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Floristic Composition and Vegetation Analysis in Dinder National Park, Southeastern Sudan

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ABSTRACT

Background and Objective: The scientific documentation of qualitative weed vegetation characteristics within a National park provides essential baseline data for informing conservation strategies and shaping biodiversity management policies. The present study aimed to investigate the floristic composition and quantitative analysis of the vegetation structure and distribution of the plant community in Dinder National Park, Southeastern Sudan. **Materials and Methods:** This study presents one of the most comprehensive qualitative and quantitative vegetation analyses conducted in the Dinder National Park, Southeastern Sudan. A random sampling technique was carried out to document the presence of plant species across the studied area and ecological community analysis to assess the structural and functional attributes of the ecosystem. **Results:** The relative frequencies (percentages) of each vegetation category were calculated by using mathematics (numerical analysis). A total of 72 (54% annuals and 46% perennials) weed plant species, distributed across 55 genera and 22 families, were recorded in the study area. The largest family was Poaceae (13 species), followed by Amaranthaceae (9 species). The other notable families included Asteraceae (6 species), Solanaceae, Fabaceae and Malvaceae (5 species each). Species distribution was nearly 60% of species belonging to just 6 families and 8 (36%) families being represented by only a single species. Therophytes were the most prevailing life forms (nearly 56%). Chronological analysis revealed that the Mediterranean (39 species) and Irano-Turanian (34 species) from the major components of the floristic structure. *Cyperus giganteus, Sorghum sudanensis and Xanthium brasilicum* appear to be the dominant species based on high values for IVI, density and cover. According to diversity indices, the natural forests of the area exhibited the highest values for Shannon's and Simpson's indices, indicating a rich and diverse ecosystem. **Conclusion:** The weed composition and diversity in Dinder National Park reflect the broader ecological dynamics of the region. Understanding these aspects is essential for effective Park management and conservation strategies.

KEYWORDS

Floristic composition, vegetation analysis, weed species, species diversity, Dinder National Park, Southeastern Sudan

INTRODUCTION

Floristic diversity is a key component of ecosystem health and function[1]. It encompasses the variety of plant species in a specific area, contributing to the local flora[2]. Taxonomy, concerned with the identification of species, provides a foundation for understanding this diversity[3]. Comprehensive floristic surveys are still essential for fully documenting the plant diversity of a region[4].

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Weeds play a vital role in agroecosystems, significantly enhancing land diversification. Floristic studies are important not only for assessing plant species diversity in a given area but also because many plants offer substantial socioeconomic benefits. Vegetation acts as a dependable indicator of environmental gradients, with the size and composition of plant populations often reflecting underlying environmental patterns. Plant communities are essential for sustainable management, as they promote biodiversity and contribute to environmental conservation[5,6].

Dinder National Park located in Southeastern Sudan, is a significant protected area known for its rich biodiversity and unique ecosystems. Understanding the composition and diversity of weeds in such areas is crucial for conservation efforts and management strategies. Dinder National Park Bordering Ethiopia, approximately 10,000 km^2. This Park is known for its diverse habitats including: (i) *Acacia seyal-Balanites* Ecosystem, which is the woodland or wooded grassland dominated by *Acacia seyal, Balanites aegyptiaca* and *Combretum hartmannianum*, (ii) The Riverine Ecosystem, is found on the silty banks of the Dinder and Rahad Rivers, with multilayered vegetation dominated by *Ficus sycomorus, Hyphaene thebaica, Acacia sieberiana, Stereospermum kunthianum, Tamarindus indica* and *Combretum hartmannianum* and (iii) Mayas Ecosystem, this is an ecosystem characterized by the presence of mayas and pools formed by river meandering and water flow processes. Vegetation includes *Sorghum* species and Chamaecrista *nigricans*[7,8].

This study aimed to examine the floristic composition, including life forms, floristic categories and vegetation types, while also describing community structure through parameters such as frequency, density, cover, abundance and the importance value index (IVI). Additionally, it sought to quantify biodiversity within the community using different diversity indices.

MATERIALS AND METHODS

Study area: This study was carried out in Dinder National Park, Southeastern Sudan. The park concession is situated at Latitude 12°26'N and Longitude 35°02'E and then continues in a Northwestern direction up to Latitude. 12°42'N and Longitude. 34°48'E at Dinder River. The climate of the park is characterized by two seasons: The hot and humid rainy season (May-November) and the cool and dry season (December-March)[7].

Vegetation analysis: Stands area (100×100 m^2) were selected for sampling vegetation in the study area during a course of two years from 2021 to 2022 representing several sites These sites were visited during flowering and fruiting time and through different seasons. Plant specimens have been collected in duplicates. The identification of plants and taxonomic nomenclature of the species in the study area was given[9-14].

The lifeform of each species was listed, as follows: Ch: Chamaephytes, H: Hemicryptophytes, GH: Geophytes-helophytes and th: Therophytes. The phytogeographical range of species distribution was carried out and is coded as follows: ME: Mediterranean, COSM: Cosmopolitan, SA-AR: Sahara-Arabian, Trop: Tropical, S-Z: Sudano-Zambezian, ER-SR: Euro-Siberian, IR-TR: Irano-Turanian, PAL: Palaeotropical and PAN: Pantropical[15].

Data analysis: Ecological methods were adopted to measure the different parameters[16,17].

The IVI was calculated from each plant with the formula:

$$\text{IVI} = \text{Rbc}+\text{Rd}+\text{Rf}$$

$$\text{Relative basal cover (Rbc)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} \times 100$$

$$\text{Relative density (Rd)} = \frac{\text{Number of individual species}}{\text{Number of all species}} \times 100$$

$$\text{Relative frequency (Rf)} = \frac{\text{Number of occurrences of the species}}{\text{Number of occurrences of all species}} \times 100$$

Species diversity (H) and species evenness or equitability (E) were determined according to the Shannon-Wiener function[18].

- **Frequency:** Number of times the plant species was observed
- **Density:** Number of individuals per unit area
- **Abundance:** Measure of the total number of individuals of a species in the sampled area
- **Cover:** Percentage of area covered by a particular species
- **IVI (Importance value index):** Composite index that integrates three attributes: frequency, density and cover, giving an overall estimate of the ecological importance of a species in the study area

Species diversity analysis: Species diversity measurements were determined[19]. The parameters calculated were:

- Shannon-weiner index
- Simpson index
- Reciprocal simpson index
- Menhinick index
- Margalef richness index
- Dominance index
- Berger-parker dominance index
- Inverted berger-parker dominance
- Bugas and gibson index
- Equitability index
- Gini coefficient

The relative frequencies (percentages) of each vegetation category were calculated by using mathematics (numerical analysis indicator).

A total of 72 (54% annuals and 46% perennials) weed plant species, distributed across 55 genera and 22 families, were recorded in the study area Table 1).

The relationship between families and species, according to species diversity within each family, ecological trends and the possible relationships between different plant families[20-23].

Species diversity within families: Table 1 shows that some families contain many species, while others only have one or two species. This variation in species diversity can give insights into the ecological dominance or adaptability of certain plant families in a particular environment.

The Amaranthaceae family has the highest number of species (9 species), indicating that this family may be highly adaptable to various environmental conditions. The dominance of *Amaranthus* species suggests they are widespread and resilient in the ecosystem, possibly thriving in disturbed or nutrient-poor soils.

The Poaceae family also shows high species diversity (13 species). This suggests that grasses play a significant role in this region's ecology, which is consistent with their importance in open, grassy, or savanna-type ecosystems. The wide range of grass species highlights the ability of this family to dominate in different soil types and moisture conditions.

Table 1: Families and species of vegetation, life forms and floristic category type (chronological affinities) of the recorded species in the Dinder National Park, Southeastern Sudan

Family	Plant names	Vegetation type	Life form	Floristic category
Aizoaceae	*Trianthema crystallinum*	*Annual*	Th	ME+ER-SR+IR-TR
	Zaleya pentandra (L.) *Jeffrey*	*Annual*	Th	ME+ER-SR+IR-TR
Amaranthaceae	*Achyranthes aspera* L.	Annual	Th	IT-ES
	Amaranthus blitum L.	Annual	Th	ME+ER-SR+IR-TR
	Amaranthus hybridus L.	Annual	Th	COSM
	Amaranthus graecizans	Annual	Th	COSM
	Amaranthus spinosus L.	Annual	Th	ME+IR-TR
	Amaranthus viridis L.	Annual	Th	COSM
	Amaranthus graecizans ssp. thellungianus (Nevski) Gusev.	Annual	Th	COSM
	Chenopodium album L.	Annual	Th	COSM
	Chenopodium murale L.	Annual	Th	COSM
Apocynaceae	*Leptadenia arborea* (Forssk.) Schweinf.	Perennial	Ph	ME+IR-TR
Asteraceae	*Ageratum conyzoides* L.	Annual	Th	SA-AR
	Eclipta prostrata (L.) L.	Annual	H	SA-AR
	Pluchea dioscoridis (L.) DC.	Perennial	H	SA-AR+IR-TR
	Pulicaria undulata subsp. *undulata*	Perennial	H	SA-AR+IR-TR
	Pulicaria crispa	Perennial	H	SA-AR+IR-TR
	Xanthium strumarium L.	Annual	Th	Trop
Boraginaceae	*c*	Annual	Th	COSM
	Heliotropium sudanicum F.W.Andrews	Annual	Th	COSM
	Heliotropium supinum L.	Annual	Th	COSM
Brassicaceae	*Farsetia aegyptia* Turra.	Annual	Th	ME ER-SR
	Rorippa indica (L.) Hiern	Annual	Th	ME+ER-SR
Capparaceae	*Cleome gynandra* L.	Annual	Th	COSM
	Cleome spp.	Annual	Th	ME+ER-SR
Convolvulaceae	*Convolvulus prostratus* Forssk.	Perennial	H	Trop
	Ipomoea wightii (Wall.) Choisy	Perennial	H	ME+IR-TR
	Ipomoea cordofana Choisy	perennial	H	ME+IR-TR
	Ipomoea aquatica Forssk.	perennial	H	ME+IR-TR
Cucurbitaceae	*Cucumis dipsaceus* Ehrenb. ex Spach	Annual	Th	COSM
Cyperaceae	*Cyperus difformis* L.	Perennial	Gh	ME+IR-TR
	Cyperus rotundus L.	Perennial	Gh	ME+IR-TR
	Pycreus mundii Nees	Perennial	Gh	ME+IR-TR
	Kyllinga alba Nees	Perennial	Gh	ME+IR-TR
Fabaceae	*Chamaecrista nigricans*	Perennial	Th	ME
	Mimosa pigra L.	Perennial	Th	COSM
	Rhynchosia ferruginea A. Rich.	Perennial	Ph	ER-SR+ME+IR-TR
	Rhynchosia minima (L.) DC.	Perennial	Ph	ER-SR+ME+IR-TR
	Sesbania sesban (L.) Merr.	Perennial	Ph	S-Z
Malvaceae	*Abutilon pannosum* (G.Forst.) Schltdl.	Annual	Th	ME+IR-TR
	Abutilon impressum	Annual	Th	ME+IR-TR
	Hibiscus trionum	Annual	Th	ME+IR-TR
	Sida spinosa L.	Annual	Th	ME+IR-TR
	Pavonia burchellii (DC.) R.A.Dyer	Annual	Th	ME+IR-TR
Molluginaceae	*Glinus lotoides* L.	Annual	Th	ME+SA-AR
	Mollugo nudicaulis Lam.	Annual	Th	ME+SA-AR+IR-TR
Onagraceae	*Ludwigia erecta* (L.) H.Hara.	Annual	Th	ME+SA-AR+IR-TR
Poaceae	*Aristida mutabilis* Trin. & Rupr	Perennial	GH	ME+SA-AR+IR-TR
	Brachiaria eruciformis (Sm.) Griseb.	Annual	Th	TR-MA
	Cenchrus ciliaris L.	Perennial	GH	SA-AR+S-Z
	Chloris breviseta Benth.	Perennial	GH	PAL
	Cynodon dactylon (L.) Pers.	Perennial	GH	COSM
	Dactyloctenium aegyptium (L.) Willd.	Annual	Th	COSM
	Digitaria ciliaris	Annual	Th	PAL
	Dinebra retroflexa	Annual	Th	PAL
	Lasiurus scindicus Henrard	Annual	Th	ME+SA-AR+IR-TR
	Tetrapogon cenchriformis (A.Rich.) *Clayton*	Perennial	GH	ME+SA-AR+IR-TR
	Tragus berteronianus Schult.	Perennial	GH	ME+SA-AR+IR-TR

Table 1: Continued

Family	Plant names	Vegetation type	Life form	Floristic category
	Schoenefeldia gracilis Kunth.	Annual	Th	ME+SA-AR+IR-TR
	Setaria barbata (Lam.) Kunth.	Annual	Th	COSM
Polygonaceae	*Persicaria glabra* (Willd.) M.Gomez	Perennial	GH	S-Z
Polygalaceae	*Polygala erioptera* DC.	Annual	Th	ME+SA-AR
Portulacaceae	*Portulaca quadrifida* L.	Annual	Th	COSM
Rhamnaceae	*Ziziphus spina-christi* (L.) Desf.	Perennial	Gh	COSM
Solanaceae	*Datura innoxia* Miller	Perennial	H	ME+ER-SR+IR-TR
	Datura stramonium L.	Perennial	H	ME+ER-SR+IR-TR
	Physalis angulata L.	Perennial	H	ME+ER-SR+IR-TR
	Solanum incanum L.	Perennial	Ch	ME+ER-SR+IR-TR
	Solanum nigrum L.	Perennial	Ch	ME+ER-SR+IR-TR
Tamaricaceae	*Tamarix nilotica*	Perennial	Ph	SA-AR
Zygophyllaceae	*Zygophyllum creticum* (L.) Christenh. & Byng	Perennial	Ch	SA-AR
	Tribulus terrestris L.	Perennial	GH	SA-AR

Chorotype: COSM: Cosmopolitan, PAL: Paleotropical, S-Z: Saharo-Zambezian, ME: Mediterranean, SA-SI: Saharo-Sindian, IR-TR: Irano-Turanian, ER-SR; Euro-Siberian Lifeform: Th: Therophytes, H: Hemicryptophytes, Ch: Chamaephytes, Ph: Phanerophytes and GH: Geophyte-Hemicryptophytes.

Asteraceae (6 species) and Fabaceae, Solanaceae and Malvaceae (5 species each) also have notable diversity, indicating their ecological importance in the studied area. Asteraceous plants suggest adaptation to a range of habitats, while Fabaceous plants likely play a key role in nitrogen enriching the soil.

Other families, such as Cyperaceae and Convolvulaceae, have moderate species representation, suggesting they are also ecologically significant but perhaps more specialized or adapted to specific conditions.

Families like Onagraceae, Polygonaceae, Polygalaceae, Portulacaceae, Tamaricaceae and Zygophyllaceae have only one or two species listed, indicating a more limited presence or specialization in the environment.

Ecological trends: By analyzing the species and their families, this study infers ecological trends related to habitat types, life forms and ecological roles.

The Amaranthaceae family is known for its tolerance to arid conditions and disturbed soils. The dominance of species such as *Amaranthus* suggests that these plants may be pioneers in disturbed habitats, contributing to soil stabilization and resilience in harsh environments. Grasses (Poaceae) are typically dominant in grassland or savanna ecosystems, where they provide essential cover, reduce soil erosion and serve as the primary food source for herbivores. The high diversity of grasses points to the significance of these ecosystems.

The Asteraceae family is generally made up of hardy plants that can survive in various conditions, from wetlands to dry lands. The species listed, such as *Pulicaria* and *Pluchea*, suggest the family's adaptability to different moisture regimes. Fabaceae family is important for its ability to fix nitrogen, enriching the soil and benefiting other plant species. The presence of *Sesbania* and *Rhynchosia* indicates that these species contribute to soil fertility, especially in poor or disturbed soils.

Solanaceous species, such as *Datura* and *Physalis*, are often associated with disturbed areas or environments where competition for resources is high. Their presence may suggest adaptation to environments undergoing stress or change.

Relationship between families: The relationships between plant families could be driven by similarities in ecological functions, habitat preferences or evolutionary history.

Families with similar ecological roles: Families like Poaceae, Amaranthaceae and Fabaceae may cluster together due to their shared dominance in open or disturbed ecosystems. These families represent fast-growing, resilient plants that can survive in nutrient-poor or dry conditions, playing crucial roles in succession after disturbance.

Families with specialized habitats: Families such as Cyperaceae, Convolvulaceae and Cucurbitaceae may cluster together based on their preference for specific habitats like wetlands, sandy soils or riverbanks. Their ecological strategies differ from generalist families but still serve vital niche roles.

Drought-tolerant families: Families like Zygophyllaceae, Tamaricaceae and Capparaceae include species that are highly adapted to arid environments, making them more likely to cluster together in an analysis focused on environmental stressors like drought or saline soils.

Ecological groupings: To arrange the plants based on their ecological habitat, the plants were classified into broad habitat categories such as terrestrial, aquatic, wetland and disturbed areas (including roadsides and agricultural fields). These habitats define the ecological niches where each plant is commonly found.

Terrestrial habitat: This is the most common category and includes a wide variety of families like Amaranthaceae, Aizoacea, Boraginaceae, Brassicaceae, Fabaceae, Malvaceae, Poaceae and Zygophyllaceae. These plants are adapted to survive in dry, open, or even desert-like conditions.

Wetland habitat: Families such as Cyperaceae and Onagraceae contain plants that thrive in moist or wet conditions. Some plants from the Fabaceae and Solanaceae families also show affinity for wet habitats.

Aquatic habitat: Only a few plants, like Ipomoea aquatica from Convolvulaceae, are fully adapted to aquatic environments.

Disturbed or ruderal habitat: These are plants commonly found in human-disturbed environments, such as fields, roadsides and urban settings and include species from Amaranthaceae, Asteraceae, Solanaceae, Poaceae and Portulacaceae.

By grouping the plants in this manner, it can be observed that most species are terrestrial, followed by plants that occupy wetland and disturbed habitats, with fewer aquatic species. This ecological arrangement gives us insight into the habitat preferences and ecological roles of the species listed in Table 1.

RESULTS AND DISCUSSION

The relative frequencies (percentages) of each vegetation category were calculated by using mathematics (numerical analysis). A total of 72 (54% annuals and 46% perennials) weed plant species, were distributed across 55 genera and 22 families. The largest family was Poaceae (13 species), followed by Amaranthaceae (9 species). The other notable families included Asteraceae (6 species), Solanaceae, Fabaceae and Malvaceae (5 species each). Species distribution was nearly 60% of species belonging to just 6 families and 8 (36%) families being represented by only a single species. Therophytes were the most prevailing life forms (nearly 56%). Chronological analysis revealed that the Mediterranean (39 species) and Irano-Turanian (34 species) form the major component of the floristic structure.

Ecological parameters: Table 2 presents various ecological attributes of different plant species, including frequency, density, abundance, cover and importance value Index (IVI).

The abundance data shows that *Cyperus giganteus* and *Sorghum sudanensis* were the most dominant species in the Dinder National Park, with the largest populations. Other species like *Celosia argentea* are also quite populous. This distribution of abundance can inform management practices to maintain biodiversity and monitor dominant species for potential overgrowth or competition issues.

The important value index (IVI) analysis highlights *Xanthium brasilicum, Cyperus giganteus* and *Sorghum sudanensis* as the most ecologically significant weed species in the Dinder National Park, with high levels of dominance across frequency, density and cover. These species shape the weed community and their high IVI values suggest they could influence the overall structure and biodiversity of the ecosystem. Meanwhile, species with moderate to low IVI values still contribute to the community but are less competitive and may require conservation efforts to maintain ecological balance.

Xanthium brasilicum have the highest frequency, indicating it is most important species Cyperus giganteus, *Ipomoea cordofana* and Sorghum *sudanensis* have the highest densities, which suggests these species are more abundant and dominate the area.

Some species have high abundance values, which means they are present in significant numbers such as Sesbania sesban, *Cyperus giganteus*, *Sorghum sudanensis* and *Celosia argentea* Species like *Ipomoea aquatica*, *Cyperus giganteus* and *Sorghum sudanensis* cover more area *Xanthium brasilicum* shows the highest IVI value (96), indicating it is the most important species in terms of frequency, cover and density.

Diversity of weeds in Dinder National Park: Table 3 shows the species diversity of weeds in the study area.

The species diversity indices for weeds in Dinder National Park provide insights into the community structure, species richness, evenness and dominance patterns.

Shannon-Wiener index: This index measures species diversity by considering both species richness (number of species) and evenness (distribution of species). A value of 4.211 is high, indicating that the weed community is very diverse, with many species evenly distributed.

Simpson index: The Simpson index measures the probability that two individuals randomly selected from a sample will belong to the same species. A value of 0.0152 is very low, meaning there is a very small chance that two individuals will be from the same species. This indicates a high level of diversity, with no single species dominating.

Reciprocal Simpson index: The Reciprocal Simpson index is another measure of diversity, with higher values indicating greater diversity. A value of 65.79 confirms the high diversity observed in the community, indicating many species present in nearly equal proportions.

Menhinick index: This index relates species richness to the total number of individuals. A value of 3.885 suggests that the weed community is rich, with a high number of species relative to the number of individuals observed.

Table 2: Ecological parameters of different plant species in the study area

Plant species	Frequency	Density	Abundance	Cover	IVI
Aristida mutabilis Trin. & Rupr.	50	0.67	0	20	70.7
Brachiaria deflexa	50	0	0	20	70.7
Brachiaria ramosa (L.) Stapf	50	0	0	20	70.7
Celosia argentea	50	1.08	2.1	22	73.0
Chrozophora spp.	50	0	0	20	70.7
Cymbopogon nervatus (Hochst.) Chiov	50	0	0	15	65.5
Cymbopogon schoenanthus subsp. *proximus*	50	0	0	20	70.7
Cyperus giganteus	50	1.42	2.9	35	86.4
Dinebra retroflexa	50	0	0	15	65.5
Heliotropium supinum	50	0	0	15	65.5
Hibiscus spp.	50	0	0	15	65.5
Ipomoea cardiosepala	50	1.34	0	20	70.7
Sesbania sesban	50	1.08	2.1	22	73.0
Sorghum sudanense	50	1.42	2.9	35	86.4
Xanthium brasilicum Vell.	75	1.08	0	25	96
Amaranthus spinosus	0	0.5	0	0	0
Ipomoea cordofana	0	1.4	1.4	0	52.3
Cyperus echinatus	0	0	1.4	0	52.3
Dactyloctenium aegyptium	0	0	1.7	0	0
Foeniculum vulgare	0	0	1.7	0	0
Heliotropium sudanicum	0	0	1.7	0	0
Hyparrhenia rufa	0	0	1.7	0	0
Ipomoea aquatica	0	0	1.4	0	52.3
Ischaemum brachyantherum	0	0	1.7	0	0
Kyllinga sp.	0	0	1.7	0	0
Leptadenia heterophylla (Delile) Decne.	0	0	1.7	0	0
Leucas africana	0	0	1.5	0	0
Rottboellia cochinchinensis	0	0	1.5	0	0
Saccharum spontaneum	0	0	1.5	0	0
Schoenefeldia gracilis	0	0	1.5	0	0
Scribus inclinatus	0	0	1.5	0	0
Sporobolus hirsutus	0	0	0	0	65.5
Chloris gayana	0	0	0	0	52.3
Cynodon dactylon	0	0	0	0	52.3
Borreria verticillata	0	0	0	0	65.5

Table 3: Species diversity of weeds in study area in Dinder National Park

Index	Value
Shannon-Weiner index	4.211
Simpson index	0.0152
Reciprocal Simpson index	65.79
Menhinick index	3.885
Margalef's Richness index	13.06
Dominance index	24.94
Berger-Parker Dominance index	0.9825
Inverted Berger-Parker dominance	0.04009
Bugas and Gibson's index	0.8432
Equitability index	0.9611
Gini coefficient	0.3126

Margalef's richness index: This index measures species richness based on the number of species relative to the total number of individuals. A value of 13.06 indicates high species richness in the community, implying that many different species are present.

Dominance index: This index measures the degree to which a few species dominate the community. A value of 24.94 suggests that some species may be slightly more abundant, but it does not indicate overwhelming dominance by a few species.

Berger-Parker Dominance index: This index reflects the proportion of individuals in the most abundant species. A value of 0.9825 suggests that a single species or a few species dominate the community significantly, despite the overall diversity.

Inverted Berger-Parker Dominance index: The inverse of the Berger-Parker Index gives a perspective on diversity. A low value like 0.04009 suggests that, although there is high diversity, a few species are still very dominant.

Bugas and Gibson's index: This index measures the evenness of species distribution. A value of 0.8432 indicates that species abundances are fairly even, with no single species having overwhelming dominance.

Equitability index: The equitability index measures how evenly individuals are distributed among species. A value of 0.9611 is close to 1, showing that species are very evenly distributed, with few dominating the community.

Gini coefficient: The Gini coefficient measures inequality in species abundance. A value of 0.3126 suggests a moderate level of inequality, meaning that while the community is generally even, some species are more abundant than others.

The high Shannon-Weiner Index (4.211) and Reciprocal Simpson Index (65.79) indicate that the weed community in Dinder National Park is highly diverse, with many species present. The high Equitability Index (0.9611) and Bugas and Gibson's Index (0.8432) suggest that species are evenly distributed, with no extreme dominance. Despite the overall diversity, the Berger-Parker Dominance Index (0.9825) indicates that a few species still dominate the weed population. Margalef's Richness Index (13.06) and Menhinick Index (3.885) confirm that the weed community has a high level of species richness. The Gini Coefficient (0.3126) suggests that, although most species are evenly distributed, some are more abundant, leading to moderate inequality in species representation.

The growth pattern of woody plant species without referring to the growing herbs in the Dinder region was studied by Hassaballah[7]. The Dinder National (DNP) park supports a diverse array of fauna and flora that may not be found elsewhere in the region. The composition and diversity of woody species in five different habitats in the DNP[7].

Another research aligns with our study in terms of the dominant plant families and plant diversity. The dominant families were Fabaceae and Poaceae. The phenology of flora revealed 71% of herbs, perennial herbs and shrubs forming 7% each. The annual weeds, grass, perennial grass, sub-shrub and trees represented 3% for each. Conclusion: There was a great diversity in species composition and families. It showed variations in species and families within the same meadow over the years. Also, there were variations in species and families between the meadows[24].

The floristic composition and vegetation structure of Dinder National Park are reflective of the park's diverse ecosystems, influenced by its unique geographical position and climatic conditions. Previous studies on vegetation in arid and semi-arid regions highlight the significant role of climatic factors, particularly rainfall variability, in shaping plant communities. Studies in other regions with similar ecological zones indicate a dominance of Acacia species and grasses as typical vegetation patterns in dryland savannas. The presence of these species in Dinder National Park is consistent with findings from comparable ecosystems in East Africa[20].

Vegetation analysis has demonstrated that species richness is closely linked to edaphic factors, as documented in studies on savanna ecosystems in Kenya and Ethiopia. Researchers have emphasized that areas with varied soil textures and nutrient profiles tend to support a higher diversity of species. For example, the heterogeneity of soils in semi-arid regions has been associated with diverse plant assemblages, which may be evident in the park's diverse habitats, such as riparian zones and grasslands.

Additionally, human activities, including overgrazing and unregulated fire regimes, have been identified as major influences on vegetation dynamics. Similar studies in Sudan and neighboring regions have reported shifts in floristic composition due to anthropogenic pressures, underscoring the importance of effective park management and conservation strategies. For instance, the encroachment of invasive species in other protected areas has been linked to habitat degradation, which is a potential threat in Dinder National Park.

The ecological significance of wetland vegetation, as noted in other studies, is crucial for maintaining biodiversity and supporting wildlife. Research on wetlands in East African parks has shown that these habitats act as biodiversity hotspots, providing refuge and resources for numerous plant and animal species. The documentation of aquatic and semi-aquatic plant species in Dinder National Park aligns with these findings, highlighting the critical role of wetlands in the ecosystem.

Furthermore, previous research on the Shea (*Vitellaria paradoxa*) and other economically significant plant species in African savannas suggests that these species contribute not only to ecosystem services but also to local livelihoods. Similar findings can provide insights into the socio-ecological importance of certain species within the park[21,23,25].

Future research should build on the established literature to explore species-specific adaptations and responses to environmental stressors. A comparative analysis with studies from other savanna parks in the Sahel region would also provide valuable context for understanding the ecological dynamics of Dinder National Park.

CONCLUSION

The study highlights the diverse weed flora of Dinder National Park, with 72 species from 22 families, dominated by Poaceae and therophytes as the prevailing life forms. Mediterranean and Irano-Turanian elements significantly contribute to the floristic structure. The park's natural forests exhibit high biodiversity, as evidenced by robust Shannon and Simpson indices. These findings underscore the importance of strategic conservation efforts to manage invasive species and protect biodiversity. Sustainable management practices, community involvement and international collaboration are essential for preserving the park's ecological integrity and promoting sustainable development.

SIGNIFICANCE STATEMENT

The floristic composition and vegetation analysis of Dinder National Park provide essential baseline data that are crucial for understanding the park's biodiversity and ecological dynamics. By documenting 72 plant species across 22 families, with an emphasis on the prevalence of therophytes and Mediterranean and Irano-Turanian floristic components, this study contributes valuable insights into the plant community structure and its distribution patterns. The study's findings underscore the importance of the park's diverse ecosystems, including its Acacia Seyal-Balanites, Riverine and Mayas ecosystems, for biodiversity conservation. Moreover, the comprehensive analysis of vegetation structure, species dominance and biodiversity indices offers critical information that can guide effective conservation strategies, promote sustainable management and inform future ecological studies in the region.

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