

CASE STUDY

Diversity of bird's communities on dumpsite and sewage stabilization ponds of Moshi Municipal, Kilimanjaro, Tanzania

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ABSTRACT: Urban development is rapidly expanding across the globe and is a major driver of environmental change. It is important to understand how bird species responds to urbanization. Therefore I conducted a qualitative study of birds associated with waste sites such as dumpsite and sewage stabilization ponds was carried out on Moshi municipal. The study assessed the diversity between dumpsite and sewage stabilization ponds using the "Timed species count" method. A total of 15 bird families and 17 species were recorded at both sites. 13 species in 12 bird families at dumpsite and 14 species in 13 bird families at sewage stabilization pond were recorded respectively. There was significant difference in species diversity within the two sites ($p < 0.05$) because of good breeding sites at sewage stabilization ponds which include a wide variety of resources, high productivity and moderate levels of disturbance compared to dumpsite. This study was carried out to enhance conservation awareness. These sites serve as biodiversity reservoirs, urban planners should involve interdisciplinary team to make decisions from an ecological perspective when designing urban areas. From this micro-survey It is worth concluding that waste stabilization ponds contains number of resource that attracts bird's species, as birds are bio indicators of ecosystem health.

KEYWORDS: *Dumpsites; Diversity; Sewage stabilization pond; Time species count (TSC); Waste area*

INTRODUCTION

Background Information

The world is increasingly urban and cities are growing twice as fast in terms of land area as they are in terms of population (Angel *et al.*, 2011). Consequently, between 2000 and 2030 global urban areas will triple and hundreds of thousands of additional square kilometers will be transformed for urban type land use (Angel *et al.*, 2011). High rate of urbanization and the rapid loss of wild habitat land, cities are now viewed as challenging ecosystems for sustaining biotic communities and rich diversity (Shochat *et al.*, 2010). In such ecosystems only certain representatives of the native flora and fauna are able to exist.

Global declines of natural habitat for birds, they have become increasingly dependent on alternative and artificial habitats such as dumpsites and sewage

stabilization ponds (Akinpelu, 2001) these man made sites are found useful for birds with unlimited food sources and considered to be one of the factors attracting the birds on sewage stabilization pond and dumpsites area (Anika, 2013). Connecting to the urbanization and biodiversity, it is to be stated that nearly 20 percent of the world's population lives in biodiversity hotspot regions. Therefore, predicting patterns of urbanization in the areas of high biodiversity are critical for conservation (Yeragi and Mendhulkar, 2015).

Many studies have found that within cities, native flora and fauna communities are usually radically altered in terms of species composition, abundance, richness and evenness (Murgui and Hedblom, 2017). In the case of urban fauna, the main effects of urbanization are: biotic homogenization a decrease in richness and diversity of fauna species along with the degree of urbanization (McKinney, 2008).

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The effects of urbanization on biotic communities have commonly been studied across urban-rural gradients (Saito and Koike, 2013). This approach has the advantages of being intuitive and easily measured. In their review of urban-rural gradient analyses, (Łopucki and Kitowski, 2017) noted that the concept of urbanization gradients is based on the well-established application of gradient analysis tools in order to understand the ecology and distribution of organisms in response to various changes to the environment. They also pointed out that typically, the most intense 'urban' environmental conditions occur in the older, more man-modified centers of cities, with decreasing 'urban' effects further away from city centers.

Bird's species have changed their behavior and distribution due to the available sewage stabilization pond and dumpsites. Dumpsite and sewage stabilization pond can be key feeding habitats of birds when properly managed (Camiña, 2004). Simply human activities have the great influence attracting bird's species through accumulation of waste products such as solid waste and sewage stabilization area. These sites are located in the municipal areas and are used for disposal of the unwanted and used product that are generated by people living in urban areas. These are the wastes that are no longer wanted after primary use, worthless and defective (Singh *et al.*, 2017).

Decreased habitat availability, vegetative complexity, and food supply, and increased habitat fragmentation, competition, and human disturbance (Donnelly and Marzluff, 2004). Are examples of some of the mechanisms that have been identified as contributing to decreases in richness and evenness in urban bird communities conversely, factors such as supplemental feeding, reduced predation, and reduced human persecution have benefited certain species in urban environments (Donnelly and Marzluff, 2004). It is expected that increasing urban densification modifies both bird community compositions and structure. Nevertheless, abiotic conditions are similar between cities (Fontana *et al.*, 2011).

Birds are biological indicator because they play ecological role and lives in all kinds of habitat as herbivores or carnivores, Some birds tend to migrate in different season of the year, which can provide the insight whether the area is normal or its polluted, total absence of birds is significant and noticeable indicator that the area is polluted (Lepczyk *et al.*, 2017) biological indication of birds may have more than one objective

and serve to highlight the health of urban bird populations, changes in populations of special conservation interest, the degree of 'urbanization' of the local avifauna, or the impact of certain environmental pressures (Herrando *et al.*, 2012).

Urban development has been linked to a decline in bird's species richness and an increase in the abundance of urban-associated species (Larsen, 2008). Remaining habitat patches in a developed area typically support fewer species. If urban bird conservation is to be considered a serious part of bird conservation worldwide, conservation efforts must be more strategic and less non-committal than current practices in most cities (Snep *et al.*, 2016). Urban management should be focused on maintaining bird species diversity and preventing vulnerable populations from local extinction Species richness was predicted to decline as a result of the loss of natural habitat and the reduction of resource availability However, other studies found bird richness increased with increasing and intermediate levels of urbanization (Silva *et al.*, 2015). Increased urbanization there is a shift in avian species composition, often accompanied with a decrease in bird species richness and diversity, and an increase in total bird density as a few human-commensal, often non-native species, such as the House Sparrow *Passer domesticus* (Blair, 1996).

Species composition and richness have also varied in relation to the city and the locality within a city in which studies were conducted, with some areas showing considerable diversity, depending on local environmental conditions (Lin *et al.*, 2008). The design and management of an area can have an appreciable effect on the distribution of birds across an urban environment.

The importance of artificial and recreated habitat such dumpsites and sewage stabilization pond has increased as a result of the loss of natural habitats and wetlands that harbor the number of birds. The use of such areas, including dumpsite and sewage stabilization pond are typically opportunistic, and little consideration has been given by managers of dumpsites and sewage stabilization to the potential implications for either wastewater treatment for pond and sustainable implications in designing/planning for dumpsites in conservation of urban.

Birds regularly visit the sewage stabilization ponds to drink and eat. It is generally known that animals and plants respond to intermittent pollution and that organic

pollution affects the organisms in a pond by lowering the available oxygen in the water (Akinpelu, 2001).

Clean water fauna are thus eliminated from such a pond. Severe organic pollution usually results in a restriction in the variety of macro invertebrates to only the most tolerant ones and a corresponding increase in the density of those tolerating the polluted condition, usually of low dissolved oxygen concentration. In spite of these restrictions, a number of birds have been observed to be closely associated with the stabilization ponds (Murray *et al.*, 2014). Macro invertebrates are fed upon by fish and eventually birds, hence the type and diversity of macro invertebrates will determine the bird species associated with such ponds. City dumpsite, an artificial ecosystem, is of considerable value to biodiversity and provide appropriate feeding sites for many bird species. Variety of vegetation types influence land snail and bird species richness and distribution in terrestrial ecosystem (Onen *et al.*, 2016). The rapid growth experienced in urban centers worldwide is fast leading to change in morphological pattern resulting in demand for natural resources.

This has given rise to the volume of garbage generated within urban population (Onen and Bassey 2017). Different Studies found dumpsite provide positive impacts for birds creating suitable habitats as feeding sources. About 20 per cent of the world's population lives in biodiversity hotspot region, hence creating an interjection between biodiversity and urbanization. On this premise that other scholars, concluded that predicting patterns of urbanization in the areas of high biodiversity are critical for conservation (Onen and Bassey, 2017).

The aim of the study was to evaluate the impact of city dumpsites and sewage stabilization pond to biodiversity conservation of birds in Tanzania and this brought to focus the benefits of such sites that supports bird's diversity. There is now a growing need to evaluate the impact of dumpsites and sewage stabilization pond in relation to bird's diversity in order to maintain and enhance the value of wildlife value at the artificial ecosystem. The understanding of the relationship between biodiversity and city dumpsites will enable urban planners to make informal choices to provide sustainable environment for the future.

Problem Statement and Justification

Waste site are considered to have negative effect on human in terms of having toxic gas and outbreak of

diseases as cholera and typhoid (Onen *et al.*, 2016). However utilization of dumpsites and sewage stabilization ponds by birds is always remained a topic of debate (Anika, 2013).

Despite of the fact that improper waste management may cause serious impacts on biodiversity and environment such as diseases carrying organism, poisonous gas and can be source of pollution, but the waste sites may offer resource and birds species adapt the area in relation of feeding due food availability (Camerini and Groppali, 2014).

Very little is known whether these recreated habitats such as dumpsites and sewage stabilization pond represent a significant resource in terms of bird's conservation in municipal area. (Murray *et al.*, 2014) conducted a study on bird's diversity and found that sewage stabilization ponds have significant role on abundance of bird's population. This study aim to compare the diversity of bird's species between the two sites such as dumpsite and sewage stabilization pond and understand the association of waste site with birds in detail. To provide basics for Spatial- temporal monitoring of birds in municipal areas with response to environmental changes.

Objectives

To enhance this study, the following objectives were set as guide to the work:

- To compare the birds diversity among dumpsite and sewage stabilization pond
- To develop checklist of the birds in dumpsite and sewage stabilization ponds

Hypotheses

(Ha) -There is a significant difference in species diversity between between solid waste disposal and sewage stabilization pond area.

MATERIAL AND METHODS

Description of the study area

The study was carried out in Kilimanjaro region city of Moshi municipal which lies in latitude of 3°31'39.53"S and longitude of 37°25'31.6"E (Fig. 1). It is the administrative, commercial and tourist center of Kilimanjaro Region and the entire Northeast Tanzania (Soini, 2006).

The "Timed Species Count (TSC)" method developed by (Gregory *et al.*, 2004) was conducted for

assessing birds communities for this study. Two vantage positions in areas of sewage stabilization pond and dumpsite areas were used for the observation of birds. The data was recorded in six columns, corresponding to six 10-minutes intervals during a survey that last for one hour. For the first 10-minutes, all species encountered were recorded in the first column. Only the names of species but the number of individuals were not recorded on the data form. For the second 10-minutes period, any species that was not already recorded in the second column. The remainder of the hour was divided into 10-minutes periods and any species recorded for the first time during any 10-minutes period were recorded in the appropriate column.

Every type of the species that recorded during the hour was written down only once, in the column representing the 10-minutes period during first seen. The distant birds were viewed only for identification

purposes with the aid of a pair of 8 x 30mm binocular. Each TSC episode started between 07:00–07:30am or 16:30–17:00p.m.

Each species was assigned a score depending on the 10 minutes period in which it was first recorded. Species recorded in the first ten minutes was given a score of six (6), species first recorded in the second ten minutes a score of five (5), and so on. If a Species was not recorded from a survey, then it has a score of zero (0) for that survey.

Data Analyses

Data was analyzed using Shannon wiener index-Formula for calculating species diversity index. T- Test was applied to compare the samples of different two areas and to test the hypothesis. Graph and tables were used to make data presentation. Also R-statistics was used through the use of Vegan package analyzed the data to obtain diversity of sewage stabilization pond and dumpsite.

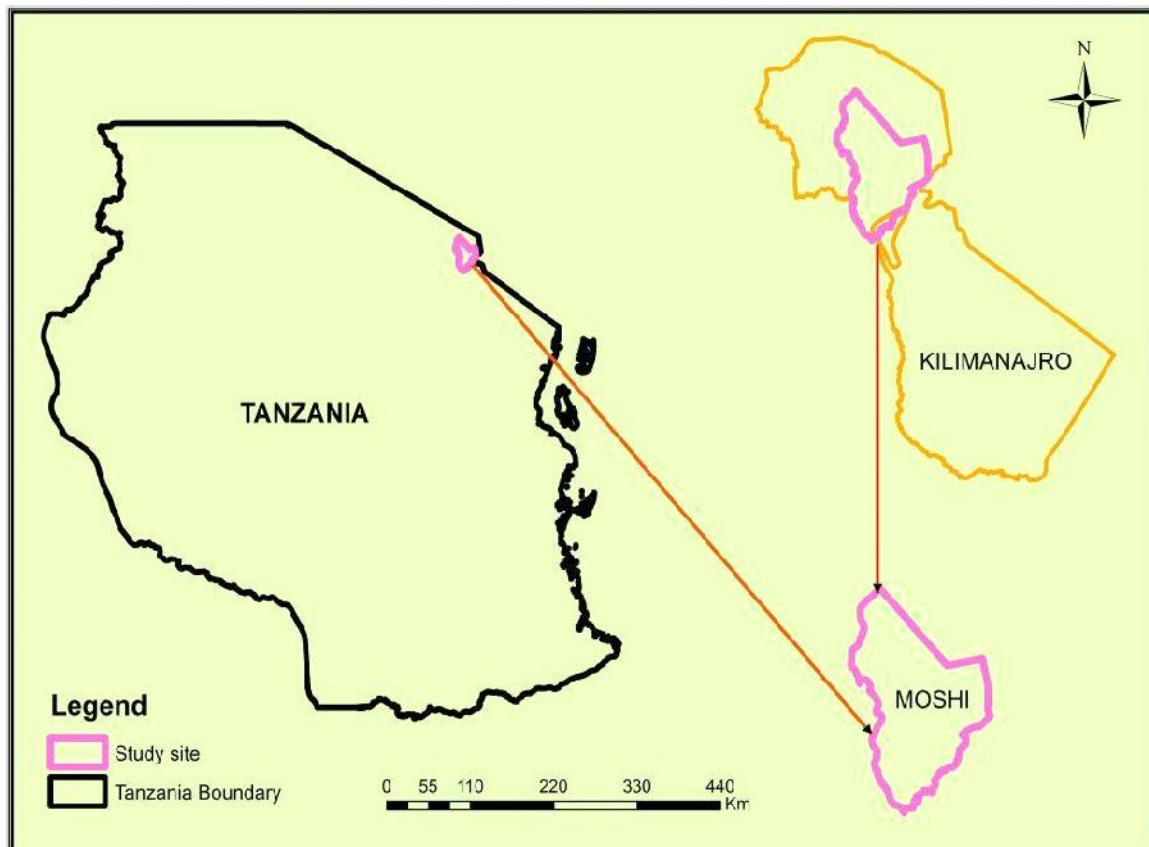


Fig. 1: The location of Kilimanjaro Municipal

RESULTS AND DISCUSSION

Research results

A total of 17 birds species were documented in the study area of both dumpsite and sewage stabilization pond. Dumpsite consist the diversity of 2.28 species obtained, comprise of 10 species. Sewage stabilization pond consist diversity of 2.58. The value of *t* was 1.801706. The value of *p* was 0.090464. The result was *not* significant at *p* > 0.05 which clearly showed that there was no significant difference between the dumpsite and sewage stabilization pond. Hence rejected alternative hypothesis and supported the null hypothesis that there is no significant difference between the two areas of dumpsites and sewage stabilization pond.

The use of Fig. 2 shows the number of occurrence of bird species provided the information on the matter of order and family which dominate with highest number to the lowest number on both dumpsite and sewage

stabilization pond. On the basis of order Passeriformes (5) was highly recorded followed with pelicaniformes (4) Anseriformes (3), Ciconiformes (1), Apodiformes (1), and Charandriiformes. Some of contributing factors of high occurrences of Passeriformes was estimated that roughly 60 percent of all bird species were passerines, but they were only about 40 percent of the families. Thus, this order makes up an extremely large fraction of bird diversity (Ricklefs, 2012). Many species in this order have evolved a greater diversity of feeding adaptation. Mostly where observed feeding insects in both areas.

The family *Threskiornithidae*, *Muscicapied* and *corvidae* found to dominant followed with *Alcenidea*, *Ardeidae*, *Numidae*, *Apodidae*, *Passeridae*. High occurrences *Threskiornithidae* was influence presence of sewage stabilization pond birds such as spoonbills and ibises lead to high occurrences of the family with reference to Fig. 3.

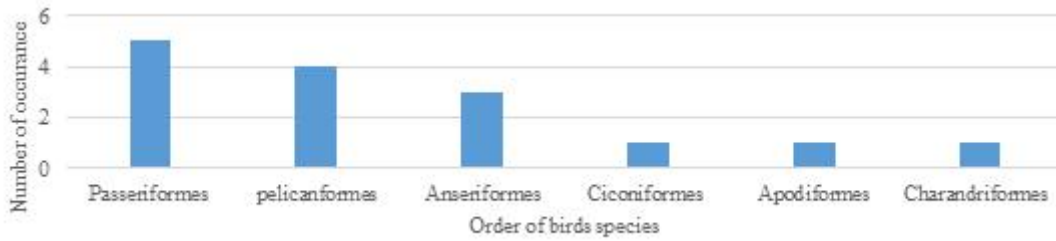


Fig. 2: The order wise number of families on dumpsite and sewage stabilization pond

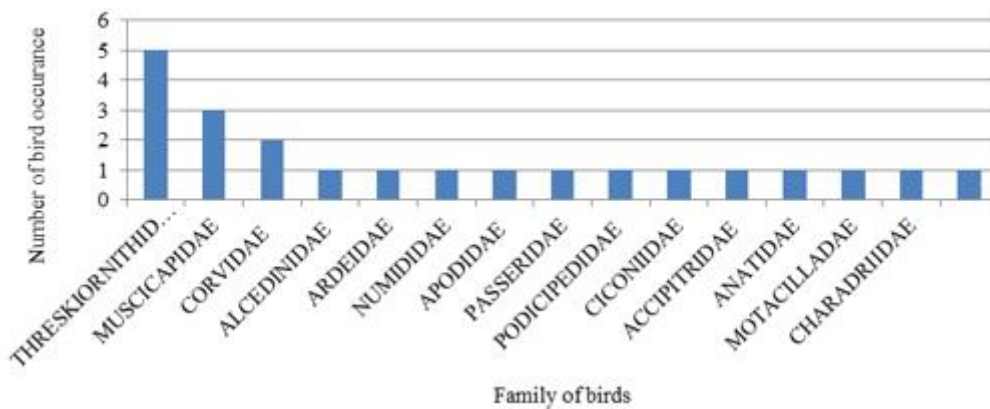


Fig. 3: The Family wise Number of bird on dumpsite and sewage stabilization pond

The regression of analysis provides the information on the relationship between two variables which is the number of individual that can occupy the habitat. It explains that as the size of habitat increases also the number of birds species increases by twofold this proves the positive correlation that habitat influence the number of species to occupy the area ($y=15x-13$). A survey of birds was only done in one month period and encounter the list of the birds Table 1, its gives brief highlight on occurrences of birds and set as basics for understanding the beneficial aspects of dumpsite and sewage stabilization pond.

Research discussion

Present study supports the importance of sewage stabilization pond and dumpsite as the bird’s habitat. The birds used areas for feeding, roosting and nesting.

The results of this study suggest that, whilst the diversity of bird species present at sewage stabilization pond and dumpsite and varies considerably between sites, these artificial habitats can support relatively rich bird communities.

Also through the use of T- test for comparing two areas, proved that there is no significant difference between two areas so null hypothesis was accepted for the study. Hence, these results highlight the importance of dumpsite and sewage pond/sewage stabilization ponds for supporting the residential species.

The objective on comparison of two areas conducted to test the hypothesis that there is no significant difference in species diversity between solid waste disposal and sewage stabilization pond area and hence it supports the hypothesis since the value of *t* is

Table 1: Scientific Checklist of birds which were observed on Dumpsite and Sewage stabilization pond on April 2017

Order	Family	Scientific name	Common name
PASSERIFORMES	PLOCEIDAE	<i>Ploceus cucullatus</i>	Village weaver
PASSERIFORMES	CORVIDAE	<i>Corvus albus</i>	Crows Pied crow
CORACIIFORMES	ALCEDINIDAE	<i>Ceryle rudis</i>	Pied kingfisher
PASSERIFORME	MUSCICAPIDAE	<i>Elminia albicauda</i>	White-tailed blue flycatcher
GALLIFORMES	NUMIDIDAE	<i>Numida meleagris</i>	Guineafowls Helmeted
APODIFORMES	APODIDAE	<i>Cypsiurus parvus</i>	African palm swifts
PASSERIFORMES	PASSERIDAE	<i>Passer domesticus</i>	House sparrow
PODICIPEDIFORMES	PODICIPEDIDAE	<i>tachybaptus ruficollis</i>	Little grebe
PELECANIFORMES	THRESKIORNITHIDAE	<i>Platalea alba</i>	African spoon bill
		<i>Threskiornis aethiopicus</i>	African sacred ibis
		<i>bostrychia hagedash</i>	Hadada ibis
CICONIIFORMES	CICONIIDAE	<i>Mycteria ibis</i>	Yellow billed storks
ANSERIFORMES	ACCIPITRIDAE	<i>Milvus migrans</i>	Black kite
ANSERIFORMES	ANATIDAE	<i>Sarkidiornis malenotos</i>	Knob billed duck
PASSERIFORMES	MOTACILLADAE	<i>Moticila aguimp</i>	African pied wagtail
CHARADRIFORMES	CHARADRIIDAE	<i>Venellus armatus</i>	Blacksmith lapwings

1.801706. The value of p is 0.090464. The result is not significant at $p < 0.05$. There are various factors that caused major difference between the two sites includes (1) human settlement (2) The difference in size of two habitat (3) location of two habitats differences. Human activities have greater influence on distribution pattern of bird's species occurrences. Urban areas that are highly disturbed lower the number of birds species example noise pollution and activity on dumpsites such as rag pickers specifically in the dumpsite and these make a difference of which sewage stabilization pond are not subject to higher activity that are carried by human and this one factor causes difference in diversity. It should be the goal of municipal and state agencies to provide urban dwellers with nearby natural areas that meet the habitat requirements of a variety of wildlife, including birds (Tilghman, 1987).

The size of dumpsite is larger compared to sewage stabilization pond although it shows that dumpsite have low diversity and this clearly provide the evidence that dumpsite is much disturbed. The significant causes of the difference is the area which the dumpsite is located which is much closer to human settlement than the area where as the sewage stabilization pond is located much far from human settlement and hence this makes the differences. Above all it is very important

to conserve these areas because they can serve as the bird watching area and also from environmental point of view are ecologically very important. Referring to Fig. 4, as the habitat size increases the number of birds species increase two in terms of number. Habitat heterogeneity hypothesis state that an increase in the number of habitats and/or, at a different scale, an increase in their structural complexity leads to increase species diversity (Tagliapietra and Sigovini, 2010).

Locations of dumpsites requires careful attention. If it is away from a city, with a minimum human movement, avian activity will be highest. The dumpsite that the study was conducted in, was one such site, being located 5km from Moshi Town, compared to sewage stabilization pond that is located far away that dumpsite and that is the main reason leads activities of birds in the highest level since there was minimal disturbance.

Restricting access to the center of the dumpsites will enhance the richness and abundance birds. The common bird species observed in all the study sites were Magpie (*Pica pica*) and Village weaver (*Pioceus cucullatus*). Ensuring minimal disturbance will support rich number of birds, poorly managed of dumpsite can cause serious impacts to human health (Yeragi and Mendhulkar, 2015).

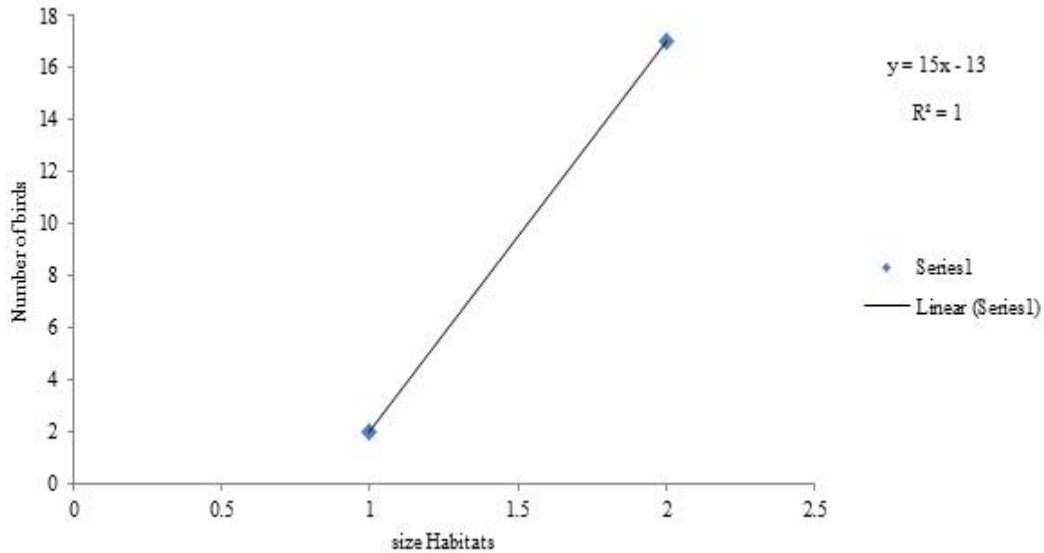


Fig. 4: Regression of the number of birds occupied on both dumpsite and sewage stabilization pond

Particularly it is very important to manage these sites in order to maximize their value for bird's habitat. Although high habitat diversity is more readily achievable on large sites, the results of this study show that, even small sewage stabilization pond and dumpsite works with a good range of habitats can support diverse bird communities. For instance, sewage stabilization pond at only 2.2 ha and yielded 14 birds species.

The correlation coefficient (r) result obtained between number of birds and habitat size is shown in Fig. 4. The strength of association was higher in a sense that as the size of habitat increases the number of species also increases. Factors that lead to positive correlation between sewage stabilization site and the dumpsite are: first, the habitat diversity of these sites itself – a site comprising a diversity of habitat types will provide feeding and nesting habitat for a wider range of species and second, the importance of the nature of the surrounding environment whether it is surrounded by farmland or urban landscape which can determine the potential bird community available to use the site (Gough *et al.*, 2003).

Greater habitat heterogeneity connotes greater species diversity (Oka and Majuk, 2016). Availability on variety of habitat types increase the number of species richness in the area. Some of the birds species harbor in both areas such as *Bubulcus ibis*, *Platalea alba*, *Threskiornis aethiopicus*, *venellus armatus*, *Milvus migrans*, *Bostrychia hagedash* and so on.

Recommendation

This study indicates that city dumpsite and sewage stabilization pond work as habitat for birds, there is need to develop a new sustainable development plan with the objective addressing the challenges that face dumpsite and sewage stabilization pond that causes side effect to birds. These could be archived through involving various stakeholders composed of urban ecologists, economists, sociologists, meteorologists, hydrologists, health-care professionals, landscape designers, planners, and politician of which will generates useful questions in designing urban area with focus preserving urban biodiversity and make cities more livable and sustainable.

CONCLUSION

The present study provides evidence of sewage pond playing an important role in supporting residential

species in Moshi municipal. Most of the natural habitat of birds are destructed due to the human activities such deforestation causing birds species to adapt to the artificial habitat. Constant flow of water and organic contents in sewage stabilization pond throughout the year make a significant advantage for the birds to be utilized as the permanent habitat.

Dumpsite is important feeding and nesting site for large number of bird species. So it is very important to reduce the human activities such as road passing inside and around the dumpsites. Through reducing human interference, the impact will favors the increase of the number of species. Hence, this sewage/ sewage stabilization pond plays key role in conservation of birds. However, detail research on the health related issued should be done to avoid any hazardous condition.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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Dumpsite and Sewage Works as habitat for Birds

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