these studies examined the impact of vehicular traffic on the presence or absence of volatile organic compounds (VOCs) (Clifford *et al*. 1997, Tsai *et al*. 2002). Surprisingly few studies have examined the effects of chemical pollutants at the intermediate scale that could provide valuable information on total area effects primarily in watersheds or protected areas. Although most of the concern with roads and air quality focuses on new emissions added by vehicle tail-pipe emissions, suspendedss particles from traffic flow, dust from roadside areas, and other fugitive (non-tail-pipe) emissions are of concern.

**Biotic Consequences of roads construction.**

Roads can have biotic effects on the genetics of populations, on species, and on ecosystems, and their effects can accumulate over space and time (e.g., NRC 2003). The framework prepared by the Environmental Protection Agency (EPA) is also a helpful way to conceptualize the ecological effects that roads can have. In general, their effects can operate through a variety of ecological mechanisms. The biotic consequences of the following effects of roads are considered below: direct effects include roads as barriers, road kill, and effects on habitats; indirect effects include results of the access that roads provide to previously inaccessible areas, changes in water and air quality, and effects of lighting and noise.

**Roads as Barriers**

Roads can impede animal movements by direct mortality or avoidance behavior. The barrier effect varies between species, road types, and adjacent habitat quality; however, traffic volume and speed strongly influence the effect. Some authors have suggested that divided highways with 90 m of cleared areas as barriers are as effective as bodies of water twice as wide in obstructing dispersal of small forest mammals (Werner 1956, Sheppe 1965). The barrier effect for some species is less related to traffic than to habitat changes (road-forest edges and gap creation caused by roads). Small road clearances (less than 5 m) can impede movement of certain small mammals. For example, road crossing by small mammals was inversely related to road width in Australia (Barnett *et al*. 1978), and small barriers to the movement of wildlife can lead to fragmentation of populations. Isolation

caused by physical barriers to movement, such as roads, may reduce gene flow, thus causing genetic effects (Slatkin 1987) that in the extreme could result in local extirpation.

**Road kill**

Road kill can have demographic consequences for some species of wildlife (Maehr *et al*. 1991, Jones 2000). Roads and traffic can reduce wildlife population densities and ultimately affect the survival probability of local populations. Traffic-related mortality has contributed to the decline of several species: Eurasian badger (Meles meles) (Bekker and Canters 1997) and moor frog (Rana arvalis) (Vos and Chardon 1998) in The Netherlands, Hermann's tortoise (Testudo hermannii) (Guyot and Clobert 1997) in southern France, and Florida panther (Felis concolor coryi) (Maehr *et al*. 1991) are some examples. Road networks also particularly affect wide-ranging carnivore species (Maehr *et al*. 1991, Brandenburg 1996). Metapopulation theory suggests that more mobile species are better able to manage with habitat loss (Hanski 1999). Yet mortality of individuals in the matrix habitat (for example, road corridors) does not typically figure into metapopulation theory. Studies show that when mortality is high in the matrix habitat; highly mobile species are actually more vulnerable to habitat loss (Carr and Fahrig 2001, Gibbs and Shriver 2002). (Fowle 1996).

**Habitat Effects**

Roads construction inevitably transforms natural habitat into a sealed and highly disturbed environment which always implies a net loss of wildlife habitat. The physical encroachment on the land gives rise to disturbance and barrier effects that contribute to the overall habitat loss, fragmentation and degradation. These modifications in earth ecological communities cause a compelling concern for ecosystem diversity loss.

Roads have large, widespread effects on aquatic habitats (NRC 1996, 2004; Forman *et al*. 2003). When roads fail, landslides and torrents of water-borne debris can have serious adverse effects on stream habitats (NRC 1996). Roads and their associated structures, such as bridges, culverts, and berms, modify stream flows and sediment transport and often make passage for aquatic organisms more difficult or even impossible (NRC 1996, 2004; Forman *et al*. 2003; Warren and Pardew 1998; Schaefer *et al*. 2003). Because paved roads (and to a lesser degree, unpaved roads) are impervious, they increase runoff and otherwise alter hydrological patterns. Finally, they often interrupt the connectivity of aquatic ecosystems, although by providing new networks of aquatic systems, for example, in long ditches, they can enhance connectivity as well (Forman *et al*. 2003). Fragmentation effects of roads, as part of the cumulative effects of many factors, can strongly influence the distribution and land-use patterns of wide-ranging and migratory wildlife (Ward 1982, Noss *et al*. 1996).

**The effect of road construction on livelihood**

**Positive effects of roads construction on livelihood.**

The development and presence of road infrastructures in Bo city is a major indicator of economic growth. Research has shown that several important indicators of economy like trade, electricity, communication and health are positive correlated with the road infrastructure. Therefore any government of a country consider it important to invest in road infrastructure for future prospect of the country with the best possible way. The roads construction project in Bo city will benefit the people in diverse ways, such as easy movement and accessibility of people. However the consequences of roads construction cannot be neglected as it stated below.

**Displacement of Business places**

Road infrastructures in a town or city have a major effect on traders who are closest to the sites. During the construction phase some businesses were displaced. The business experience a significant impact when they are removed or relocated. The traders may have difficulty in obtaining suitable relocation sites; they may lose clients, and, upon relocation, may incur additional costs to re-establish.

**Impacts on Residents**

During the construction phase, residents may be disrupted and inconvenienced by detours, local road closures, dust, noise, and heavy equipment traffic on existing roads, changes in the level of service, safety hazards, and interference with emergency services. Occasionally, there is vibration damage to near-by structures. However, residents may benefit from construction employment. When the roadway is opened for use, positive impacts result for many residents. Travel time, petrol consumption, accidents and inconvenience to users generally decrease. The roadway increases access to jobs, schools, stores, recreation and other community services and amenities. These effects can be reflected in increased land values. However, there may be negative impacts for some residents living near the roadway. These include increased noise, pollution and aesthetic impacts.

**National and international ecological biodiversity policies**

**National policies on ecological diversity**

The perennial problem of weak law enforcement has been a key factor affecting the conservation of species, habitats and ecosystems in Sierra Leone. Some NBSAP 2002- 2010 interventions have come from the willingness by government to improve on policy and legislations that would ensure effective law enforcement. These include the following legislative and policy interventions:

1. 2008–The Environment Protection Agency Act, which brought into existence the EPASL. This agency now controls and coordinates all activities, business and development programmes that impinge on the environment. It is now one of the most powerful agencies of government hosted in the Office of the President.
2. 2010 – The Review of Forestry and Wildlife policies, respectively with the aim of ensuring that these two key components of the functions of the Forestry Division of MAFFS are effective and creating the desired impacts. These two policies also focus the importance of building community consensus through education and management approaches in conservation biodiversity.
3. 2012 – The National Protected Area Authority Act, which brought into existence the National Protected Areas Authority as a statutory body that manages, coordinates, and promote the operations of protected areas in the country. Its mandates also include the identification of areas that can potentially be designated for protection as well as mobilising the funds for the conservation of protected areas including REDD+ initiatives.
4. 2015 – The Review of the Wildlife Conservation Act of

1972 (WCA) and the orestry Act of 1998. This process was funded by the World Bank under the Sierra Leone Biodiversity Conservation Project (SLBCP) which ended in December 2015. The review of the WCA, among other things addressed the issues of out-dated fines and the inclusion of the legal protection of species that are listed in the IUCN Red List and all other species of national conservation interest. Both reviewed acts await ratification by the parliament

2015-Drafting of the Wetlands Conservation Act. This is one of the key achievements of the Wetlands Conservation Project, a subsidiary of the BCP. The Act now awaits parliamentary enactment. In addition, the BCP developed a National Wetlands Conservation Strategy and conducted a national inventory of the country's major wetlands as one of the main key tools for the implementation of the Wetlands As

a member of the international community, principally the United Nations and the African Union, Sierra Leone is having a fair share of the global decision making processes that affect a wide range of local national and international issues, including inter alia politics, environment and biodiversity. The country's contribution to addressing global environmental and biodiversity issues is well recognised, particularly as a founding signature of the African Convention on the Conservation of Nature and Natural Resources at its inception in 1968. Successive governments have put environment and biodiversity issues at the forefront of their policies and legislative actions, especially in terms of working with other nations in addressing these and related concerns. Among the many conventions and agreement signed by the Government of Sierra Leone, those related to biodiversity are outlined in Table 1; the dates of signing and/or ratification are also given.

**Table 1:** List of convention and agreements signed and/or ratified by the government of Sierra Leone relevant to biodiversity

| Convention/Agreement | Date signed | Date ratified |
|---|---|---|
| Nagoya Protocol | 30th January 2017 | - |
| Basal Convention | - | 1st November 2016 |
| Kyoto Protocol (extension of UNFCC) | - | 10th November 2006 |
| International Convention for theControl and Management of ShipsBallast Water and Sediment 2004 | | 21st November 2003 |
| Montreal Protocol | - | 29 August 2001 |
| Stockholm Convention on Persistent Organic Pollutants | - | 26th September 2003 |
| International Convention for thePrevention of Marine Pollution fromShips, 1973 and Protocol of 1978(MARPOL 73/78) | - | 23rd May 2000 |
| Convention on Wetlands (Ramsar) | - | December, 1999 |
| UN Convention on Desertification (UNCCD) | - | 20th September 1997 |
| Convention on Biological Diversity (CBD) | 10th March 1995 | |
| Convention on the International Trade in Endangered Species (CITES) | October 1994 | January 1995 |
| Convention on Migratory Species (CMS) | Non Party | - |
| African Eurasian Waterbird Agreement | MoU | - |
| UN Convention on the Law of the Sea (UNCLOS) | 15th December 1994 | - |
| UN Framework Convention on Convention (UNFCC) | 11th February 1993 | 22nd June 1995 |
| International Plant Protection Convention 1997 | 23rd June 1981 | |
| African Convention on Conservation of Nature and Natural Resources | !968 | 15th September 1968 |

Since the mid-1980s, Sierra Leone has implemented international wildlife regulations long before the signing of CITES. In 1986, a presidential ban was imposed on the export of wildlife and their trophies from the county because of the indiscriminate wildlife exploitation for trade (particularly chimpanzees and elephants). This ban was preceded by the confiscation of twenty infant chimpanzees deem for shipment, an action that wasinitiated by the WWF against a major pharmaceutical company in Vienna, Austria. In addition all border posts have stationed wildlife officers whose function is to stem the smuggling of wildlife, trophies and souvenirs out or into the country. Also, the Conservation Society of Sierra Leone (CSSL) has been conducting regular surveys of migratory water birds in collaboration with the former Wildlife Branch of the Forestry Division, MAFFS; these activities, which started in 1992, long before the signing of the Ramsar Convention, are still on-going and are mainly sponsored by Wetlands International and Wadden Sea Initiative.

**International policies on ecological biodiversity**

At international level, the main legal instrument for biodiversity protection is the Convention on Biological Diversity (CBD). It three main objectives are the

conservation of biological diversity; the sustainable use of the components of biological diversity; and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. This convention was negotiated under the auspices of the United Nations Environment Programme (UNEP) in Nairobi in 1992, and came into force on 29 December 1993. The CBD now has 196 Parties:5 195 countries plus the European Union, which has been a Party since the beginning. The CBD is complemented by two major protocols. The Cartagena Protocol on
Biosafety, which was adopted in 2000 and entered into force in 2003, seeks to protect biodiversity from the potential risks posed by living modified organisms resulting from modern biotechnology. It refers to the precautionary principle and establishes an 'advance informed agreement' procedure to make sure countries can make informed decisions before agreeing to import such organisms. The Nagoya Protocol, which was adopted in 2010 and entered into force in 2014, aims to create greater legal certainty and transparency for both providers and users of genetic resources, by regulating 'bioprospecting' and by making sure benefits are shared fairly among them. In practice, agreements concerning access to genetic resources are expected to be signed between biodiversity-rich (and often developing) countries, and companies using the genetic resources, typically from more advanced count.

**EU Policy Framework.**

The main legislative acts related to the protection of biodiversity in the European Union are the Birds Directive (2009/147/EC, which repealed the original Directive 79/409/EEC) and the Habitats Directive (92/43/EEC, most recently modified in 2013). The aim of both directives (sometimes called 'Nature Directives') is to contribute to the conservation of natural habitats and species (wild fauna and flora) in the EU. They are complemented by several other pieces of legislation relating to the protection of biodiversity.
The Birds Directive aims to achieve good conservation status for all wild bird species occurring naturally in the European territory of the Member States. Recognising that habitat loss and degradation are serious threats to wild bird conservation, it protects habitats for endangered and migratory species by establishing a coherent network of 'special protection areas' (SPAs).
The Habitats Directive aims specifically to achieve 'favourable conservation status'14 for habitat types and species deemed to be of Community interest. Under this Directive, Member States must designate 'special areas of conservation' (SACs) 15 and establish conservation measures, which may include management plans. They are required to carry out an appropriate impact assessment for any plan or project likely to have an impact on a designated site. In principle, a project can only be approved if it has no negative impacts on the integrity of the site, although exceptions are possible if there is an overriding public interest and if alternative solutions do not exist, provided that compensatory measures are taken. Member States must take measures to ensure the strict protection of all plant and animal species listed in the annexes to the Habitats Directive. They must monitor the conservation status of habitats and species and report to the Commission every six years.
A biodiversity strategy (COM (2011) 244), presented in 2011 by the Commission, sets a target for 2020 ('halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as feasible') and a vision for 2050 ('European Union biodiversity and the ecosystem services it provides are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human wellbeing and economic prosperity.'). Trying to address the shortcomings of the 2006 Biodiversity Action Plan,16 the biodiversity strategy seeks to integrate some sectors such as agriculture, forestry and fisheries, and to halt biodiversity loss outside protected areas. It prioritises 20 actions grouped into six targets: implementing the Nature Directives; maintaining and restoring ecosystems and their services; increasing the contribution of agriculture and forestry to biodiversity protection; ensuring a sustainable use of fisheries; combatting invasive alien species; and helping avert global biodiversity loss. In October 2015, the Commission presented a mid-term review of the biodiversity strategy (COM(2015)478).17 It concluded that no significant progress had been made towards reaching the headline target, as biodiversity loss and ecosystem degradation have continued.

**European parliament**

In its Resolution of 20 April 2012 on 'Our Life Insurance, Our Natural Capital: an EU Biodiversity Strategy to 2020' (2011/2307(INI)), Parliament supported the EU biodiversity strategy, including all its targets and actions, but indicated that more concrete measures should be deployed to ensure effective implementation of the strategy. It recognised that NGOs have an important role to play in biodiversity protection. It furthermore stressed the importance of mainstreaming biodiversity in all EU policies and called on the Commission and the Member States to identify all existing environmentally harmful subsidies and to phase these out by 2020. Lastly, Parliament called for at least €5.8 billion per year to be devoted to the Natura 2000 network through EU and Member State funding.

**Interaction with other EU policies**

Interaction between biodiversity protection policy and other EU policies can be complex, with a risk of reduction in policy efficiency caused by sometimes conflicting policy goals. In 1999, the Treaty of Amsterdam introduced the requirement to take environmental protection (including as regards biodiversity) into account across all EU policies. This principle is now enshrined in Article 11 TFEU, which provides that 'environmental protection requirements must be integrated into the definition and implementation of the Union's policies and activities, in particular with a view to promoting sustainable development'. As regards the Natura 2000 network specifically, the European Commission has produced detailed guidance for Member States and stakeholders on the implementation of the Habitats and Birds Directives in various sectors.

**Agriculture and forest policies**

Biodiversity and agricultural systems in Europe are closely interrelated, for three main reasons. First, agriculture is dependent on ecosystem processes which support plant production (e.g. pollination, maintenance of soils, regulation of pests and diseases) and rely ultimately on biodiversity. Second, many (semi-natural) European habitats have been shaped by thousands of years of human activities, and depend on traditional, extensive agricultural practices for their existence. Third, many of the habitats and species protected

under EU law are themselves dependent on agricultural practices.

Biodiversity is declining as a result of land abandonment and agricultural practices associated with intensive farming, such as use of pesticides and artificial fertilisers, conventional ploughing, overgrazing, drainage and irrigation. Biodiversity loss may threaten the long-term sustainability of farming in some areas as a result of the degradation of the ecosystem services on which farming depends, including soil processes, natural pest control, and pollination. The Commission estimates the value of pollination services alone at €14 billion per year in the EU, or 10% of agricultural productivity.

**Forest policy**

Forest policy also impacts on biodiversity protection, as forests cover around 40% of EU land area. The EU's new forest strategy (COM(2013) 659) calls for sustainable forest management in order to address pressures on forest ecosystems due to environmental changes (reduced water availability, spread of invasive alien species, increased risk of forest fires) and to human-induced changes (forest fragmentation and over-exploitation of forest resources). Biodiversity preservation, especially in Natura 2000 sites, represents a cost for farm and forest owners and managers. The main economic consequences are due to restrictions in use value, to lower productivity and the labour-intensive farming practices which generally characterise 'high nature value' farmlands, and to additional administrative tasks and costs (in particular information-gathering and supporting the overall management of sites). Support schemes, such as those introduced in the CAP, aim to preserve biodiversity outside protected areas while preserving jobs and maintaining the competitiveness of the EU farming and forestry sectors against foreign counterparts which do not face the same constraints.

**Fisheries, marine and water policies**

EU marine policies are closely interlinked with the health of natural systems sustaining sea-related economic activities and their ability to cope with pressure ('resilience'). Fisheries impact marine biodiversity mainly through the depletion of a species due to overfishing, the effects of unintentional catches (called 'by-catch') on fish, sea mammals and sea birds, and the creation of imbalances in marine food chains.

Aquaculture also interacts with the marine environment, just like agriculture on land. Many factors influence the ultimate impact of aquaculture on biodiversity, among others the location of the f arm, the type of culture (fish, crustaceans, molluscs, seaweed), and the methods used (e.g. quantity and type of food, stock density, use of chemicals).

**Regional policy**

Regional policy (also known as 'cohesion policy'), the EU's main investment policy, represents almost a third of the EU budget and provides the investment framework to meet the Europe 2020 strategy goals for smart, sustainable and inclusive growth. Regional policy may seem at odds with biodiversity protection policy, as economic development, especially the building of new infrastructure, can contribute to pressures on habitats and species.

However, EU regional policy provides direct funding opportunities for nature protection and biodiversity. Indirectly, funding is also available through synergies with a wide range of policy areas (i.e. research, innovation, business development, employment, climate change mitigation and adaptation).

## Research Methodology

### Introduction

The focus of this chapter is to discuss the methodology in conducting and collecting data, clearly state the instruments, tools for data analysis and presentation. Quantitative and qualitative method of data collection will describe the research instruments and tools being used to collect data. This chapter has the following outline: study design, population and sampling, sampling procedure, research instrument, and procedure for data collection, method of data collection, ethical consideration and summary.

### Study design

According to Vincent, (2007) study design "is the plan, structure and strategy of investigating, conceived so as to obtain answer to questions and to control variables". The study design is commenced with survey design and case study. As mentioned by Emory (1995) that a survey is possible when the population and variable is small and hence the researchers were able to cover all the elements of the population. Therefore a survey is considered to be more efficient and economical. Here, the study of individual units and its surrounding environment within the case study, will therefore, take into consideration in other to solicit more information by making a proper and careful analysis of a particular society or in other to shows a particular entity which serves as the area for the case.

However, small sample within the case study is selected to analyze the effects of road constructions on ecological biodiversity and livelihood in Bo city will be the appropriate tool in formulating and gathering the required information.

The study design will target respondent within the age of age 18yrs-25yrs, 26yrs-34yrs, 35yrs-42yrs and 43 yrs above. The small sample will be chosen at random targeting equal respondents of male and female, the analysis of data will be statistical with an application survey of issuing questionnaire.

### Study area

Bo, also commonly referred to as Bo Town, is the second largest city in Sierra Leone by landscape/geographical location (after Freetown) and the largest city in the Southern Province. Bo is the capital and administrative Centre of Bo District. The city of Bo had a population of 149,957 in the 2004 census. According to Sierra Leone population and housing census the population in 2015, the population of Bo city was about 173905 in which 84078 are males and 89827 are females. Bo city had a population of about 233,684 based on 2017 estimate. Bo is an urban Centre, and lies approximately 160 miles (250 km) eastsoutheast of Freetown, and about 40 miles (71 km) to Kenema. Bo is the leading financial, educational and economic Centre of southern Sierra Leone. It has a Coordinates of 7°57′23″N 11°44′24″W. The city of Bo is one of Sierra Leone's six municipalities and is locally governed by a directly elected city council, known as the Bo City Council, headed by a mayor. The Mayor and members of the Bo City Council are directly elected every four years in a municipal election. The city is the primary home of Njala University, the second largest university in Sierra Leone, after the Fourah Bay College. Bo is also home to the Bo Government Secondary

School, commonly known as Bo School, which is one of the biggest and most prominent secondary schools in West Africa. The school has a history of producing some of Sierra Leone's most gifted students. The city is home to the Bo Stadium, the second largest stadium in Sierra Leone, and is mostly used for football matches. Bo is one of the most ethnically diverse cities in Sierra Leone. The city is home to a significant population of many of Sierra Leone's ethnic groups, with no single ethnic group forming a majority. Bo is the principal home of the Mende people, who form the plurality of the city's population. The city's population is religiously diverse, primarily among Muslims and Christians.

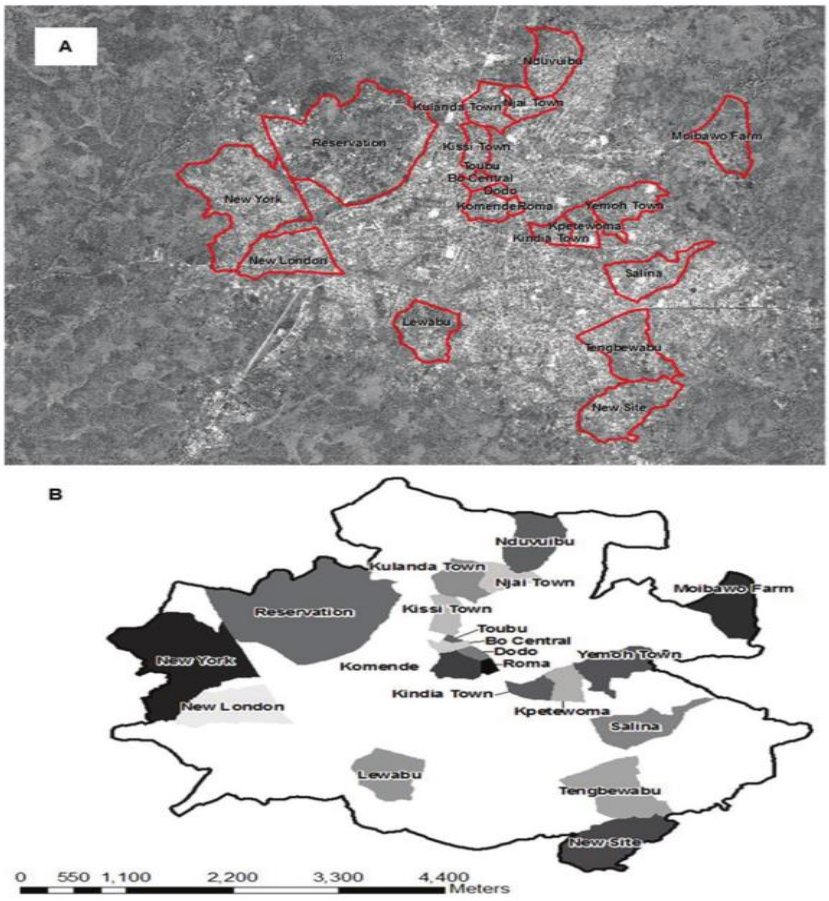


**Fig 1**

**Aerial Map of BO**

**Population and sample of the study**

**Target population**

Ezejule and Ogwo, (2009) target population is "that group usually of people or things, set of individuals, objects of measurements about whom you want to be able to draw conclusion". However, the population of the study in this research consisted of petty traders, bike riders, and the workers engaging on the Bo city roads construction project. The population of the study is five hundred (500) this will determine the sample size of the research.

**Sample size**

According to Ezejule and Ogwo (2011) a sample size is "the total number of elements of the population that are selected for a closer study". Therefore, the researcher used random sampling method to select four hundred (400) respondents in which fifty (50), two hundred and fifty (250), and one hundred (100) are workers, petty traders and customers and bike riders respectively. These targeted respondents will answer to questionnaire that has being administered to them which will be presented representing the views of the larger population. The simple size will answer questions that are related to the research objectives in particular. The respondent targeted are within the age of 18-43 years above.

**Table 2**

| Respondents Units | Number of Respondents |
|---|---|
| Construction staff | 50 |
| Bike riders | 100 |
| Petty traders and Customers | 250 |
| **Total** | **400** |

**Sampling procedure**

In this study, simple random sampling will be adopted. This technique refers to the act of selecting respondents from a specific population without any form of bias or segregation base on class, status or standings. It shows a clear picture on how the tools are used in conducting and collecting data. Information obtained is quantitative and qualitative data, one is represented by the use of interviews (qualitative) and the other is represented by questionnaires (quantitative).

**Data collection tools**

The researcher uses the following tools in gathering relevant and required information for the research study.

1. **Questionnaire**: According to Kreintner, (2013) questionnaire is "a collection of items to which a respondent is expected to react using writing". Accurate questionnaires are design by the researcher for

respondents to answers questions relating to the research study. The main purpose is for participants to answer question in the form of writing not oral. This tool enables respondents to accurately give information that are relevant for the study.

2. **Interview**: According to Dessler, (2015) interview is a technique designed to get information from a person's voiced response to oral investigation. The researcher implemented personal interview i.e. structured and semi structured. This aspect is included because other respondent's level of education is low, so therefore it is a useful tool for the study. The instruments used were helpful because it helps to gather essential information in writing (questionnaire) and oral (face-to-face interview).

**Validation**

**Validity of instrument**

Muijh, (2004: 67) state that validity is probably the single most important aspect of the design of any measurement of the instrument educational research. It can be conclude that validity is the process that refers to how well the test measures what it is purported to measure. However good our research design statistical analyses, the results will be meaningless if the researchers aren't actually measuring what the researcher is purposing to measure. According to latif, (2011: 223) valid means correct. It means that when the researcher claim that the result on effects of roads constructions on ecological biodiversity is valid, the researchers convinced that the writing assessment result correctly reflects the effects of roads construction on ecological biodiversity and livelihood in Bo city. The researcher seek to maintain validity and accuracy in the research process, with at co-efficient of at least 0.75 or 75%. According to Trivon, (2013) quality control is "the extents to which results are accurately interpreted and generalized into other population while reliability means the extent to which data is authentic".

Validity is very important because one of main characteristic of test, without having this characteristic a test is not important.

**Reliability of instrument**

While validity refers to degree of correctness of the assessment on the effects of roads constructions on ecological biodiversity. Reliability can be thought of as consistency.

It means that, reliability of instrument is needed to make sure that the instrument can be consistent if used in other time. Therefore, the instrument as questionnaires is reliable.

In this case, the questionnaires were pre-tested in the study area to ascertain the relevance of the questions posted.

**Procedures for data collection**

In order for the research to be holistic and adequate, during the research, structured questionnaires were used to obtain quantitative data from each of the respondents selected included in the sample. The questionnaires were pre-tested in the study area to ascertain the relevance of the questions posted. The number of completed questionnaires returned was recorded. A high response rate of respondents was recorded.

**Method of data collection**

The study used primary and secondary sources of data collection method. Data was collected through a self-administered questionnaire that consisted of both open and closed ended questions that were designed to extract specific responses for qualitative and quantitative analysis respectively. Information was solicited from construction staff, petty traders and customers, and bike riders that closest to the construction routes.

**Data analysis**

According to Awotunde, (2006) data analysis is "a method of scrutinizing data using different tools such as tables, charts and other figures for easy interpretation". However, the researcher analyses data using table and in percentage for accuracy and consistency throughout the research work.

**Ethical consideration**

The ethical implication of the study is that of the principle of informed consent. The principle of informed consent generally means getting the respondent aware before the collection of data. These sometimes cause respondents not to participate. In other to handle this problem, the researcher should inform the respondents or participant, explaining the objectives of the study which upon acceptance respondents will give condition as to how information should be gathered or collected. The researcher ensures the privacy and confidentiality of the information gathered. The information gathered was kept away from third party i.e. the researcher does not discussed the information gathered from respondents to third party. Although there are many challenges faced by the researcher in gathering information from respondents, one is ethical predicaments which are confidentiality.

**Summary**

The importance of this chapter is to identify and assemble the necessary tools in carry out the research process. There are many challenges despite the research was well tailored. The challenging situation was obtaining primary source of data from respondents, it was difficult to access information from the construction staff, Bike riders and petty traders.

The aim of the research is to assess the effects of roads constructions in Sierra Leone using the Bo city as a case study. Is achieving such aim, the researcher analyse and present data in tabular form and in percentage.

**Presentation, interpretation and data analysis**

**Introduction**

This chapter presents the data analysis results, as well as interpretation and discussion of findings. The study had four objectives: To investigate the causes of ecological degradation; to determine the effects of road construction on ecological biodiversity; to find out the effects of road constructions on livelihood on the residence of Bo city; and to point out the national and international ecological and biodiversity policies. Data analysis was done using frequencies, percentages and results are presented in tables.

**Response rate**

The study targeted the municipality of Bo; Sierra Leone with a sample size of four hundred respondents. The table below presents the response rate of respondents.

**Table 3:** Response rate

| | Population of the study (Questionnaire distributed) | Targeted population (Questionnaire Received) | Response rate |
|---|---|---|---|
| **Respondents** | 500 | 400 | 80% |

***Source*:** Field data 2022

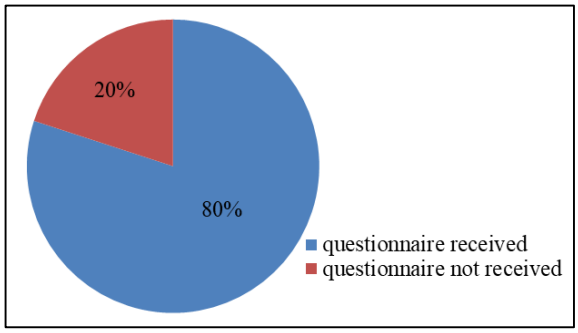


**Fig 2**

**Figure respondent rate**

From table 3 and figure 2, 400 out of the 500 respondents responded to the questionnaire representing a 80% response rate. This response rate was considered high. The 20% who did not return the questionnaires cited busy schedules as the main reason for lacking time to fill them.

**Part one: characteristics of respondents**

**Table 4:** Sex distribution of the respondents

| Sex of respondents | Frequency (F) | Percentage (%) |
|---|---|---|
| Male | 300 | 75 |
| Female | 100 | 25 |
| Total | 400 | 100 |

***Source*:** field data 2022

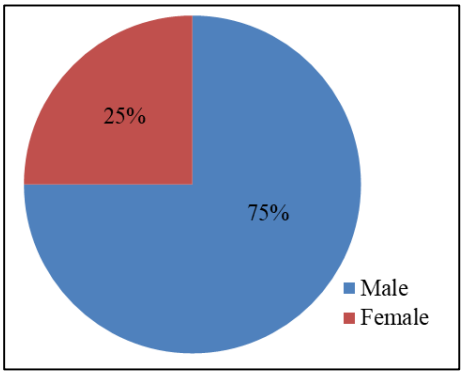


**Fig 3**

**Figure 4.2 sex distribution**

From table 4 and figure 3 confirmed 300 of the respondents are male representing 75% while 100 of the respondents are female representing 25%. This clearly indicates that more of the respondents were male.

**Table 5:** Marital status of respondents

| Marital status | Frequency (F) | Percentage (%) |
|---|---|---|
| Married | 150 | 37.5 |
| Single | 200 | 50 |
| Divorced | 20 | 5 |
| Widow | 17 | 4.25 |
| Widower | 13 | 3.25 |
| Total | 400 | 100 |

***Source*:** field data 2022

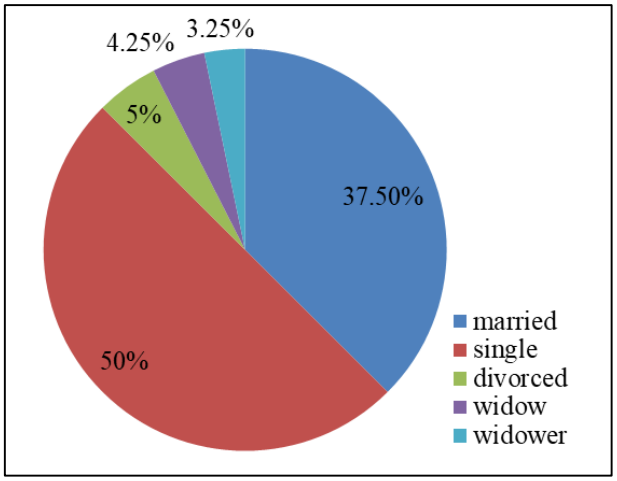


**Fig 4**

**Figure material status of respondents**

According table 5 and figure 4 above 200 of the respondents are single representing 50%; 150 of the respondents are married with a percentage of 37.5; 20 of the respondents are divorced with a percentage of 5; 17 and 13 of the respondent are widows and widowers with a percentage of 4.25 and 3.25 respectively.

**Table 6:** Age bracket of respondents

| Age Bracket | Frequency (F) | Percentage (%) |
|---|---|---|
| 18yrs-25yrs | 30 | 7.5 |
| 26yrs-34yrs | 150 | 37.5 |
| 35yrs-42yrs | 170 | 42.5 |
| 43yrs above | 50 | 12.5 |
| Total | 400 | 100 |

***Source*:** field data 2022

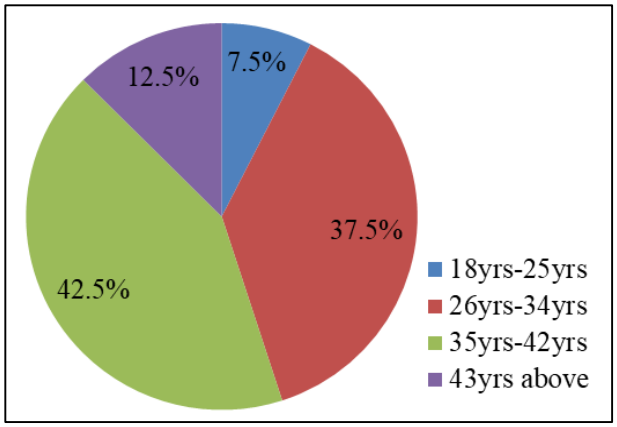


**Fig 5**

**Figure Age bracket of respondents**

Table 6 and figure 5 shows the age distributions of respondents. 30 (7.5%) of respondents are within 18-25 years of age; 150 (37.5%) of respondents are within 26-34 years of age. 170 (42.5%) of respondents are within 35-42 years of age; and 50 (12.5%) of the respondents are 45 years and above.

**Table 7:** Academic level of respondents

| Academic Level | Frequency (F) | Percentage (%) |
|---|---|---|
| Primary | - | - |
| Secondary | 200 | 50 |
| Tertiary | 50 | 12.5 |
| Technical/Vocational | 50 | 12.5 |
| Illiterate | 100 | 25 |
| Total | 400 | 100 |

***Source*:** Field data 2022

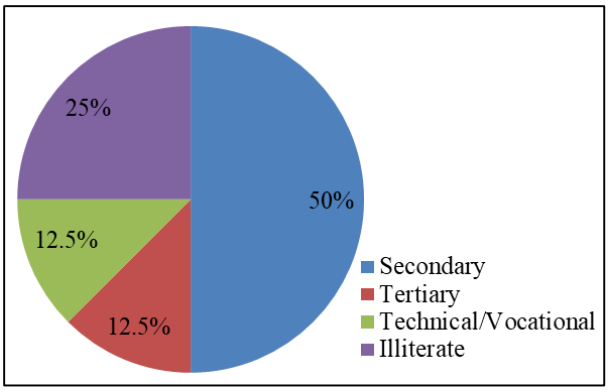


**Fig 6**

**Figure Academic level of respondents**

The findings from the study as illustrated in table 7 confirm that approximately 200 (50%) of the respondents attained secondary education, 50 (12.5%) have tertiary education; 50 (12.5%) attain technical or vocational education; 100 (25%) of the respondents are illiterate and no respondent attained primary education. It was noted that majority of the respondents were secondary students.

**Table 8:** Department of respondents

| Departments | Frequency (F) | Percentage (%) |
|---|---|---|
| Worker | 30 | 7.5 |
| Bike riders | 120 | 30 |
| Petty traders and customers | 250 | 62.5 |
| Total | 400 | 100 |

***Source*:** Field data 2022

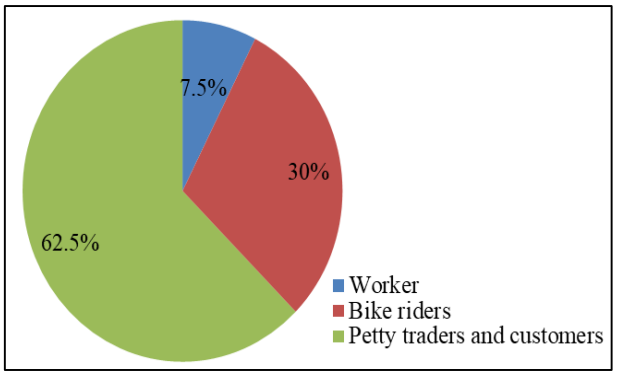


**Fig 7**

**Figure Department of respondents**

Table 8 and figure 7 presents the departments of respondents in Bo city. 30(7.5%) of the respondents are workers. 120(30%) respondents are bike riders, while 250(62.5%) of the respondents are petty traders and customers. This is evident that most of the respondents are petty traders and customers

**Part two: The causes of ecological degradation**

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

From the respondents, ecological degradation has many causes. They went further to divide it into three aspect namely natural factors, socio economic factors and human activities. 100 (25%) of the respondents strongly agreed that ecological degradation is caused by natural factors which are as follows: climate vagaries, water and wind erosion, flooding, and mud sliding etc. 100 (25%) of the respondents attest to the fact that ecological degradation is caused by socio economic factors such as urbanization, population explosion, inadequate environmental education, poverty and indoctrination etc. 200 (50%) of the said that ecological degradation is caused by human activities such as mining, mechanic farming, deforestation, infrastructural activities e.g. road construction.

**Does climate change adaptation drive has the ability to strengthen ecological conservation?**

390 (97.5%) of respondents said yes climate change adaptation drive has the ability to strengthen ecological conservation. This is because climate change can alter temperature and weather pattern. It is true that many species decline as temperature continue to rise. Changes in temperature will also cause shift in mating circles especially

for migrating animals that rely on changing seasons to indicate their migration and reproductive timing.

**Part three: The effect of road construction on ecological biodiversity**

**Are there any correlations of ecological conservation to livelihood?**

The entire respondent agreed that there is a strong correlation between ecological conversations to livelihood. They went further to state the reason by saying:

- Biodiversity provides human with raw materials for consumption and production
- Many livelihood, such as those of farmers, fishers, timbers workers are dependent on biodiversity
- Biodiversity also provides functioning ecosystem that supply oxygen, clean air and water, pollination of plant, pest control, waste water treatment and many ecosystem survives.

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

All of the respondents believed that are probabilities of species getting into extinctions as a result of threats to ecology. However, these are the views outline by the respondents. It can lead to habitant loss. The natural habitat is unable to support the species present. Ecology is threaten by man activities such mining, logging, urbanization which can result to habitat destruction that causes the extinction of species.

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

Almost all of the respondents accepted that road construction constructions impact ecological and biodiversity and livelihood. Below are there statements towards road constructions impacts ecological bio-diversity and livelihood**:**

- It causes disturbance during construction and pollution both from the road materials itself and from the traffic of established road
- It can also lead to both direct and indirect loss of habitat. The indirect loss of habitat refers to the effect such as fragmentation (i.e. portioning of an ecosystem into smaller and more isolated patches). The indirect loss of biodiversity is that they reduce the capability of an ecosystem to sustain it original biodiversity.
- Displacement of business people found along the site from their original location to a new location which can affect the business by losing customers as acquiring new customers is more expensive that to retain and maintain old ones.

**Part four: the effects of road constructions on livelihood on the residence of Bo city.**

**Table 9:** What is the knowledge base of ecological conservation in Bo City?

| Respondents | Frequency | Percentage (%) |
|---|---|---|
| Very strong | 10 | 2.5 |
| Strong | 40 | 10 |
| Fair | 150 | 37.5 |
| Poor | 200 | 50 |
| Total | 400 | 100 |

***Source*:** field data 2022

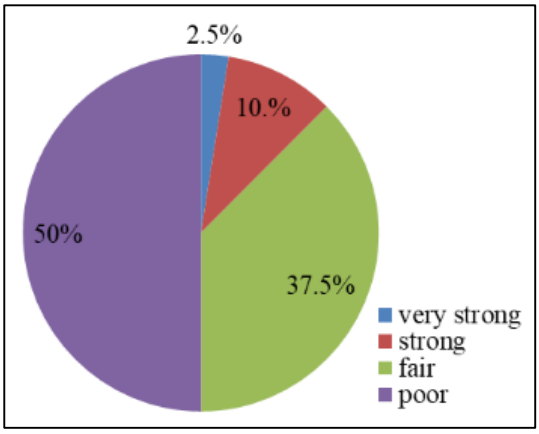


**Fig 7**

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

The table and figure above show that respondents with very strong knowledge on ecological conservation are 10 representing 2.5% respondents with strong knowledge on ecological conservation are 40 representing 10%. Respondents with fair and poor knowledge on ecological conservation are 150 and 200 representing 37.5% and 50% respectively

**Part five: the national and international ecological and biodiversity policies.**

**Does ecological policies plays crucial role to conserving environment, and thereby enhancing livelihood?**

All of the respondents confirmed that ecological policies can plays a crucial role in conserving environment, and thereby enhancing livelihood. As it serves as regulations which include prohibition, restrictions, mandatory requirements, standards and procedures that directly authorised or limits certain actions or impact. For instance restriction on the use of product such illegally logged timber, activities damaging to endangered species.

**How can the ecology be conserved?**

The respondents believed that ecological conversation is very important. Therefore below are some of the methods used to conserved ecology.

- **Management of natural resources**: natural resources management encompasses protection of endangered species, forestations, protection of aquatic habitat, the practice of organic farming and the control exploitation of natural resources.
- **Creating awareness, education and advocacy**: educative camping and advocacy crate the value of ecology. It is simply a way of establishing a workable solution towards conserving and protection both biotic and abiotic elements.
- **Creating legislation that promotes environmental conversation**: government should come up with legislations that promote environmental conversation. This should also be done by international agencies such as United Nations with it UN environment program.

**Does modern techniques in ecological conservation proves efficient and effective to enhancing a balanced environment?**

No, modern techniques in ecological conservation is not

efficient and effective in enhancing a balanced environment. This is because modern technology plays a dual role. In other word it can help in proper ecological assessment such as computer that is used for data collection, analysis, monitoring and information on ecological management. However, as a result of modern technology such as bulldozers used in mechanic farming and road constructions result to loss of habitat, extension of species and habitat fragmentation.

**Do you have anything to say about the effect of road construction on ecological biodiversity in Bo city?**

Road construction can cause both biotic and abiotic effect. The abiotic condition that can be influenced by road includes hydrological, geomorphological, and chemical characteristics. The biotic factors influence by roads construction is soil organisms, plants, and animal etc.

**Discussion of findings**

From the respondents it was confirmed that 80% of the respondents returned the questionnaire while the reaming 20% of respondents cited busy. Also 75% of the respondents are male, 50%, 37.5% of the respondents are single and married respectively, 42.5% of the respondents are adult, 7.5 of the respondents are adolescents. The result of the study showed a high proportion of 75% of the respondents were educated and completed at least secondary school education, 62.5% of the respondents are petty traders and customers, 30% of the respondents are bike riders and finally 7.5% of the respondents are workers.

**The causes of ecological degradation**

The research focused on the causes of ecological degradation and it was confirmed that natural, socio and human actives are the causes. 25% of the respondents attest to the fact that ecological degradation is caused by natural factors which are as follows: climate vagaries, water and wind erosion, flooding, and mud sliding etc. however, Issaka and Ashraf (2017) [37] confirmed that natural causes include those factors relating to climate change vagaries and surface erosion. The idea of the respondents and that of Issak and Ashraf is in line. 75% of the respondents agreed that ecological degradation is caused by human activities. According to Adejumobi (2017) [2] he states that increased urbanization and population explosion, inadequate environmental education, poverty and industrialization will lead to ecological degradation. However there are also other causes as a result of human activities such as extensive and intensive mechanized and commercial farming and salinization of agricultural land, indiscriminate harvest of forest resources, excessive uses of natural resources, poor urban planning, uncare attitude towards the environment and its resources, incessant bush burning and so on (Jiboye and Ogunshakin, 2011; Adeboyejo, 2017) [47, 2], A very high proportion of 70% of the respondents clearly confirmed that climate change adaptation drive has the ability to threaten ecological conservation. It is very clear that climate change will result to plenty disturbance on ecological conservation. Change can alter temperature and weather pattern that result to decline of species

**The effect of road construction on ecological biodiversity**

It was obvious that road construction has effect on ecological biodiversity. Most of the respondents believed that biodiversity provides human with raw materials for consumption and production, many livelihood, such as those of farmers, fishers, timbers workers are dependent on biodiversity and bbiodiversity also provides functioning ecosystem that supply oxygen, clean air and water, pollination of plant, pest control, waste water treatment and many ecosystem survives.

The respondents there are probabilities of species getting into extinction as a result of threats to ecological conversation. As it leads to habitant loss, the natural habitat is unable to support the species present and by man activities such mining, logging, urbanization which can result to habitat destruction that causes the extinction of species.

It was also confirmed that road construction impact ecological and biodiversity and livelihood because it causes disturbance during construction and pollution both from the road materials itself and from the traffic of established road, it can also lead to both direct and indirect loss of habitat. The indirect loss of habitat refers to the effect such as fragmentation (i.e. portioning of an ecosystem into smaller and more isolated patches). The indirect loss of biodiversity is that they reduce the capability of an ecosystem to sustain it original biodiversity and displacement of business people found along the site from their original location to a new location which can affect the business by losing customers as acquiring new customers is more expensive that to retain and maintain old ones.

**The effects of road constructions on livelihood on the residence of Bo city**

The study shows a high proportion of 50% respondents with poor knowledge on ecological conversation. On the other hand only 2.5% of respondent have very strong knowledge on ecological conversation. Therefore as a result of poor knowledge in ecological conservation, the biodiversity is highly disturbed as natural habitats are been converted to artificial habitats. This can disturb the adaptation and production of organisms.

**The national and international ecological and biodiversity policies**

All of the respondents confirmed that ecological policies can plays a crucial role in conserving environment, and thereby enhancing livelihood. As it serves as regulations which include prohibition, restrictions, mandatory requirements, standards and procedures that directly authorised or limits certain actions or impact. For instance restriction on the use of product such illegally logged timber, activities damaging to endangered species.

According to the respondents, the ecology can be conserved by the

Management of natural resources: natural resources management encompasses protection of endangered species, forestations, protection of aquatic habitat, the practice of organic farming and the control exploitation of natural resources. Secondly by creating awareness, education and advocacy: educative camping and advocacy crate the value of ecology. It is simply a way of establishing a workable solution towards conserving and protection both biotic and abiotic elements and finally by creating legislation that promotes environmental conversation: government should come up with legislations that promote environmental conversation. This should also be done by international agencies such as United Nations with it UN environment program.

No, The respondents have different perceptions towards the effective and efficient of modern techniques in ecological conservation. in enhancing a balanced environment. This is because modern technology plays a dual role. In other word it can help in proper ecological assessment such as computer that is used for data collection, analysis, monitoring and information on ecological management. However, as a result of modern technology such as bulldozers used in mechanic farming and road constructions result to loss of habitat, extension of species and habitat fragmentation.

**Summary, conclusion and recommendations**

**Introduction**

This chapter focuses on the summary, conclusion and recommendations of the study. It is arranged based on the research objectives in relation with the research questions. However, the research recommendation is put forward to appropriate authorities like government and other researchers.

**Summary**

The researcher ascertains that road construction have both positive and negative effect on ecological biodiversity and livelihood in Bo City. From the research, the road construction project in Bo city is an indication of economic growth and development as it enhance mobility and accessibility. On the other hand, construction process leads to loss of habitat, dispersal of organism, extension and lost of soil organism. Also, the people of Bo is greatly or negatively affected during the construction process as it leads to displacement of business people, discomfort of people as a result of heavy noise produced by machines, dust and pollution.

**Conclusion**

It is important to note that, the negative impact of road construction on biodiversity outweigh the positive impact.

The following are the negative impact of road construction:

- It leads to loss of habitat and habitat fragmentation
- It leads to the extension of animals
- It leads to the death of species most especially soil organism
- It leads to loss plant species as a result of bulldozers used in the process to do clearing.
- It leads to pollution i.e. air pollution such as dust and gases emitted from machine and water pollution
- It leads to displacement of business people from their usual location to a new location
- It causes disturbances through the heavy noise produced by machines during the process.
- It causes heavy vibrations as a result machines used in the construction process.

**Recommendations**

Based on the results presented earlier the following recommendations could be made:

- There should be proper management of natural resources.
- There must be an increase in creating awareness, education on ecological conservation.
- Government should create policies that promotes environmental conversation.
- More studies should be conducted on ecological conversation.

Further research should conducted similar research on biodiversity and ecological conversation.

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