Chapter

Land Use Impacts on Diversity and Abundance of Insect Species

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Abstract

Land use is a major constraint to the population of insect species. Insects have provided essential and irreplaceable services ranging from pollination to decomposition of large organic matters. However, these roles provided have been jettisoned as a result of human anthropogenic activities. In recent times, the conversion of existing natural forest ecosystem to other land use types has become a menace that requires urgent attention due to its effects on the population of plant and animal species. Many factors such as land-use changes, deforestation, pollution, intensive agriculture, among others have been reported to contribute to the decline in the population of insect species. As a result of changes, insects are threatened and vulnerable to extinction. Loss of key stone species also affects the function, structure and population of other species in the ecosystem. This is because of the level of interdependency between these insect species and other components of natural forest ecosystem. Such losses lead to the decline in ecosystem goods and services which human depends on for sustenance. Apart from decline in all levels of biodiversity, land use also causes climate change and environmental pollution which in turns affects the population of insect species. However, protection of area of high biodiversity hotspots should be encouraged by resources managers. Also natural forest that has been disturbed should be left alone in order to recuperate and get back to its original state.

Keywords: Land use, Insect, Biodiversity, Natural forest, Climate change

1. Introduction

Insects play a vital role in both natural and man-made settings. They perform critical and functional roles in ensuring the delivery of numerous ecosystem services that are critical for human life in areas such as agriculture, tourism, natural resource utilization etc. [1, 2] Scientific investigations have shown that insect populations have been declining globally for decades [3]. Environmental scientists as well as the press, non-governmental organizations, and policymakers, have been alerted to the eminence reports of impoverished insect faunas from Europe and around the world [4]. West Africa countries are afro-tropical with a diverse flora and fauna, as do other

tropical countries throughout the world. The tropics, which are home to over 70% of world biodiversity, are also a treasure trove of insect diversity, which is thought to be comparable to the region's plant richness [5].

2. Land use and insects dynamics

Land use is the conversion of natural environment to a built environment and this is majorly caused by human activities [6]. Natural rainforests are one of the most species-rich and functionally important terrestrial ecosystems [7]. Tropical forests are the most bio-diverse terrestrial habitat, with 50% of the world's species [8, 9], but about 68,000 km2 of tropical forest is lost annually [6], an amount that could be increasing by 3% (2000 km^2) each year [10], remains 11 million km^2, virtually half (5 million km2) is considered to be either deforested area [11] or degraded forest that has to regenerate after human use (e.g., cropped land abandonment and clear-felling: [12, 13] or natural disturbances (e.g., fires and windstorm) [14]. Insects are essential components in most natural and transformed landscapes. They play crucial functional roles that ensure the delivery of various ecosystem services necessary for several aspects of human livelihoods, such as agriculture, tourism, and natural resource use [2, 15, 16]. They also control populations of other organisms and provide a significant food source for other taxa [17]. However, they are also disease vectors to many other organisms, including humans, and they can alter the rates and directions of energy and matter fluxes in an ecosystem [18]. Recent reports imply devastating declines in the decline of all levels of biodiversity with potentially dire implications on ecosystem functioning [19, 20].

The tropical forest with high species composition, and high level of biodiversity is currently faced with a lot of challenges when it comes to its conservation [21] Natural forests have been reported to contain a high diversity of insect and trees species diversity than other land-use types and this has been attributed to the high level of relationship between the various components of the forest ecosystem [22]. According to [23], conversion of forest to other land use types is one of greatest threats to insects, causing population declines and shifts in community composition. The tropical forests have been subjected to extensive disturbance by logging and clearance for agriculture; especially palm oil, cocoa, pasture, and rubber plantation [24, 25]. [26] reported that tree species, which is a significant component of forest ecosystem plays vital roles in forest biodiversity conservation. Conversion of this forest to other land use type will affect the population and result to loss of key stone species that are very important to the forest ecosystem balance. Land-use change, particularly the conversion of natural forest to agriculture to sustain the growing global population, has negative effect on biodiversity conservation and contributes to climate change.

3. Contributions of insects to human nutrition

The decline in insect biodiversity concurrently presents an immediate threat to food security [17] and permanently affects humans' health and wealth. All terrestrial insects provide resources for higher trophic levels, especially for many vertebrates [18]. Then, the vertebrates and other beneficiaries in the trophic groups are subject to humans. It is expected that by 2050 the projected world population will be 9.8 billion and 11.2 billion by 2100 [27]. In particular, pollinating insects

have experienced significant declines for several decades in many parts around the world [28]. This is a serious concern because pollination represents a critical ecosystem service [29], and declines in pollinators have been directly linked with reductions in the plants with which they interact [30]. Though, the pollination services of honeybees are just as valuable as their production of honey and wax which are useful humans. Meanwhile, plants serve several purposes in human existence on Earth. This is of particular importance because most insects interact with plants, and an estimated 85% of angiosperms, including most tropical tree species, are directly pollinated by insects [31]. Most insect species are associated with living plants [32] and are highly specialized in food resources and micro-habitats [33].

3.1 Major edible insects

Insect are rich protein source. Practically 100 analyzed edible insects at egg, larva, pupa or adult stages and the raw protein content is generally 20–70% [34, 35]. Globally, Most commonly consumed insect orders are beetles (Coleoptera), caterpillars (Lepidoptera), Bees, wasps, ants (Hymenoptera), grasshoppers, locusts and crickets (Orthoptera), cicadas, leafhoppers, planthoppers, scale insects, true bugs (Hemiptera), termites (Isoptera), dragonflies (Odonata), flies (Diptera). Consumption of these insects differs to each region of the world depends on stages of insects. Lepidoptera are consumed completely as caterpillars and Hymenoptera are consumed regularly in their larval or pupal stages [36]. Both adults and larvae of the Coleoptera order are eaten, while the Orthoptera, Homoptera, Isoptera and Hemiptera orders are mostly eaten in the mature stage [37]. Besides serving as sources of food, insects provide humans with a variety of other valuable products. Honey and silk are the most commonly known insect products. Bees produce about 1.2 million tonnes of commercial honey per year [38, 39], while silkworms produce more than 90 000 tonnes of silk [40].

4. Impact of land use on insects population

The conversion of Natural forest ecosystem has led to decline in the population of insect species. Many factors such as land-use changes, deforestation, pollution, urbanization, intensive agriculture, among others have been reported to contribute to this decline. The activities of humans in natural ecosystems have lead to habitat fragmentation, isolated from each other by prevailing conditions of hostile lands created by human activities [41]. This fragmentation leads to smaller habitat areas and decreased biodiversity [42]. As a result of changes, species are threatened and vulnerable to extinction. Loss of key stone insect species has also affected the population of other species and other components of the forest ecosystem, and it's because of the level of inter-dependency between these insect species and the natural forest ecosystem. Such losses lead to the reduction in ecosystem goods and services which human depend on for their survival (**Table 1**).

4.1 Urbanization

Urbanization is increasing in most developed and developing nations of the world, which leads to habitat fragmentation and converting the significant habitats of insect species into smaller areas and converting the forest into agricultural areas

	Order	Common name	NF	RP	OP
1	Araneae	Spider	14	2	40
2	Coleoptera	Beetle	24	14	12
3	Dermaptera	Earwig	2	0	2
4	Diptera	cranyfly	2	0	0
5	Hemiptera	Bug	18	10	10
6	Hymenoptera	Ant	114	14	43
7	Lepidoptera	Butterfly	48	6	14
8	Mantodae	Ants/Fly	2	0	0
9	Odonta	Dragonfly	56	4	6
10	Orthoptera	Criket/Grassh	14	36	45
12	Scolopendromorphra	Centipede	4	0	0
13	Spirostreptida	Millipede	20	34	62
14	polydesmida	Millipede	4	6	8
			322	**126**	**242**

Source; Adeduntan et al., 2021.
NF; Natural forest, RP; Rubber plantation, OP; Oil palm plantation.

Table 1.
Abundance of insect composition in each ecosystem in Okomu Edo state Nigeria.

and communities [43]. In tropical West Africa, a considerable decline in some insect populations was observed due to Urbanization [43, 44]. Globally, vegetation has been converted into an urbanization setting to bridge the craving for urban population increase, which alters the habitat of insect species and leads to insect decline except in bees keeping [43, 45] in the most fragment of the forest habitats today. Then, insect crossing on the roads during construction, collusion of insects with vehicles, and death of soil-borne insects during road constructions [46] are not major factors that decrease insect species in the forest habitat.

5. Insects and organic matter decomposition

Apart from bacteria and fungi, invertebrate (insects) herbivores as well as decomposers breaks down and feeds on living, dead or decaying plant or animal matters, making organic nutrients (recycling) available to the ecosystem [47]. As a result to renew forests by reduce the old and vulnerable trees, also provide new habitat and food for wildlife. However, food resource (detritus) that supports trophic food chains in almost every territory of the heterotrophic habitat, among them is countless species of insects [48]. Meanwhile, there are three major processes through which decomposition occurs [49, 50], (a) fragmentation of litter into smaller sizes, (b) leaching of soluble compounds into soil, and (c) catabolism by decomposer organisms. Insects are mostly engaged more in the fragmentation of litter into smaller sizes. Several decomposers have special relationship with plant species and are specialized to breakdown the litter of these materials [51]. Given that the decomposer food web consisting of fauna and microbial communities also varies in the underneath of different forest floors and

affects the rates various litter fractions are mineralized in an ecosystem [52]. Most of these orders (larvae and adult) are engaged, for example Diplopoda, Isopoda, Collembola, Diptera, Coleoptera, Acari among few others.

6. Insects as pollinators

As pollinators, insects play an important role in ecosystem services. Majority of flowering plant species depend essentially on animal vectors for pollination [31]. Entomophilous (pollination by insects) serve as an important life-support mechanism that contributes to biodiversity and ecosystem services [53]. In addition to constant visitation of flowering plants by honeybees (Apis melifera), which has been considered as the most common single species of pollinator for crops in the world [54], various insects such as stingless and solitary bees, bumblebees, and a variety of beetles, flies, butterflies, and moths are significant pollinators [55–57]. Entomophilous plant species have regularly evolved ways to increase their attractiveness to insects. Many flowering plant species have developed structures or exudates that ensure insect pollinators will return to transfer pollen on a regular basis [58]. However, many types of land use (for example, agriculture and urbanization) drastically modify land cover, resulting in habitat loss for various species [59] and studies [53, 60, 61] have shown that habitat loss reduces the population sizes, composition, and species diversity of insect pollinators. The loss of habitat for native bees has been found to be much greater than that of other insect groups, as measured by species–area relationships [62].

7. Effects of pollution on insect abundance

Industrial pollution has long been known to reduce insect potential [31, 63]. Carbon monoxide from cars and engine exhaust also has its effect, primarily due to high levels of NOx [53, 64]. Though the most critical forms of industrial pollution are heavy metals in soils and waterways [54, 65], air pollution [55, 66], aquatic pollution [56, 67], and light pollution [57, 68]. Although it is somewhat reduced now in many developed nations [58, 69], it is yet a global threat to insect protection. This has drastically affected the population of the insect community, as most insects are sensitive to smell while most have disappeared due to their habitat loss.

8. Effects of climate change on insect population

The climate is crucial in determining various characteristics and distributions of managed and natural systems, including hydrology and water resources, cryptology, marine and freshwater ecosystems, terrestrial ecosystems, forestry, and agriculture [59, 70]. As a result of increased temperatures, climate extremes, increased CO2 and other greenhouse gases (GHGs), and altered precipitation patterns, global food production is under severe threat [60, 71]. Global warming is a severe problem facing the world today. It has reached record-breaking levels, as evidenced by exceptional rates of increase in atmospheric temperature and sea level [61, 72]. The World Meteorological Organization (WMO) reported that the world is now about one degree warmer than before widespread industrialization. Insects are poikilothermic

organisms; the temperature of their body depends on the temperature of the environment. Thus, the temperature is probably the most important environmental factor affecting insect behavior, distribution, development, and reproduction [62, 73]. Then, it is most likely that the main drivers of climate change (increased atmospheric CO2, increased temperature, and decreased soil moisture) could significantly affect the population dynamics of insects [63, 74]. Climate change creates new ecological niches that allow insects to react and shift from one region to another [64, 75]. The Warm and dry conditions associated with climate change have affected most forest insect species population and activity in recent years [65, 76]. However, [65, 76] reported that temperature or drought on insects community is one of the essential climatic drivers of habitat vulnerability to forest insects [66, 77]. As a result, insect populations in tropical zones are predicted to experience a decrease in growth rate due to climate changes of current temperature level for insect development and growth [67, 78].

9. Conclusion

Study showed that Land use stand a significant on diversity and abundance of insect. The gradual disappearance of natural forest habitat has resulted loss of keystone species whose function in an ecosystem cannot be overestimated. Apart from decline in all levels of biodiversity, land use also induces climate change and pollution which in turns affects the population of insect species. Since they are the major contributor to biodiversity in most habitats, except in the sea, they accordingly play a variety of tremendously ecological functions of an ecosystem. Protection of an area in high biodiversity hotspots should be encouraged by resources managers. Also natural forest that has been disturbed should be left alone in order to regenerate and get back to its original state.

Conflict of interest

The authors declare no conflict of interest.

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