

Bird Habitats in Urban Environments: A Case from an Urban Landfill in and around Tayba Al Hasanab Landfill, Khartoum, Sudan

Mutasim Essa Abdallah Adam^{1*}, Mawya Ahmed Elshafea Mohamed²

¹Department of Biodiversity, Higher Council of Environment, Urban and Rural Promotion, Khartoum, Sudan

²Department of Environmental Impact Assessment and Authorization, Higher Council of Environment, Urban and Rural Promotion, Khartoum, Sudan

Email: *mutasemessa@gmail.com

How to cite this paper: Adam, M.E.A. and Mohamed, M.A.E. (2024) Bird Habitats in Urban Environments: A Case from an Urban Landfill in and around Tayba Al Hasanab Landfill, Khartoum, Sudan. *Journal of Environmental Protection*, 15, 887-905. <https://doi.org/10.4236/jep.2024.158051>

Received: July 24, 2024

Accepted: August 27, 2024

Published: August 30, 2024

Copyright © 2024 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Managed open landfill sites can serve as crucial feeding grounds for birds. Studies have demonstrated that garbage dumps offer favorable feeding habitats for various trophic generalist species, including storks and scavenger raptors. This study aimed to assess bird diversity and abundance in and around Tayba Al Hasanab Landfill, Khartoum. A bird census was conducted using block counts in January 2021. A questionnaire complemented field observations, and interviews were conducted with landfill authorities and waste collectors to gather information on bird availability, numbers, and diversity. During the block counts, 23 bird species were recorded inside and around the landfill. These species directly relied on food resources available at and around the landfill, belonging to 8 orders and 11 families. The four most abundant species foraging at the landfill were Sparrow House (*Passer domesticus*) with 97 individuals, Black kite (*Milvus migrans*) with 67 individuals, cattle egret (*Bubulcus ibis*) with 42 individuals, and Laughing Dove (*Spilopelia senegalensis*) with 36 individuals. This suggests that these species are the primary exploiters of food resources at the landfill. The results indicate that all species are considered least concerned except the Egyptian Vulture (*Neophron percnopterus*), which is classified as endangered. Most of the interviewed individuals reported seeing birds in the study area. The study recorded instances of dead birds, such as a white stork colliding and being electrocuted with a transition line observed at different sites along transmission lines near the landfill. Surveys around Tayba landfill need to be conducted to identify deadly power lines for replacement or implement possible mitigation measures on power lines running parallel and close to the Tayba landfills. The avian community foraging at the landfill displayed fluctuations in abundance and interspecific

interactions across seasons. Given that the substantial influx of birds to landfills can pose various environmental challenges in urban settings, this study underscores the significance of examining the seasonal dynamics of bird communities concerning the location and management of landfills.

Keywords

Bird Diversity, Block Counts, Endangered Species, Collisions, Electrocutions, Landfill Management

1. Introduction

Open landfill sites can be key feeding habitats for birds if properly managed. Rubbish dumps have been shown to provide good feeding habitats to many trophic generalist species, such as storks and scavenger raptors [1]-[3]. The creation of feeding stations to remove animal carcasses from farms is a common feature of many conservation programs for scavenger raptors, including Black and Red Kites, Griffon, Egyptian and Cinereous Vultures [4] [5].

However, waste sites may also be of value for biodiversity and migrating species. They can serve as stop-over sites and a food source for many species of birds, especially in altered or heavily human-transformed habitats [1]. Rubbish dumps constitute appropriate feeding sites for many generalist bird species. The superabundance of organic residues provides species with a predictable spatial and temporal food source that greatly reduces the species' foraging time and home range. Within this frame, rubbish dumps have a high carrying capacity [1] [6]-[8]. In addition, domestic waste has a high energetic content [9].

Landfills, often viewed as environmental liabilities, can unexpectedly serve as critical habitats for avifauna. Observations during block counts have recorded 23 bird species within and around Tayba Al Hasanab Landfill, underscoring their significance as an important area for avian diversity. This phenomenon highlights the ecological value of landfills, supported by research indicating that surrounding vegetation and water channels enhance their habitat quality.

Research shows that landfills can support a diverse range of bird species due to their unique habitat features. According to [10], landfills in Mediterranean-climate regions provide essential resources and habitats for various bird species, often resulting in high bird diversity. This is further supported by [11] Jones and Coman, who note that landfills can play a vital role in avian biodiversity, particularly when these areas are integrated with surrounding vegetation and water channels that improve habitat conditions.

Understanding the influence of habitat characteristics on avian diversity is crucial for effective conservation strategies. This study, focusing on bird habitats around the Tayba Al Hasanab Landfill in Khartoum, Sudan, parallels the research conducted by [12] Kougom Piebeng *et al.* on the Kalfou Forest Reserve in Cameroon. While Kougom Piebeng *et al.* highlighted how forest reserve

boundaries and surrounding zones impact bird diversity, this study explores how urban landfill environments and waste management practices shape avian habitats. By comparing these different settings, we aim to gain a comprehensive understanding of how various environmental conditions affect bird populations and inform more targeted conservation efforts.

2. Study Area

The study was conducted in and around Tayba Al Hasanab Landfill, located in the Jabel Awlia locality, Khartoum, Sudan (N: 15.383810°, E: 32.569454°, See **Figure 1**). The Tayba landfill is recognized as a significant area for birds due to its surroundings, which include vegetation and channels that create suitable habitats for avian species. Tayba landfill was established in 2008, in the Jabel Awlia locality, about 4 km east of the residential area of Tayba Al Hasanab. It is bordered eastward by the Soba agricultural project and South by poultry farms [13]. The city of Khartoum (latitudes 15 to 16°N longitudes 31.5 to 34°E). The weather is rainy in the summer, and cold and dry in the winter; the temperature ranges in summer ranges from 25°C to 40°C from April to June, and from 20°C to 35°C from July to October. Situated at the junction between the Blue and the White Nile Omdurman to the west and Khartoum North to the north, form Khartoum Sudan's dominating urban centers [14].

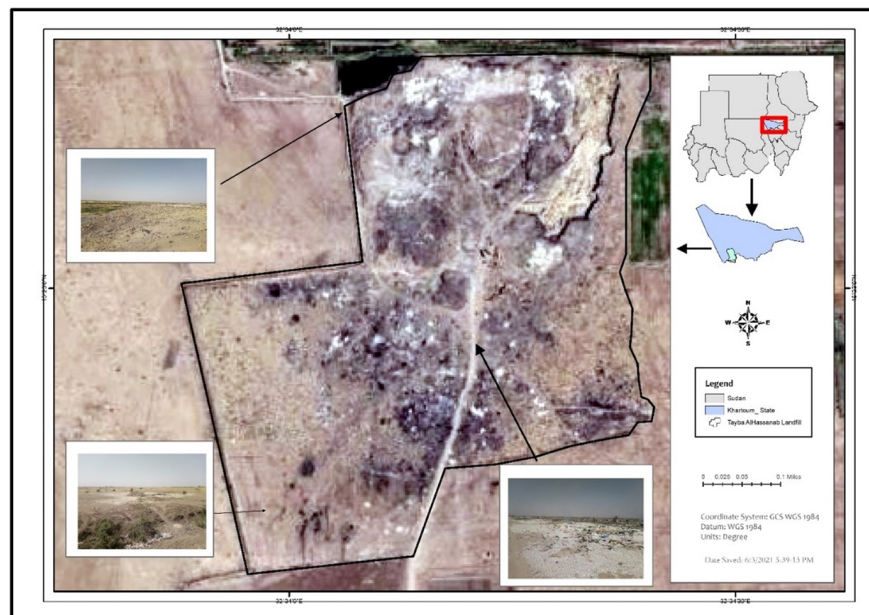


Figure 1. Map of the Tayba landfill, Khartoum, Sudan. (The photos were taken during site visits to the study area). The Map was created by Mawya [15].

3. Methodology

The survey was conducted in January 2021, the survey recorded standards such as bird species, the number of individuals, weather conditions, and time. Data collection methods included personal observations, interviews with the site's

manager and waste collector, and photo documentation. The survey employed block count techniques from 7:00 - 10:00 a.m. Bird counts and identification surveys were conducted once in January 2021. Additionally, habitat maps were generated using Google Earth, and Keyhole Markup Language (KML) files were converted to shape files in Arc Geographic Information System (GIS) 10.5 to identify potential areas preferred by birds. The equipment used for data collection included a pair of binoculars (50 × 50 magnifications), a Swarovski telescope (660 - 940), a digital still camera, data recording sheets, a notebook, and a bird identification guide. (Birds of Africa South of the Sahara by Peter Ryan and Ian Sinclair, second edition 2010).

Waste Separation Practices at Tayba Al Hasanab Landfill and Their Effects on Bird Habitats.

Waste separation at open landfill sites is a crucial aspect of waste management, significantly influencing environmental health and biodiversity. In urban environments, where landfills are prevalent, such practices can directly impact bird habitats.

Waste Separation Practices

Current Practices: Open landfills like Tayba Al Hasanab often lack systematic waste separation. Waste is typically dumped without sorting, leading to mixed waste heaps that include organic material, plastics, metals, and hazardous waste. This practice can have several detrimental effects on the environment and bird habitats [16].

Challenges:

- **Lack of Infrastructure:** There is often inadequate infrastructure for waste separation, including limited availability of designated bins for different types of waste and insufficient waste processing facilities [17].
- **Public Awareness:** Low levels of public awareness and participation in waste segregation practices contribute to the inefficiency of waste management systems [18].
- **Economic Constraints:** Financial limitations hinder the implementation of comprehensive waste separation and recycling programs [16].

Impact on Bird Habitats

- **Food Sources:** The lack of waste separation leads to an abundance of organic waste, which attracts birds. While this provides a food source, it can also lead to increased dependence on landfill sites for food, altering natural foraging behaviors and potentially impacting bird health due to the consumption of contaminated food [19].
- **Toxic Substances:** Mixed waste often contains hazardous substances that can leach into the environment. Birds ingesting or coming into contact with these substances may suffer from poisoning or other health issues [17].
- **Habitat Degradation:** Poor waste management can lead to the degradation of natural habitats around landfill sites. Accumulation of non-biodegradable waste, like plastics, can damage the local ecosystem, making it less suitable for bird habitation [16].

- **Predator Attraction:** Landfills can attract predators, such as rats and feral dogs, which pose a threat to bird populations. Increased predator presence can disrupt nesting sites and reduce bird populations [19].

4. Results

Direct Observation

The present study observed a total of 459 individuals across 23 species, distributed among 8 orders and 11 families, as detailed in **Table 1**. Among the families, Ardeidae, Passeridae, and Apodidae exhibited the highest species diversity (Refer to **Table 1**). Species statuses are outlined in **Table 2**, revealing that all species, except the Egyptian Vulture (*Neophron percnopterus*), are classified as least concern, while the latter is listed as endangered.

Among the 23 observed species, five are confirmed residents in the country based on breeding records, namely the Egyptian Vulture, Yellow-billed kite, Grey heron, Laughing Dove, and Common Kestrel. Additionally, certain species, such as the Cattle egret, Common swift, Lesser Kestrel, and Lanner falcon, were recorded as breeding in the Palearctic region. Some species, like the Western Marsh-harrier and Common Buzzard, were observed during non-breeding seasons or wintering in Sudan. Furthermore, some species breed in the Palearctic and winter in Sudan, including the Black kite, White stork, Black Stork, and Common Kestrel (Refer to **Table 2**).

Table 1. List of bird species and numbers observed in Tayba landfill, Khartoum, Sudan during January 2021.

No	Order	Family	Species Scientific Name	Species English Name	No
1	Accipitriformes	Accipitridae	<i>Milvus migrans</i>	Black kite	67
			<i>Neophron percnopterus</i>	Egyptian Vulture	7
			<i>Milvus aegyptius</i>	Yellow-billed kite	3
			<i>Circus aeruginosus</i>	Western Marsh-harrier	4
			<i>Buteo buteo</i>	Common Buzzard	6
			<i>Micronisus gabar</i>	Gabar Goshawk	4
2	Passeriformes	Alaudidae	<i>Galerida cristata</i>	Crested Lark	23
3	Pelecaniformes	Ardeidae	<i>Bubulcus ibis</i>	Cattle egret	42
			<i>Ardea cinerea</i>	Grey heron	3
4	Ciconiiformes	Ciconiidae	<i>Leptoptilos crumenifer</i>	Marabou stork	32
			<i>Ciconia ciconia</i>	White stork	17
			<i>Ciconia nigra</i>	Black Stork	6
			<i>Ciconia abdimii</i>	Abdim stork	7
5	Apodiformes	Apodidae	<i>Apus apus</i>	Common swift	28
6	Charadriiformes	Charadriidae	<i>Vanellus spinosus</i>	Spur wing lapwing	22
7	Columbiformes	Columbidae	<i>Streptopelia decipiens</i>	African Mourning Dove	8
			<i>Spilopelia senegalensis</i>	Laughing Dove	36
8	Falconiformes	Falconidae	<i>Falco naumanni</i>	Lesser Kestrel	11
			<i>Falco tinnunculus</i>	Common Kestrel	9
			<i>Falco biarmicus</i>	Lanner falcon	2
	Passeriformes	Sturnidae	<i>Lamprotornis chalybaeus</i>	Greater blue-eared starling	12
	Passeriformes	Passeridae	<i>Passer domesticus</i>	House Sparrow	97
	Passeriformes	Ploceidae	<i>Ploceus cucullatus</i>	Village Weaver	13
Total	8	11	23	23	459

Generally, bird survey results can be strongly influenced by season, time of day, and local habitat variation, including elevation [20]. Other variables such as weather conditions, human presence, observer’s experience, number of observers and observers’ limitations, and the fact that the avifauna of Sudan includes a total of 1013 species some of them classified as migratory bird species that relocate during the year can also influence on the presence of birds. Hence, to enhance comprehension and facilitate effective habitat biodiversity monitoring, surveys should ideally be conducted across various seasons and under different conditions. The House Sparrow (*Passer domesticus*) emerged as the most frequently identified bird, with a count of 97 individuals. Following closely was the Black kite (*Milvus migrans*) with 67 individuals, the Cattle egret (*Bubulcus ibis*) with 42 individuals, and Laughing Dove (*Spilopelia senegalensis*) with a count of 36 individuals (Refer to Table 1 and Figure 2).

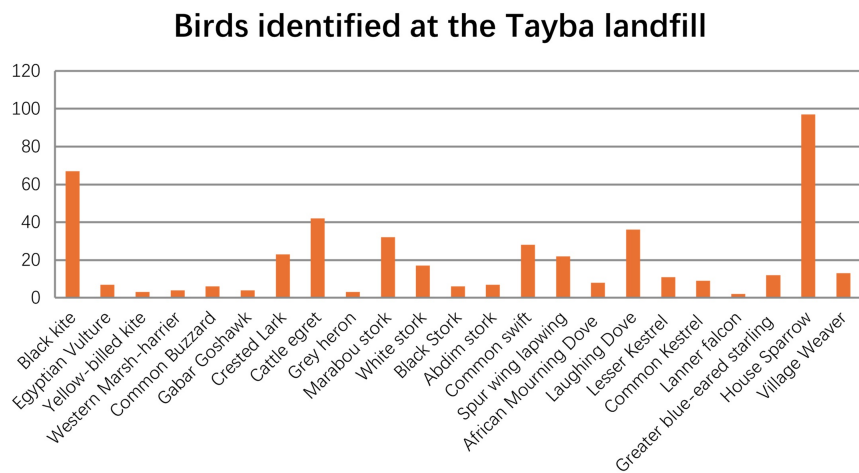


Figure 2. Common birds were identified at the Tayba Landfill, Khartoum, Sudan in January 2021.

Table 2. Bird species and their general status observed in Tayba landfill, Khartoum, Sudan during January 2021.

No.	Order	Family	Species total number	Species scientific name	Species English name	Status	IUCN Red list
1	Accipitriformes	Accipitridae	7	<i>Milvus migrans</i>	Black kite	PW	LC
				<i>Neophron percnopterus</i>	Egyptian Vulture	RB	EN
				<i>Milvus aegyptius</i>	Yellow-billed kite	RB	LC
				<i>Circus aeruginosus</i>	Western Marsh-harrier	W	LC
				<i>Buteo buteo</i>	Common Buzzard	W	LC
				<i>Micronisus gabar</i>	Gabar Goshawk	R	LC
				<i>Galerida cristata</i>	Crested Lark	R	LC
3	Pelecaniformes	Ardeidae	2	<i>Bubulcus ibis</i>	Cattle egret	P	LC
				<i>Ardea cinerea</i>	Grey heron	RB/P	LC

Continued

4	Ciconiiformes	Ciconiidae	4	<i>Leptoptilos crumenifer</i>	Marabou stork	MB	LC
				<i>Ciconia ciconia</i>	White stork	PW	LC
				<i>Ciconia nigra</i>	Black Stork	PW	LC
				<i>Ciconia abdimii</i>	Abdim stork	AM	LC
5	Apodiformes	Apodidae	1	<i>Apus apus</i>	Common swift	P	LC
6	Charadriiformes	Charadriidae	1	<i>Vanellus spinosus</i>	Spur wing lapwing	RB	LC
7	Columbiformes	Columbidae	2	<i>Streptopelia decipiens</i>	African Mourning Dove	R	LC
				<i>Spilopelia senegalensis</i>	Laughing Dove	RB	LC
8	Falconiformes	Falconidae	3	<i>Falco naumanni</i>	Lesser Kestrel	P	LC
				<i>Falco tinnunculus</i>	Common Kestrel	RB/PW	LC
				<i>Falco biarmicus</i>	Lanner falcon	P	LC
9	Passeriformes	Sturnidae	1	<i>Lamprotornis chalybaeus</i>	Greater blue-eared starling	R	LC
10	Passeriformes	Passeridae	1	<i>Passer domesticus</i>	House Sparrow	R	LC
11	Passeriformes	Ploceidae	1	<i>Ploceus cucullatus</i>	Village Weaver	AM	LC
	8	11	24	-	-	-	-

Key to status information: B—Breeding record confirmed; M—Migrant including on passage through Sudan; P—Breeds in Palearctic; R—Resident; W—Winters in Sudan (non-breeding season); RB—Resident in Sudan as confirmed by the breeding record; PW—Breeds in the Palearctic and winters in Sudan; AM—Intra African Migrant; RB/PW—There is both a resident breeding population and a wintering population; AM—Intra African Migrant; LC—Least Concern; EN—Endangered.

5. Discussion of Questionnaires

Typically, the baseline field survey should extend over a minimum period of 12 months to assess the seasonal significance of birds in the study area, encompassing a full annual cycle. The primary focus should be on understanding the diversity and abundance of avian species. There might be a justification for conducting specific surveys during winter or, in some cases, even summer. The rationale behind this decision should be thoroughly explained, with a particular emphasis on assessing migration periods. To address this aspect, a questionnaire was employed to augment field observations.

The questionnaires were distributed to and completed by the landfill authority and waste collectors. These surveys aimed to capture information on the availability, numbers, and diversity of birds throughout the year, as well as details on bird mortality and the causes thereof. Notably, instances of bird mortality, as recorded during observations, were attributed to factors such as electrocution.

Question 1: Gender Distribution—The questionnaire participants predominantly identified as male (91.2%), with only 8.8% identifying as female (Refer to **Figure 3(a)**).

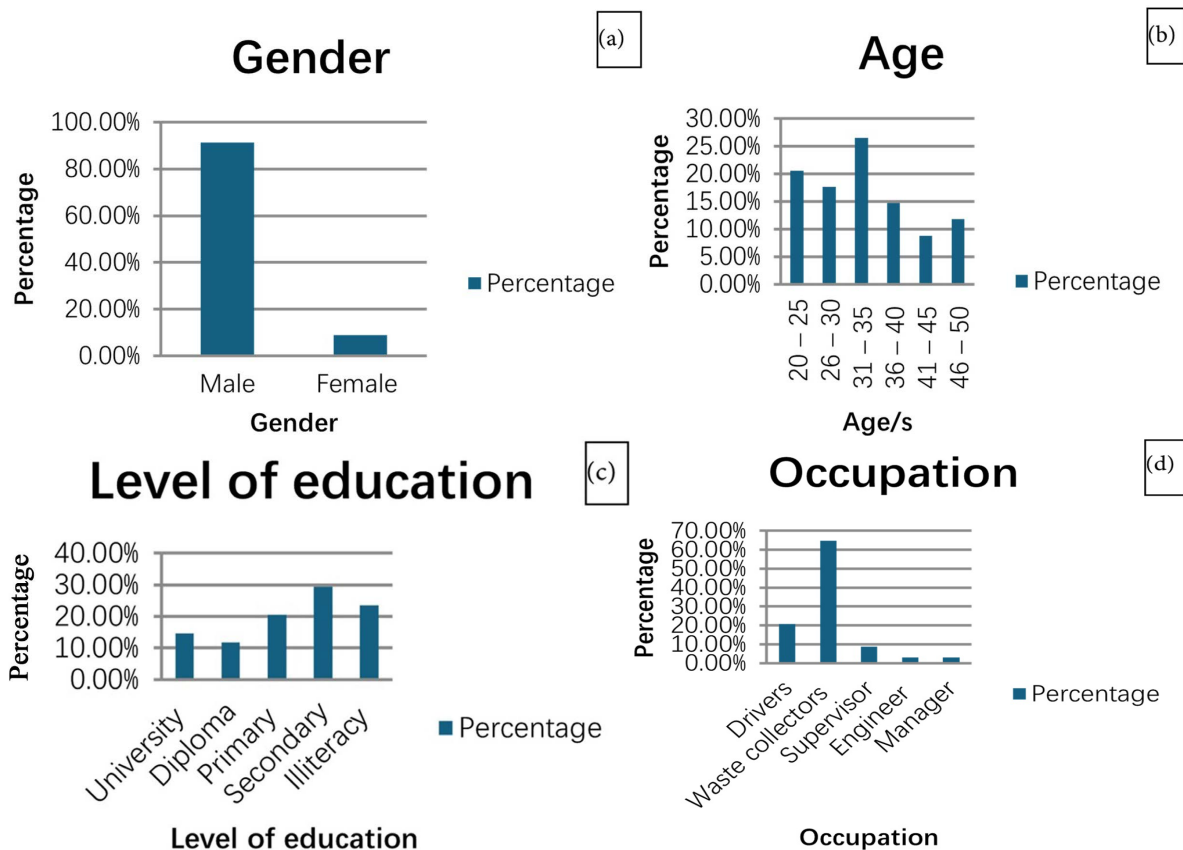
Question 2: Age Distribution—Analysis of the age demographics from the interviews reveals that a significant portion of participants falls within the 31 - 35 years age range (26.5%), while a smaller percentage is aged between 41 and 45 years (8.8%) (Refer to **Figure 3 (b)**).

Question 3: Educational Attainment—A predominant number of participants attained a secondary level of education (29.4%), while only 11.8% held a Diploma (Refer to **Figure 3(c)**).

Question 4: Occupational Distribution of Landfill Workers—Out of 34 participants at Tayba landfill, the breakdown of occupations includes 22 waste collectors (64.7%), 7 drivers (20.6%), 3 supervisors (8.8%), 1 engineer, and 1 manager, each accounting for 2.9% (Refer to **Figure 3(d)**).

Question 5: Marital Status Distribution—The marital status of participants reveals a majority being unmarried (64.75%), while only 12 individuals are married (35.3%) (Refer to **Figure 3(e)**).

Question 6: Bird Sightings in the Study Region—When asked about bird presence in the area, the majority of respondents (97.1%) affirmed observing birds, while only one person reported no bird sightings in the region (See **Figure 3(f)**). The frequently mentioned bird species included the House Sparrow, Black Kite, Laughing Dove, Marabou Stork, and Common Swift, with the Western Marsh-harrier and Common Buzzard being less commonly spotted (Refer to **Figure 4**).



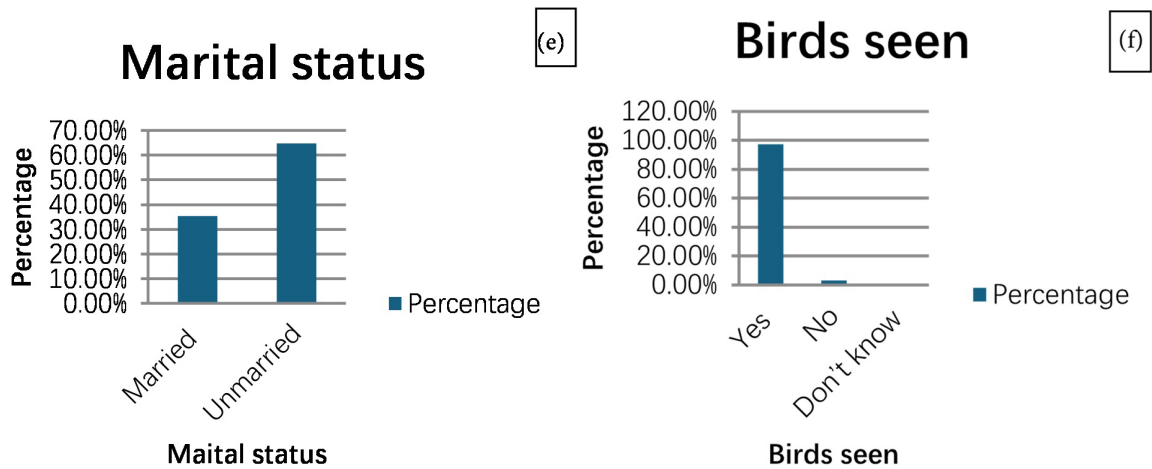


Figure 3. (a)-(f) shows gender, age level of education, occupation, and material status and birds have seen percentages of the questionnaires.

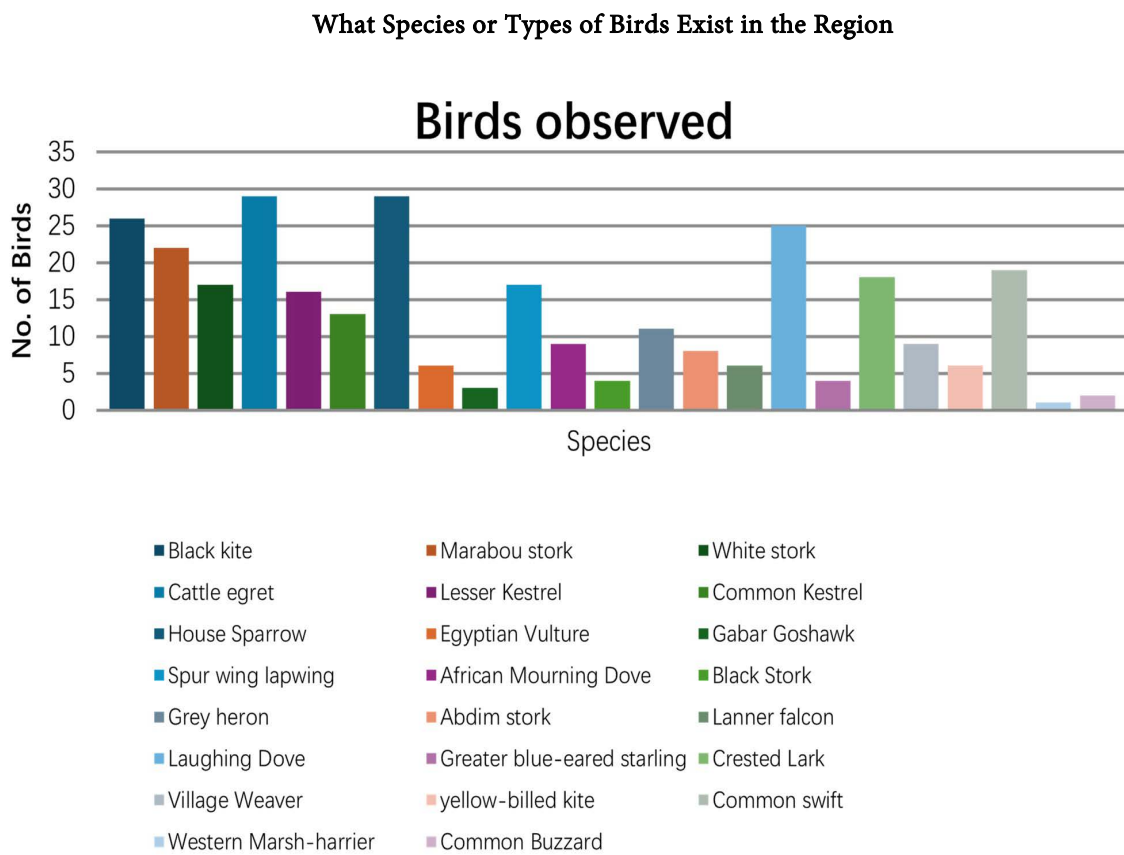


Figure 4. Types of birds seen in the region in January 2021.

Question 8: Regarding the existence of birds, the observations indicate that they are predominantly solitary individuals (32.4%) or gather in groups of tens (44.1%). In fewer instances, birds are observed in larger congregations, with some forming groups of hundreds (17.6%) or even thousands (5.9%) of individuals (Refer to **Figure 5**).

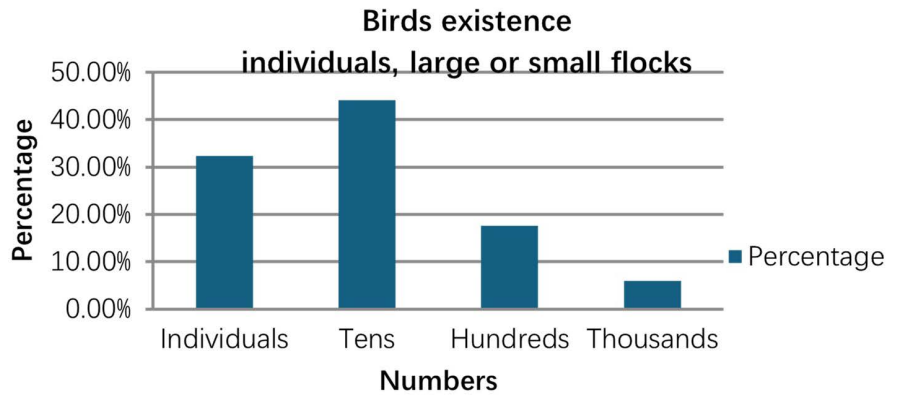


Figure 5. Birds exist as individuals, large or small flocks.

Question 9: Bird Mortality Observation—When asked if respondents had witnessed any dead birds, the majority (79.4%) reported not observing any deceased birds. However, 14.7% confirmed witnessing dead birds, while 5.9% indicated uncertainty, responding that they didn’t know (Refer to **Figure 6(a)**).

Question 10: Perceived Causes of Bird Mortality—The majority of respondents (79.4%) reported not witnessing any dead birds. However, 11.8% attributed bird mortality to electricity as the primary cause, while only 2.9% suggested poisonings as a potential cause of death (Refer to **Figure 6(b)** and **Figure 7(a)-(d)**).

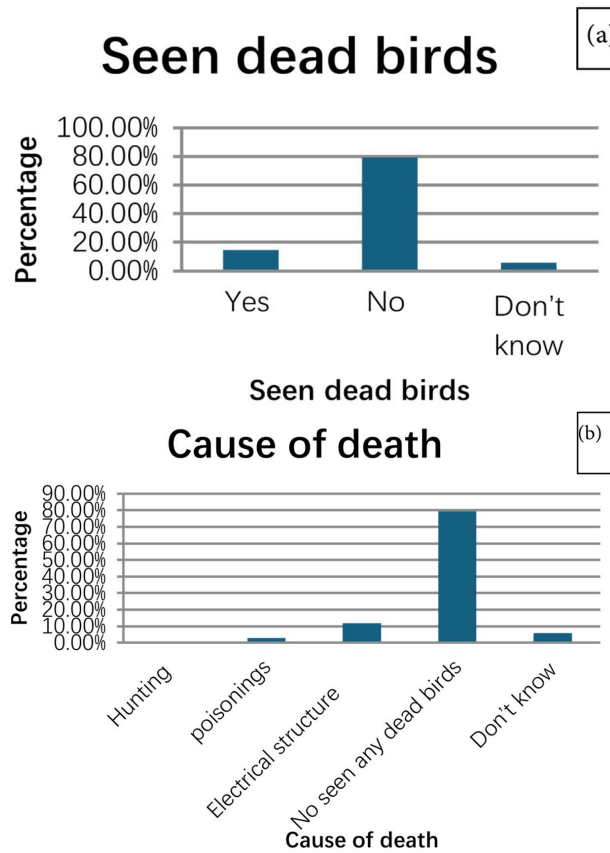


Figure 6. (a) and (b). Seen birds and cause of death.



Figure 7. (a)-(d): Dead white stork collided with transition line, common kestrel electrocuted, white stork at bottom collision with the transmission line, spur-winged lapwing dead, observed at different sites along transmission lines near to the landfill.

Question 11: During which time of the year have you observed the highest diversity of birds—A majority of respondents (32.4%) indicated that the period from June to October exhibits the highest abundance and diversity of birds in landfills. This phenomenon may be attributed to the rainy seasons causing flooding around the landfill, leading to birds roosting in the waste dump. Additionally, 23.5% of those interviewed reported observing the highest number of birds from December to March. Conversely, the fewest respondents reported seeing birds from March to June (**Figure 8**).

Seen birds during the year

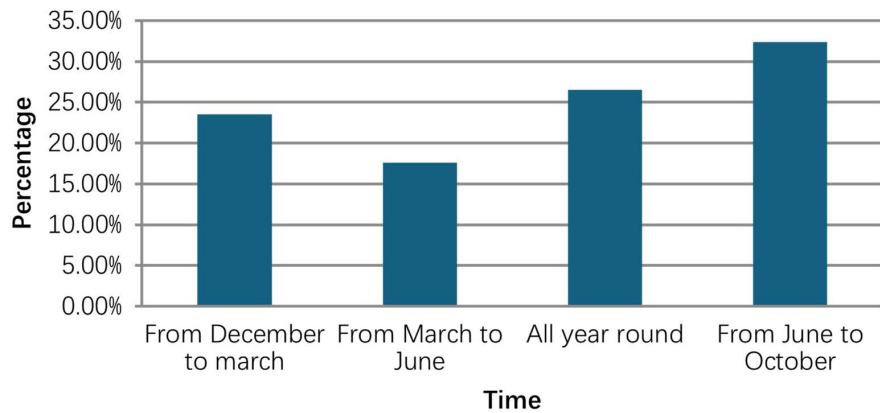


Figure 8. Most birds diversity during the year.

Question 12: Have you observed birds feeding on waste in the region—A majority of respondents (61.8%) affirmed that they have witnessed birds feeding on waste in the study area, with 32.4% specifically noting the presence of birds around the landfill (Refer to **Figure 9(a)**). It is noteworthy that domestic waste is characterized by a high energetic content [9]. Rubbish dumps in southwestern Europe have been shown to provide key habitats for at least twenty-one bird species [2] where they feed directly from organic wastes.

Question 13: Do birds alter their flight path to avoid the landfill in the study area—As depicted in **Figure 9(b)**, 73.5% of respondents indicated that birds do not avoid the landfill during their flight, while 11.8% reported that birds do avoid the landfill. Only 14.7% responded with uncertainty, stating that they do not know.

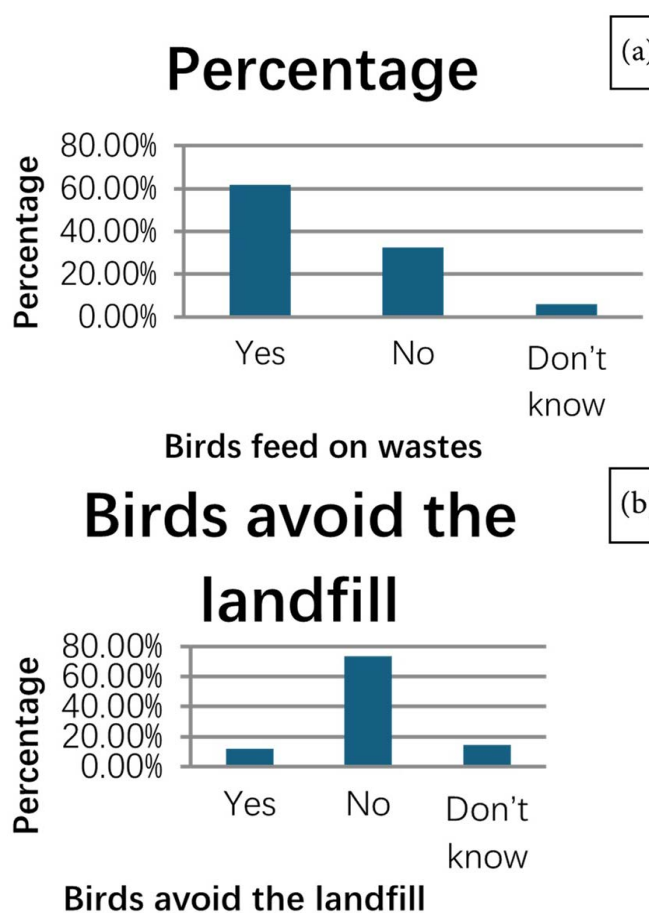


Figure 9. (a)-(b) show birds that feed on Waste in the region and **Figure B** shows birds that avoid the landfill.

Question 14: Are you aware of areas where birds are commonly found in waste—Some individuals believe that there are numerous locations in the study area where birds are present, particularly in proximity to poultry farms. Additionally, through site visits and direct observation, it has been noted that there are indeed some farms situated around the landfills.

Question 15: For landfill authorities only: Do your plans consider the presence of birds and/or soaring birds—Five respondents indicated that there are no plans in place. It is crucial to understand the utilization of waste sites by MSBs (Migratory Soaring Birds) and other bird species and how this usage evolves. Such an approach can aid in recognizing potential adverse effects on birds, and determining how, when, and where species utilize waste sites. This understanding is essential for identifying critical sites for the conservation of MSBs. Additionally, post-construction monitoring is necessary at new MSB-friendly waste sites to confirm their safety and importance to birds. It is vital to ensure that the best practices and guidelines for addressing migratory bird conservation in the waste management sector are effectively implemented.

Question 16: Are you aware of locations where birds are commonly found in waste—Several respondents indicated that there are numerous areas within the study vicinity where birds are observed, particularly in connection with chicken farms.

Carcasses and livestock producers

Vultures and other animals feed on the meat of livestock carcasses; however, this practice can pose public health risks and draw birds to areas where they may come into conflict with humans. Additionally, losses from domestic livestock may provide necrophagous birds with larger amounts of meat than animals that die naturally in the wild. Implementing carcass incineration plants that utilize dry rendering processes in major towns could address this issue by processing carcasses appropriately. These plants should handle the solid waste generated by slaughterhouses, as well as locations of illegal slaughter. The study area frequently observed carcass disposal at the garbage dump, potentially increasing vulture activity, though this varied with the seasons. At garbage dumps, the mixture of organic waste with carcasses (**Figure 10(a)-(d)**) is likely to attract vultures, Black Kites, and storks, with the latter being particularly prominent due to their population size.



Figure 10. (a)-(b): Horn of cow and poultry carcass around Tayba Landfill, Khartoum, Sudan (the pen and binoculars used to determine the size). Photos by Mutasim Adam 2021.

Discussion

Factors influencing bird diversity in urban environments

Urban environments introduce a variety of challenges and opportunities for bird species. Urban landfills, such as the Tayba Al Hasanab Landfill in Khartoum, Sudan, offer unique ecosystems where diverse factors influence bird diversity. Key factors impacting bird populations in urban settings include habitat availability and quality. Urbanization leads to habitat fragmentation, reducing natural habitats for birds [21]. Despite this, landfills can provide alternative food sources and nesting sites, attracting various bird species [22]. Abundant food resources in landfills attract birds, offering a consistent food supply [5], although reliance on anthropogenic food sources can affect birds' health and behavior, potentially leading to negative long-term impacts [23]. Higher human activity in urban areas can disturb nesting and feeding behaviors [24]. Urban pollution, including chemical and noise pollution, adversely affects bird health and reproductive success [25]. Additionally, birds in landfills might be exposed to hazardous waste, leading to the bioaccumulation of toxins [26]. Effective urban planning that incorporates green spaces and minimizes pollution can enhance bird diversity in urban environments. For instance, reducing pollution can help mitigate some negative impacts of urbanization on bird populations, and managing human activity around sensitive areas can further support bird diversity.

Habitat Variation and Bird Diversity

Our study on bird habitats at the Tayba Al Hasanab Landfill reveals that the diverse waste types and landfill management practices contribute to a variety of microhabitats. This diversity supports different bird species, akin to the natural habitat variability observed in Phou Khao Khouay National Park. Thongsoulin demonstrated that habitat diversity in PKK significantly influenced bird species composition and abundance [27]. Both environments, though differing in origin—anthropogenic versus natural—create a mosaic of habitats that support varying bird communities. This similarity suggests that habitat diversity, whether from natural or human-made sources, is crucial for maintaining bird biodiversity.

The study was conducted in and around the Tayba Al Hasanab Landfill, located in the Jabel Awlia locality of Khartoum. This landfill is considered a focal area for birds due to its surroundings, featuring vegetation and channels that create suitable habitats for avifauna.

Generally, the richness of avifaunal species is directly or indirectly influenced by environmental characteristics, especially in areas with a high rate of anthropogenic activities [28]. Consequently, the surrounding area naturally supports a significant diversity of bird species. However, the human-modified urban landfill site hosts a high abundance and low diversity of birds. During block counts, 23 bird species were recorded inside and around the landfill, with these species relying on various food resources available at and around the landfill. These species belong to 8 orders and 11 families.

Among them, the four most abundant species foraging at the landfill were the House Sparrow (*Passer domesticus*) with 97 individuals, the Black Kite (*Milvus migrans*) with 67 individuals, the Cattle Egret (*Bubulcus ibis*) with 42 individuals, and Laughing Dove (*Spilopelia senegalensis*) with 36 individuals. This suggests that these species are the primary exploiters of food resources at the landfill.

The families with the highest numbers of different species observed were Ardeidae, Passeridae, and Apodidae (Refer to **Table 1**). The species' conservation status is outlined in **Table 2**, indicating that all species are classified as least concern, except for the Egyptian Vulture (*Neophron percnopterus*), which is classified as endangered.

Throughout the study period, instances of dead birds were recorded, including collisions and electrocutions of white storks observed along transmission lines at various sites near the landfill. Surveys around the Tayba landfill are necessary to identify hazardous power lines that may need replacement or implement possible mitigation measures on power lines running parallel and close to the Tayba landfills.

While only one endangered species, the Egyptian Vulture (*Neophron percnopterus*), has been observed utilizing the waste sites within the study area, it is important to note that this vulture species typically intensively utilizes feeding sites and garbage dumps. Moreover, frequent carcass disposal was observed at the garbage dump in the study area, potentially increasing the attractiveness of the site to vultures. However, this attractiveness varied with the seasons. Garbage dumps, especially those mixing organic wastes with carcasses, were observed to attract Vultures, Black Kites, and Storks, with the latter being particularly prominent due to their population size.

6. Conclusions

In summary, this research contributes valuable insights to our understanding of the diversity of birds, their habitats, and the natural ecosystems within the study area. The constant and abundant availability of food in landfills can attract a large number of birds. The foraging bird community at Tayba Al Hasanab Landfill is characterized by the House Sparrow (*Passer domesticus*) at 97, Black Kite (*Milvus migrans*) at 67, Cattle Egret (*Bubulcus ibis*) at 42, and Laughing Dove (*Spilopelia senegalensis*). The substantial presence of these species, with their foraging and social behaviors, likely deters other bird species from exploiting food resources in the working area of the landfill, even when there is no overlap in their diets. Despite being a man-made urban ecosystem in a highly urbanized area, the foraging bird community at the landfill exhibits complex ecological relationships among its members.

The findings of this study underscore the importance of considering the seasonal patterns of local and regional bird populations about the location and management practices of landfills.

This study establishes a baseline of information for future studies concerning

the birds in and around Tayba landfill. The abundant availability of food at Tayba landfill attracts several birds. The foraging bird community at the Tayba landfill site is characterized by species diversity and richness, but there is a high abundance and dominance of a few species.

Within the study area, only one endangered species, the Egyptian Vulture (*Neophron percnopterus*), has been observed using the waste sites. Throughout the study period, instances of dead birds, such as white storks, were recorded colliding and electrocuting along transition lines observed at various sites along transmission lines near the landfill. Most of the interviewed people affirmed that they observed birds in the study area.

Effective waste separation practices are vital for protecting bird habitats in urban environments, particularly around open landfill sites like Tayba Al Hasanab in Khartoum, Sudan. By addressing the challenges of infrastructure, public awareness, and policy enforcement, and by investing in research and monitoring, we can mitigate the negative impacts of poor waste management on biodiversity. Collaborative efforts between government bodies, NGOs, and local communities are essential for achieving sustainable waste management and conserving bird habitats.

To mitigate the adverse effects on bird habitats at Tayba Al Hasanab, we propose adopting best practices from conservation strategies to enhance bird diversity, applying these strategies to the landfill context could improve habitat conditions, support biodiversity, and reduce the negative impacts of waste accumulation.

7. Recommendations

1) An annual survey of avifauna at the Tayba landfill is needed to determine the diversity and abundance of birds, as well as their conservation status. Measures should be taken to identify and mitigate hazardous power lines that pose a threat to birds. Implementing these recommendations will help manage the landfill's impact on local bird populations and enhance biodiversity conservation efforts in the area.

2) Organic waste should be collected and separated from inorganic waste; food discards should be used to feed birds at safety points, and the oldest organic waste should be removed to be composted.

3) Invest in infrastructure for waste separation by providing separate bins for different waste types and establishing waste processing facilities to reduce the organic and hazardous waste that attracts birds and degrades their habitats.

4) Raise public awareness about the importance of waste separation and its impact on the environment and biodiversity through educational campaigns and community involvement initiatives to enhance participation in waste management programs.

5) Enforce policies that mandate waste separation at the source and provide incentives for recycling to improve waste management practices, significantly reducing the amount of mixed waste reaching landfill sites.

6) Conduct regular environmental studies to monitor the impact of waste management practices on bird populations and habitats to identify areas for improvement and guide policy decisions.

7) Manipulate the vegetation structure near and around the dump site to avoid visual impact on the landscape and attract potential birdwatching tourists.

8) Remove dead birds regularly to prevent disease transmission.

9) Install perimeter fencing to prevent the access of scavenger mammals and limit interactions between domestic and wild birds, reducing the risk of disease transmission. Fence diverters should be designed to prevent collision incidents.

10) Enhance mechanisms for the disposal of carcasses from slaughterhouses to livestock producers, ensuring health transportation that is easy, fast, and secure.

11) The perimeter of the landfill should be fenced to prevent the access of scavenger mammals and contact between domestic and wild birds to prevent disease transmission. Fence diverters should be designed to prevent collision incidents.

12) To prevent disease transmission, regularly remove dead birds to mitigate disease spread and install perimeter fencing to restrict scavenger mammals and limit interactions between domestic and wild birds.

Acknowledgments

The authors express their sincere gratitude to the colleagues and staff at the Higher Council of Environment and Urban and Rural Promotions for their encouragement and support. Thanks also are expressed to the landfill authority and waste collectors for their invaluable contributions.

Authors' Contributions

The final manuscript was read and approved by the authors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Garrido, J.R. and Sarasa, C.G. (1999) Los vertederos como elementos de gestión y conservación de la avifauna. *La Garcilla*, **105**, 10-13.
- [2] Peris, S.J. and Rodriguez, R. (1996) Feeding Habitats of the White Stork *Ciconia ciconia* in a Newly Created Wetland in SPAIN. *Bird Study*, **43**, 101-105.
- [3] Garrido, J.R., Sarasa, C.G. and Fernández-Cruz, M. (2002) Rubbish Dumps as Key Habitats for Migration and Wintering in the Griffon Vulture (*Gyps fulvus*) in a Migratory Bottleneck. Implications on Conservation. *Proceedings of the World Conference on Birds of Prey and Owls*, Eilat, 2-8 April 2000, 143-151.
- [4] Donázar, J.A., Margalida, A. and Campión, D., Eds. (2009) Vultures, Feeding Stations and Sanitary Legislation: A Conflict and Its Consequences from the Perspective of Conservation Biology. Sociedad de Ciencias Aranzadi.
- [5] Martínez-Abraín, A. and Oro, D. (2013) Preventing the Development of Dogmatic Approaches in Conservation Biology: A Review. *Biological Conservation*, **159**, 539-547. <https://doi.org/10.1016/j.biocon.2012.10.020>

- [6] Isenmann, P. (1978) Le décharge d'ordures ménagères de Marseille comme habitat d'alimentation de la Mouette Rieuse *Larus ridibundus*. *Alauda*, **46**, 131-146.
- [7] Donázar, J.A. (1992) Muladares y basureros en la biología y conservación de las aves en España. *Ardeola*, **39**, 29-40.
- [8] Sampietro, F.J., Pelayo, E. and Cabrera, M. (1997) La importancia de los muladares en la conservación de las rapaces carroñeras de Aragón. *Quercus*, **137**, 18-22.
- [9] Sibly, R.M. and McCleery, R.H. (1983) Increase in Weight of Herring Gulls While Feeding. *Journal of Animal Ecology*, **52**, 35-50. <https://doi.org/10.2307/4586>
- [10] Miller, R.R. and Kiser, S. (2006) Bird Diversity on Landfills in a Mediterranean-Climate Region. *Bird Conservation International*, **16**, 395-407.
- [11] Jones, N. and Coman, B. (2015) The Role of Landfills in Providing Habitat for Bird Species: An Overview. *Journal of Avian Biology*, **46**, 492-503.
- [12] Kougoum Piebeng, G.N., Tamungang, S.A., Wansang, D., Tonleu, J., Soufo, L., Bilal, M., Taku, A.II. and Teguaia, A. (2024) Birds' Diversity in Kalfou Forest Reserve and Its Peripheral Zone, Far North, Cameroon. *Open Journal of Animal Sciences*, **14**, 137-155. <https://doi.org/10.4236/ojas.2024.142010>
- [13] Higher Council for Environment, Urban and Rural Promotion (HCEURP) (2018) Personal Communication. Khartoum, Sudan.
- [14] Ali FAH (2017) Evaluation of Solid Waste Management in Khartoum State and Selection of Landfill Sites, Using GIS Technique, Sudan University of Science and Technology. <http://repository.sustech.edu/handle/123456789/16460>
- [15] Mawya (2021) Department of Environmental Impact Assessment and Authorization, Higher Council of Environment, Urban and Rural Promotion.
- [16] Khaleel, H.A. and Saeed, R.T. (2021) Environmental Impact of Open Landfills in Sudan. *Sudanese Journal of Environmental Studies*, **8**, 45-59.
- [17] United Nations Environment Programme (2019) Waste Management Practices and Their Impact on Urban Wildlife. Nairobi.
- [18] Williams, R.B. and Jones, M.T. (2022) The Role of Public Participation in Waste Management. *Waste Management Research*, **40**, 235-249.
- [19] Parker, W. and Hopewell, J. (2020) Waste Management and Urban Bird Conservation. *Journal of Environmental Management*, **275**, 111-123.
- [20] Abu Sin, M.E. and Davies, H.R.J., Eds. (2002) The Future of Sudan's Capital Region: A Study in the Development and Change. Khartoum University Press.
- [21] Chace, J.F. and Walsh, J.J. (2006) Urban Effects on Native Avifauna: A Review. *Landscape and Urban Planning*, **74**, 46-69. <https://doi.org/10.1016/j.landurbplan.2004.08.007>
- [22] Cook, A., Rushton, S., Allan, J. and Baxter, A. (2008) An Evaluation of Techniques to Control Problem Bird Species on Landfill Sites. *Environmental Management*, **41**, 834-843. <https://doi.org/10.1007/s00267-008-9077-7>
- [23] Shochat, E., Lerman, S.B., Anderies, J.M., Warren, P.S., Faeth, S.H. and Nilon, C.H. (2006) Invasion, Competition, and Biodiversity Loss in Urban Ecosystems. *BioScience*, **56**, 199-208. <https://doi.org/10.1525/bio.2010.60.3.6>
- [24] Fernández-Juricic, E. and Jokimäki, J. (2001) A Habitat Island Approach to Conserving Birds in Urban Landscapes: Case Studies from Southern and Northern Europe. *Biodiversity and Conservation*, **10**, 2023-2043. <https://doi.org/10.1023/A:1013133308987>
- [25] Orłowski, G. (2008) Factors Affecting Road Mortality of the Barn Swallow *Hirundo*

- Rustica in Farmland. *Acta Ornithologica*, **43**, 209-217.
- [26] Burger, J. (2001) Landfills, Nocturnal Foraging, and Risk to Aircraft. *Journal of Toxicology and Environmental Health, Part A*, **64**, 273-290.
<https://doi.org/10.1080/15287390152543735>
- [27] Thongsoulin, P., Phanthumath, V., Islam, M.S., Thongmanivong, S. and Kang, Y. (2019) The Relationship between Birds Diversity and Habitats in Phou Khao Khouay (PKK) National Park of Lao PDR. *Open Journal of Forestry*, **9**, 143-158.
<https://doi.org/10.4236/ojf.2019.92006>
- [28] de Oliveira, L.V.L. (2013) Avifauna in Areas with Different Stages of Conservation in the Southern Espinhaço. Master's Thesis, Federal University of the Jequitinhonha and Mucuri Valleys.