

Composition, Diversity and Structure of Woody Vegetation by Topographic Unit around Temporary Pools in the Ferlo, Senegal

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Abstract

Original Research Article

Temporary ponds constitute distinct ecological units within the forested-pastoral landscape of the sandy Ferlo region, but their role in maintaining the diversity and structure of woody vegetation remains poorly documented. This study aims to compare the composition, diversity, and structure of woody vegetation across three topographic units (pond, slope and plateau) around 19 temporary ponds located in Widou Theingoly, in northern Senegal. Floristic and dendrometric inventories focused on woody species, their structural characteristics, and their regeneration. Floristic richness and diversity were assessed using the Shannon, Pielou, and Jaccard indices. Differences between topographic units were tested using the Friedman test, supplemented by pairwise comparisons with the Wilcoxon test and a Holm correction. A total of 21 woody species were recorded. The pond unit exhibited the highest species richness with 21 species, compared to 8 on the slopes and 9 on the plateaus. Floristic similarity was low between the ponds and the other units, whereas it was high between the slopes and the plateaus. *Balanites aegyptiaca* is the dominant species and contributes most significantly to natural regeneration. Statistical analyses reveal highly significant differences among the topographic units in terms of species richness, density, cover, number of individuals, number of suckers, and distance between individuals ($p < 0.001$). The regeneration rate also differs significantly ($p = 0.004$), while the number of regenerating species does not vary significantly ($p = 0.433$). Pools are thus characterized by richer, denser, and more developed woody vegetation. These results highlight their ecological importance and their significance for the conservation of plant diversity and the monitoring of Ferlo ecosystems.

Keywords: Sandy Ferlo, temporary ponds, woody vegetation, floristic diversity, structure, regeneration, topographic units.

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1. INTRODUCTION

For several decades, the Ferlo has been experiencing a gradual decline in its vegetation cover, resulting in particular from a combination of recurring droughts and pressures on natural resources. This degradation has resulted, among other things, in a decrease in woody vegetation cover and significant mortality of trees and shrubs during periods of low rainfall (Chamard & Courel, 1999 ; Touré et al., 2010). However, this trend is not uniform across the landscape. Certain ecological units offer conditions more favorable to the maintenance of woody vegetation and can thus play a special role in the conservation of plant diversity.

In the pastoral landscape of the sandy Ferlo region, temporary pools are depressions that differ from the surrounding topographic units in terms of their ecological characteristics (Faye et al., 2020a ; 2020b ; 2021). Their position within the terrain promotes the temporary accumulation of runoff water and can create local conditions more favorable to the establishment and maintenance of vegetation. These depressions may thus exhibit establishment conditions that differ from those found on slopes and plateaus, with potential implications for the composition and structure of woody plant communities (Dendoncker & Vincke, 2020 ; Sagna et al., 2024).

The woody vegetation of the sandy Ferlo is also characterized by a high proportion of species adapted to the harsh climatic and edaphic conditions of the Sahel. Species such as *Balanites aegyptiaca* (L.) Delile, *Boscia senegalensis* (Pers.) Lam. ex Poir. and *Calotropis procera* (Aiton) W.T.Aiton are widely represented in the region's vegetation formations (Talla *et al.*, 2020 ; Diallo *et al.*, 2023). However, their distribution and structural importance may vary depending on local conditions. Analyzing the floristic composition, diversity, and structure of plant communities according to topographic units therefore allows for a better characterization of this variability and the identification of the ecological characteristics associated with temporary pools. Pools are thus important elements of the sandy Ferlo landscape, not only because of their hydrological and pastoral functions, but also because of their potential role in maintaining woody vegetation. Previous studies have notably shown better conservation of woody cover around the pools over the past few decades, compared to other landscape units (Faye *et al.*, 2021 ; 2025). These observations raise the question of to what extent ponds actually differ from adjacent topographic units in terms of floristic richness, species composition, and the structure of woody vegetation.

In this context, the present study aims to compare the composition, diversity, and structure of woody vegetation across three topographic units pond, slope, and plateau in the Ferlo region of Senegal. More specifically, it seeks to: (i) characterize the floristic composition of woody stands in the three topographic units ; (ii) compare their species richness and diversity ; (iii) analyze differences in density and cover; and (iv) characterize stand structure through diameter and height

distributions. The objective is thus to better understand the ecological specificity of temporary ponds and their potential contribution to maintaining woody diversity in a Sahelian environment subject to severe climatic and anthropogenic constraints.

2. MATERIALS AND METHODS

2.1. Study Area

The study area is located in the sandy Ferlo region, in northern Senegal, at the heart of the Six Forages Forest-Pastoral Reserve, in the rural commune of Tessékéré, specifically in the village of Widou Thiengoly (Figure 1). This region is an important pastoral area and is characterized by a semi-arid steppe climate according to the Köppen-Geiger classification (Kottek *et al.*, 2006), marked by a long dry season and a short rainy season. Observations were conducted around 19 temporary waterholes.

The study area features relatively gentle terrain and predominantly sandy soils. The average annual rainfall is 371.67 mm (Ndiaye *et al.*, 2014), calculated over a 50-year period, while the average annual temperature is estimated at 27.73 °C (Ndiaye *et al.*, 2013). The dry season lasts approximately nine months, and the rainy season lasts approximately three months (Ngom *et al.*, 2014).

The landscape is characterized by numerous endorheic depressions that fill temporarily during the rainy season. These pools constitute distinct ecological units within the pastoral landscape of the Ferlo. The vegetation consists mainly of shrubby and wooded steppe formations.

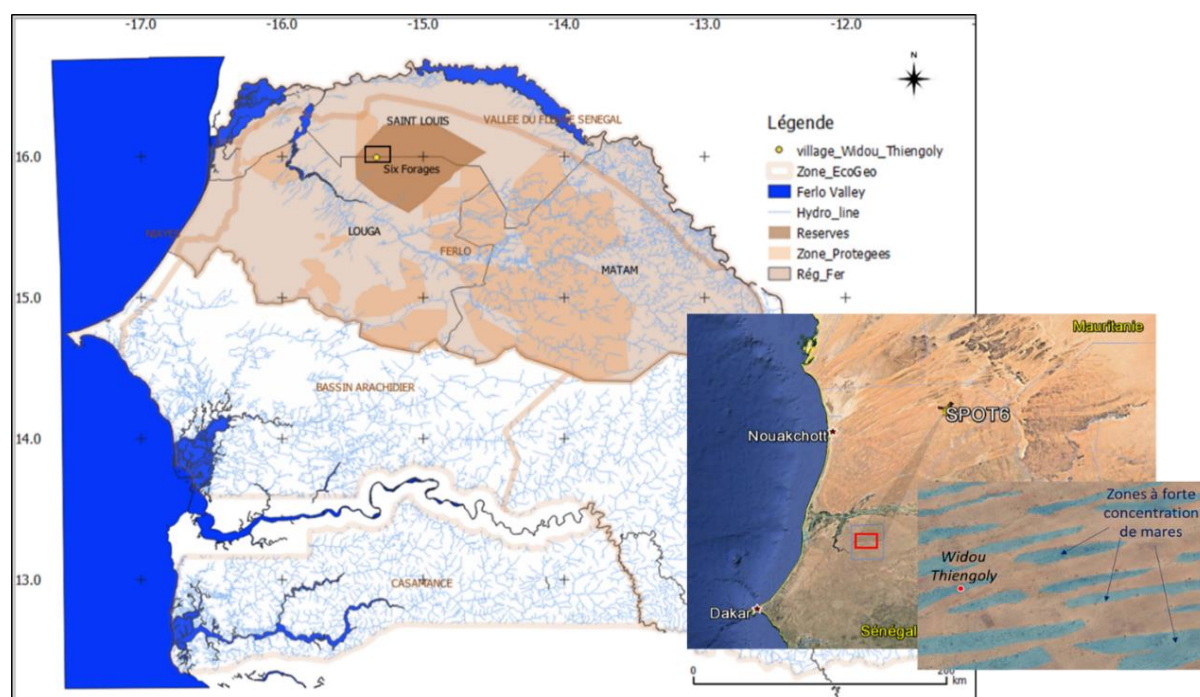


Figure 1. Geographic Location of Ferlo and Location of the Study Area

2.2. Research Equipment and Topographic Units

The study focused on 19 temporary ponds. Three topographic units were identified around these ponds:

- The pond unit, corresponding to the depression;
- The slope unit, corresponding to the intermediate zone between the pond and the higher-elevation areas;
- The plateau unit, corresponding to the topographically highest areas.

This classification allowed for a comparison of the composition, diversity, and structure of woody vegetation based on topographic location.

2.3. Inventory of woody vegetation

A floristic and dendrometric inventory was conducted to characterize the woody vegetation in the three topographic units. The geographic coordinates of the sites were recorded using a GPS. In the “mare” unit, woody plants were inventoried directly in the field. Individuals with a diameter measured 0.30 m above the ground greater than 3.5 cm were classified as woody (Diallo, 2011 ; Sylla, 2020).

In the slope and plateau units, the inventory was conducted on 2,500 m² plots spaced 10 m apart and georeferenced (Boudet, 1984 ; Ndiaye, 2013).

For each individual tree surveyed, the trunk diameter, total height, and crown dimensions were recorded. Young trees with a diameter at 0.30 m of less than 3.5 cm were included in the regeneration analysis.

Species identification was based on the botanical references used in the study, notably the Flora of Senegal by Berhaut (1971-1979) and the Illustrated Flora of Senegal by Vanden Berghen (1988). The names were updated using the “Enumeration of Flowering Plants of Tropical Africa” by Lebrun & Stork (1991-1997).

2.4. Data Analysis and Processing

The collected data were organized according to the three topographic units studied: pond, slope, and plateau. The analyses focused on species richness, structural parameters of woody vegetation, and regeneration parameters.

Floristic composition was characterized based on species richness and species frequency. Species diversity was assessed using the Shannon & Weaver index (1963), and evenness was assessed using the Pielou index (1966). Floristic similarity among the topographic units was assessed using the Jaccard index.

The importance of different species within the stands was assessed using their importance value index (IVI). The contribution of species to regeneration was also evaluated using the specific regeneration index (ISR).

Stand structure was also analyzed through the distribution of individuals by diameter and height classes, in order to compare stand structure among the lake, slope, and plateau units, as well as based on the main dendrometric parameters measured in the field: density, average distance between individuals, crown cover, and regeneration rate.

Descriptive statistics were used to characterize the various parameters in each topographic unit. The results are presented as mean $\pm$ standard deviation. The parameters analyzed include species richness, number of individuals, density, cover, number of cuttings, number of regenerating species per area, regeneration rate, and average distance between individuals.

Since the floristic surveys were conducted in all 19 ponds, the parameters available for all sites were analyzed across the 19 ponds. However, certain dendrometric measurements could not be taken in six of the ponds (M14 through M19) due to the presence of a deep layer of water at the time of the surveys. Comparisons between the three topographic units for these parameters were therefore conducted on the 13 ponds (M1 to M13) for which complete data were available for the pond, the slope, and the plateau.

Given the paired nature of the design where the three topographic units belonging to the same pond constitute dependent observations differences between the pond, the slope, and the plateau were assessed using the nonparametric Friedman test. When the overall test was significant, pairwise comparisons were performed using the Wilcoxon test for paired samples, with a Holm correction to account for multiple comparisons. The significance threshold was set at 5% ($p < 0.05$). Statistical analyses and graphical representation of the results were performed using R/RStudio.

3. RESULTS

3.1. Floristic Composition and Diversity

The inventory of woody vegetation identified 21 species, belonging to several botanical families and genera, across all the topographic units studied. However, the floristic composition varies greatly depending on topographic location.

The marsh unit exhibits the highest species richness, with 21 species recorded. It thus encompasses all species identified in the study area. In contrast, species richness is significantly lower in the other two units, with 8 species in the slope unit and 9 species in the plateau unit (**Table I**).

A comparison of the floristic composition thus reveals a clear differentiation between the pond unit and the topographic units located on the slopes and plateaus. Several species are common to all three units, while others are found exclusively in the pond unit.

The most commonly encountered species throughout the study area include *Balanites aegyptiaca*, *Boscia senegalensis*, and *Calotropis procera*. These three species are present in the various topographic units and play a significant role in the composition of the plant communities.

The floristic composition thus reveals a high level of species richness in the ponds, while the slopes and plateaus exhibit a poorer woody flora, characterized more by a limited number of common species. The floristic composition table presents the detailed distribution of species across the three topographic units.

Table I. Floristic composition of the study area (+ species present; - species absent)

Families	Species	Pond	Slope	Plateau
ANACARDIACEAE	<i>Sclerocarya birrea</i> (A. Rich.) Hochst.	+	+	+
ASCLEPIADACEAE	<i>Calotropis procera</i> (Aiton) W.T.Aiton	+	+	+
	<i>Leptadenia hastata</i> (Pers.) Decne.	+	+	+
	<i>Leptadenia pyrotechnica</i> (Forssk.) Decne.	+	+	+
BALANITACEAE	<i>Balanites aegyptiaca</i> (L.) Delile	+	+	+
CAPPARIDACEAE	<i>Cadaba farinosa</i> Forssk.	+	+	+
	<i>Boscia senegalensis</i> (Pers.) Lam. ex Poir.	+	+	+
COMBRETACEAE	<i>Anogeissus leiocarpa</i> (DC.) Guill. & Perr.	+	-	-
	<i>Combretum aculeatum</i> Vent.	+	-	-
	<i>Combretum glutinosum</i> Perr. ex DC.	+	-	-
	<i>Guiera senegalensis</i>	+	-	-
FABACEAE	<i>Acacia senegal</i> (L.) Willd.	+	+	+
	<i>Acacia seyal</i> Del.	+	-	-
	<i>Acacia tortilis</i> var. <i>raddiana</i>	+	+	+
	<i>Acacia nilotica</i> (L.) Willd. ex Delile	+	-	-
	<i>Bauhinia rufescens</i> Lam.	+	-	-
MALVACEAE	<i>Adansonia digitata</i> L.	+	+	-
MERISPERMACEAE	<i>Tinospora bakis</i> (A. Rich.) Miers	+	-	-
RHAMNACEAE	<i>Ziziphus mauritiana</i> Lam.	+	-	-
RUBIACEAE	<i>Feretia apodanthera</i> Del.	+	-	-
TILIACEAE	<i>Grewia bicolor</i> Juss.	+	-	-
	21 espèces	21	8	9

3.2. Frequency, Abundance of Species and Regeneration

The analysis of specific frequency shows a strong presence of certain species across all topographic units. *Balanites aegyptiaca* has the highest specific frequency, at 57.57% across all topographic units. It is followed by *Boscia senegalensis* at 26.56%. These two species also have high importance value indices at 45.56% and 14.25%, respectively.

In the pond unit, *Balanites aegyptiaca* has a species frequency of 66.10% and an IVI of 44.37%. It is thus the most important species in this unit. It is followed notably by *Adansonia digitata*, whose IVI reaches 13.88%, and *Boscia senegalensis*.

In the slope and plateau units, *Balanites aegyptiaca* also remains an important species. Its IVI is 52.55% in the slope unit and 38.21% in the plateau unit, respectively. However, other species exhibit relatively high importance depending on the unit considered.

The analysis of regeneration shows a significant contribution from three species: *Balanites aegyptiaca*, *Boscia senegalensis*, and *Calotropis procera*. Together, they account for more than 97% of the specific

regeneration index across the entire study area. *Balanites aegyptiaca* alone has an SRI of 84.48%.

Across the various topographic units, *Balanites aegyptiaca* also continues to make a significant contribution to regeneration, with a specific regeneration index (SRI) of 86.89% in ponds, 77.10% on slopes and 63.02% on plateaus. Other species, notably *Acacia tortilis* var. *raddiana*, *Leptadenia pyrotechnica*, and *Leptadenia hastata*, also exhibit regeneration capacity in the study areas. Overall, the results thus highlight the significant contribution of *Balanites aegyptiaca* to the structure and renewal of woody stands, while a few other species contribute to regeneration to a more limited extent depending on the topographic units.

3.3. Floristic Diversity and Similarity

The species richness of the entire study area is 21 species. The Shannon index is 1.85 and the Pielou evenness index is 0.43. The pond also has a species richness of 21 species, with a Shannon index of 1.76 and an evenness index of 0.41. The values recorded in the slope and plateau topographic units are 8 and 9 species, respectively, with Shannon indices of 1.64 and 1.76. The evenness indices are 0.37 and 0.39, respectively (Table II). A comparison of floristic similarity among the

different topographic units reveals low similarity between the pond topographic unit and the other two units. The Jaccard index is 0.40 between the pond and slope and 0.45 between the pond and plateau. In contrast, the similarity between the slope and plateau is high, with a value of 0.89 (Table III).

These results thus demonstrate a differentiation in the floristic composition of the pond compared to the slope and plateau, while the latter two exhibit a floristic composition that is much more similar.

Table II. Floristic Diversity Index for Different Topographic Units

Diversity Parameters	Study area	Pond	Slope	Plateau
S	21	21	8	9
H'	1,85	1,76	1,64	1,76
E	0,43	0,41	0,37	0,39

Specific Presence (S); Shannon Index (H'); Pielou's Evenness (E)

Table III. Similarity Index Among Different Topographic Units

Study area	Pond	Slope	Plateau
Pond	1		
Slope	0,4	1	
Plateau	0,45	0,89	1

3.4. Statistical Comparison of the Structural Characteristics of Woody Vegetation Between Ponds, Slopes and Plateaus

Analysis of structural and regeneration parameters reveals differences in woody vegetation depending on topographic location. Comparisons between ponds, slopes, and plateaus were conducted for the 13 ponds for which data were available simultaneously across all three topographic units. The average species richness is significantly higher in the ponds (7.85 ± 2.85 species) than on the slopes (3.62 ± 1.71 species) and plateaus (3.38 ± 1.39 species). The Friedman test reveals a highly significant difference among the three locations ($\chi^2 = 19.14$; $p < 0.001$). Pairwise comparisons show that species richness is significantly higher in the ponds than on the slopes and plateaus, while no significant difference is observed between the slopes and the plateaus.

The number of spawnings also varies significantly depending on topographic location. It averages 602.54 ± 547.19 spawnings in pools, compared to 145.31 ± 97.25 on slopes and 49.77 ± 43.21 on plateaus. This difference is highly significant ($\chi^2 = 22.62$; $p < 0.001$). Pairwise comparisons reveal significant differences among the three locations, with a decreasing gradient from the pond to the slope and then to the plateau.

In contrast, the number of regenerating species per area does not vary significantly among the topographic units. The mean values are 3.54 ± 1.66 species in the ponds, 3.85 ± 1.41 on the slopes and 3.23 ± 1.30 on the plateau ($\chi^2 = 1.68$; $p = 0.433$).

The density of woody vegetation shows a very marked difference among the three units. It averages 229.50 ± 102.16 individuals/ha in ponds, compared to 33.36 ± 14.24 individuals/ha on slopes and 22.54 ± 11.40 individuals/ha on plateaus. The Friedman test confirms a

highly significant difference ($\chi^2 = 21.38$; $p < 0.001$). Post-hoc comparisons indicate that density is significantly higher in the ponds than on the slopes and plateaus. However, the difference between the slopes and the plateaus is not significant after Holm correction.

Coverage shows a similar trend. It reaches $58.71 \pm 16.27\%$ in the ponds, compared with $7.24 \pm 4.48\%$ on the slopes and $4.58 \pm 3.06\%$ on the plateaus. The difference between the locations is highly significant ($\chi^2 = 19.85$; $p < 0.001$). Ponds exhibit significantly higher coverage than slopes and plateaus, whereas the difference between slopes and plateaus is not significant.

The number of individuals also follows a marked topographic gradient. It averages 140.62 ± 61.31 individuals in the pools, 57.46 ± 30.97 individuals on the slopes, and 32.38 ± 18.32 individuals on the plateaus. The Friedman test reveals a highly significant difference ($\chi^2 = 26.00$; $p < 0.001$). All three pairwise comparisons are significant after Holm's correction, indicating a decreasing gradient from the pond to the slope and then to the plateau.

The average distance between individuals shows the opposite trend. It is 3.06 ± 1.19 m in the pools, 8.06 ± 2.25 m on the slopes and 13.60 ± 6.70 m on the plateaus. The overall difference is highly significant ($\chi^2 = 20.46$; $p < 0.001$). Distances in the pools are significantly shorter than those on the slopes and plateaus. In contrast, the difference between the slopes and the plateaus is not significant after Holm's correction.

The average regeneration rate is $74.54 \pm 13.47\%$ in ponds, $67.96 \pm 12.48\%$ on slopes, and $53.44 \pm 17.14\%$ on plateaus. The Friedman test reveals a significant difference among the three locations ($\chi^2 = 11.23$; $p = 0.004$). Post-hoc comparisons show that the regeneration rate does not differ significantly between

the pond and the slope, whereas it is significantly higher in the pond and on the slope than on the plateau.

Overall, these results (Table IV) highlight a marked differentiation in the structure of woody vegetation depending on topographic position. Pools are characterized by higher species richness, density, cover, number of individuals, and number of suckers (Figures 2

and 3). In contrast, the plateaus have the least dense and most open stands, with a greater average distance between individuals and a lower regeneration rate. Slopes generally occupy an intermediate position. The number of species regenerating via suckers, however, is an exception, as it shows no significant difference among the three topographic units.

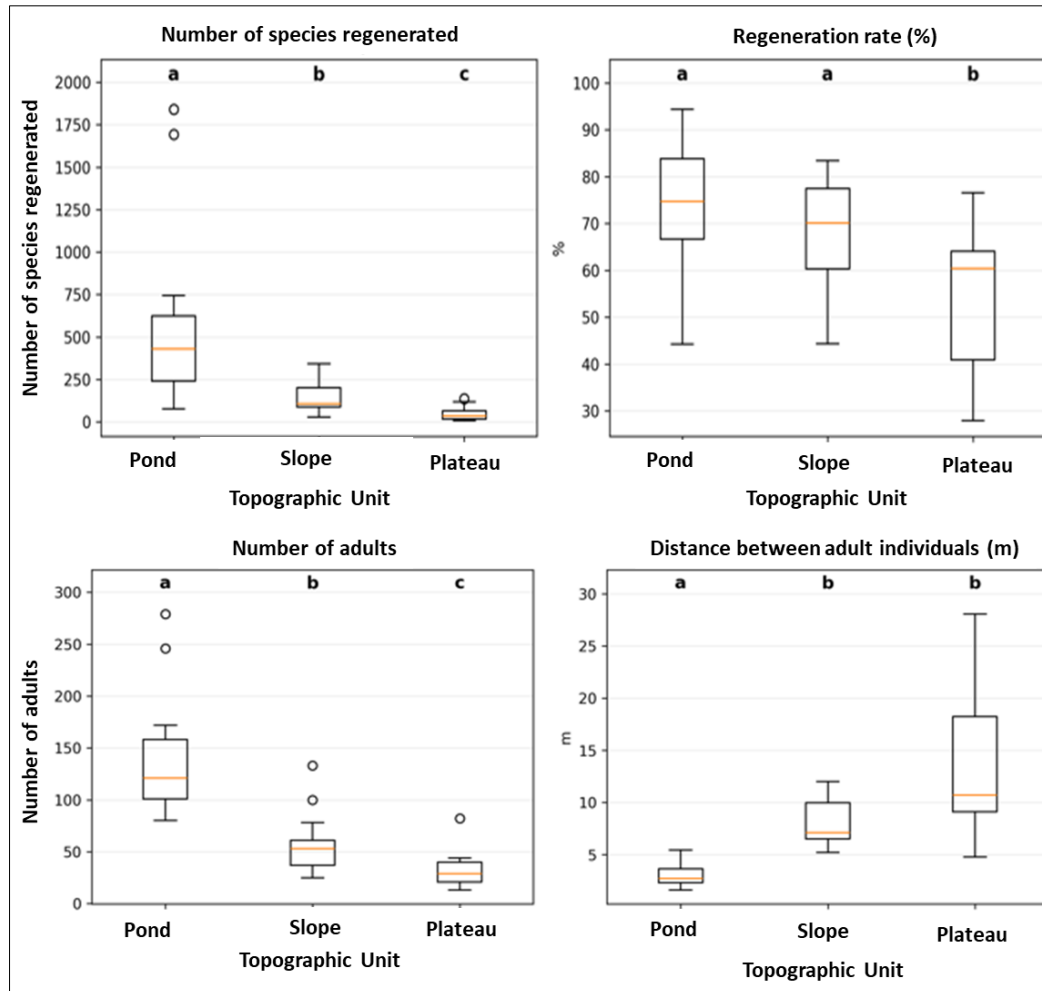


Figure 2: Box plot showing the variation in the number of individuals, the number of cuttings, the distance between individuals, and the regeneration rate by topographic unit

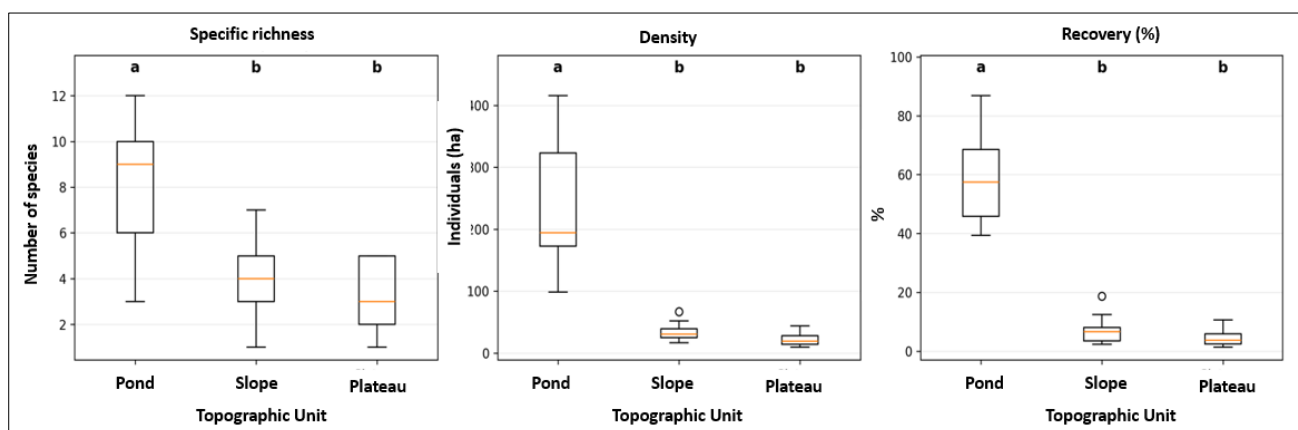


Figure 3: Box plot showing the variation in specific richness, density, and coverage by topographic unit

Table IV: Structural and Regeneration Parameters by Topographic Location

Parameter	Pond	Slope	Plateau	χ^2	p	Comparison
Specific richness	7,85 $\pm$ 2,85	3,62 $\pm$ 1,71	3,38 $\pm$ 1,39	19,14	< 0,001	Pond > S $\approx$ P
Number of rejects	602,54 $\pm$ 547,19	145,31 $\pm$ 97,25	49,77 $\pm$ 43,21	22,62	< 0,001	Pond > S > P
Number of species regenerated	3,54 $\pm$ 1,66	3,85 $\pm$ 1,41	3,23 $\pm$ 1,30	1,68	0,433	NS
Density (units/ha)	229,50 $\pm$ 102,16	33,36 $\pm$ 14,24	22,54 $\pm$ 11,40	21,38	< 0,001	Pond > S $\approx$ P
Recovery (%)	58,71 $\pm$ 16,27	7,24 $\pm$ 4,48	4,58 $\pm$ 3,06	19,85	< 0,001	Pond > S $\approx$ P
Regeneration rate (%)	74,54 $\pm$ 13,47	67,96 $\pm$ 12,48	53,44 $\pm$ 17,14	11,23	0,004	Pond $\approx$ S > P
Number of adults	140,62 $\pm$ 61,31	57,46 $\pm$ 30,97	32,38 $\pm$ 18,32	26,00	< 0,001	Pond > S > P
Distance between adult individuals (m)	3,06 $\pm$ 1,19	8,06 $\pm$ 2,25	13,60 $\pm$ 6,70	20,46	< 0,001	Pond < S $\approx$ P

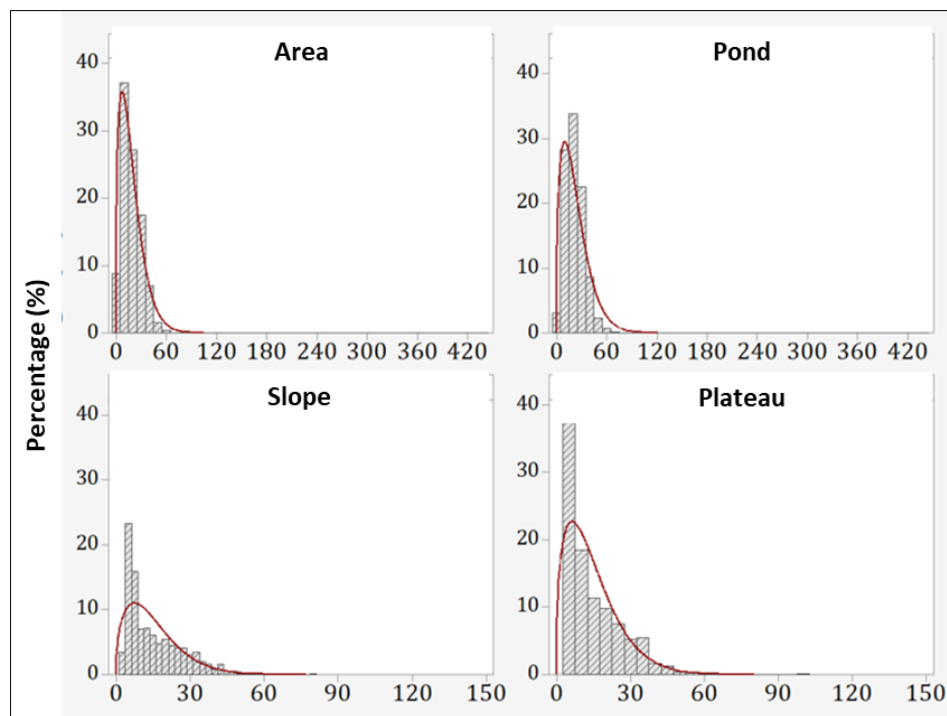
S: Slope

P: Plateau

3.4.1. Distribution of Individuals by Diameter

The diameter distribution is skewed toward smaller values, with a significant proportion of individuals with small diameters across all topographic units. More than 40% of the trees have a diameter of less

than 20 cm. This proportion exceeds 60% in the slope and plateau topographic units. Conversely, in the pond topographic unit, more than 60% of the trees have a diameter greater than 20 cm.

**Figure 2. Distribution of individuals by diameter for topographic units**

3.4.2. Distribution of Individuals by Height

The heights of individual plants range from 1 to 26 m and follow a bimodal distribution, with a first group consisting mainly of shrubs, averaging around 2 m, and a second group consisting of trees, with a mode between 6 and 8 m.

The pond transect unit is characterized by a large number of trees 6 to 10 m tall, along with shrubs

approximately 2 m tall. In the slope and plateau transect units, shrubs are largely dominant compared to trees.

A comparison of the distributions shows that diameters and heights vary by topographic unit. Individuals in the pond generally have the largest diameters and heights, with particularly marked differences compared to the slope and plateau.

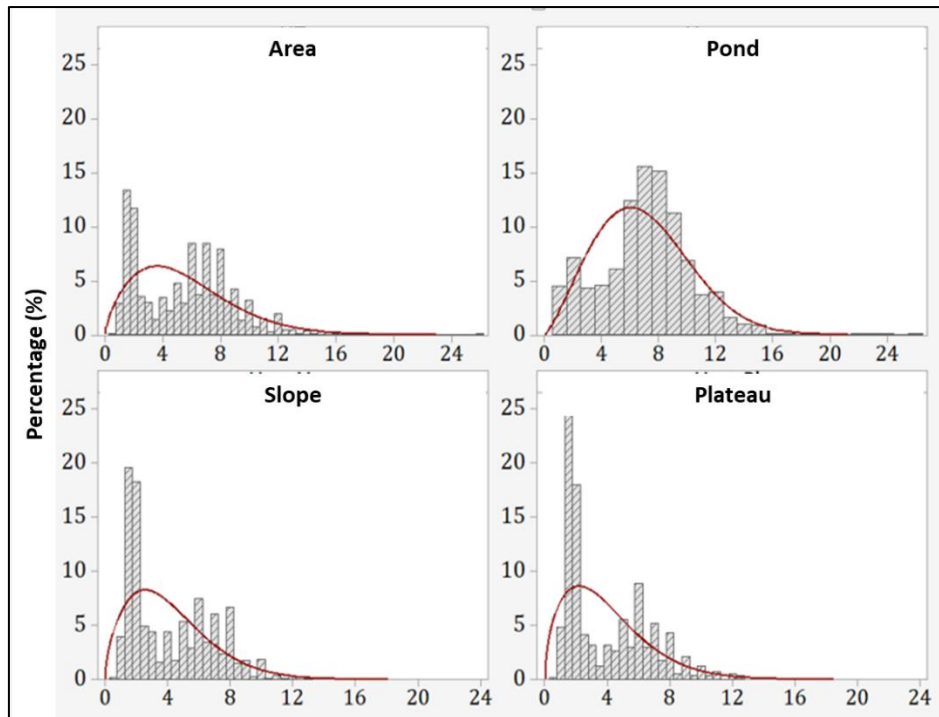


Figure 3: Distribution of Individuals by Height for Topographic Units

4. DISCUSSION

The woody vegetation recorded in the study area comprises 21 species distributed across 16 genera and 11 families. This diversity exceeds that reported by Niang (2009) in the village of Widou Thiengoly, where 10 species belonging to 8 families had been recorded. The floristic composition, however, varies greatly depending on topographic location. The ponds contain all of the recorded species, whereas the slopes and plateaus exhibit significantly lower species richness. The low floristic similarity between the ponds and the other two units in contrast to the high similarity between the slopes and plateaus confirms the floristic distinctiveness of the ponds. This differentiation may be linked to the specific ecological conditions of the depressions, particularly potentially more favorable water availability. However, this interpretation should be treated with caution, as water availability in the pools is temporary and its direct effect was not measured in this study. The presence of several species observed exclusively in the pools also contributes to their floristic distinctiveness. The dominance of *Balanites aegyptiaca*, *Boscia senegalensis*, and *Calotropis procera* in several units reflects their ability to persist under the harsh environmental conditions of the Ferlo (Sarr, 2013 ; Talla *et al.*, 2020).

Balanites aegyptiaca is the most abundant species across all units, with the highest IVI, and also contributes most significantly to natural regeneration. Its strong presence in all three units confirms its importance in the structure of the woody plant communities of the sandy Ferlo region. This dominance is consistent with its ability to thrive under the region's dry conditions, as previously reported by Ndour (1998) and Ndiaye *et*

al., (2013). The presence of other species in the regeneration, notably *Acacia tortilis* var. *raddiana*, *Leptadenia pyrotechnica*, and *Leptadenia hastata*, nevertheless shows that stand renewal does not rely exclusively on a single species.

Differences in vegetation structure are particularly pronounced across topographic units. Statistical results show that the ponds exhibit significantly higher species richness, density, cover, number of individuals, and number of suckers than the slopes and plateaus, while the distance between individuals is shorter in the ponds. The diameter and height distributions also confirm the greater development of stands in the pools, which contain more large individuals. Conversely, slopes and plateaus are characterized by more open stands dominated by smaller individuals.

The concentration of biodiversity and the most developed woody stands in the ponds thus highlights their ecological distinctiveness within the Ferlo's forest-pastoral landscape (Sagna *et al.*, 2024). The specific conditions of these depressions may favor the maintenance of more diverse and developed vegetation (Faye *et al.*, 2020a ; 2020b), but their respective contributions cannot be precisely determined based solely on the available data. Nevertheless, the pools are important units for the conservation of tree diversity and deserve special attention in strategies for managing and monitoring vegetation in the Ferlo.

5. CONCLUSION

This study highlights the ecological distinctiveness of temporary ponds in the sandy Ferlo's

forest-pastoral landscape. Topographic location appears to be an important factor in the differentiation of woody vegetation, with the ponds forming distinct units from the slopes and plateaus.

Beyond their hydrological and pastoral functions, these pools should therefore be considered as areas that contribute to maintaining biodiversity and fostering the development of woody vegetation. Their conservation should be integrated into strategies for the sustainable management of natural resources in the Ferlo, particularly in efforts related to restoration, habitat protection, and vegetation monitoring.

The implementation of regular ecological monitoring would provide a better understanding of the dynamics of these stands and help identify the factors responsible for their differentiation. Such monitoring should specifically include water availability, edaphic characteristics, grazing pressure, and other anthropogenic factors likely to influence vegetation composition and structure.

Further research on the long-term dynamics of regeneration, the herbaceous layer, and the interactions between vegetation, soil, water, and pastoral land use would also help improve our understanding of the ecological functioning of temporary ponds. This knowledge could help define management and conservation measures tailored to these unique ecological units in the Ferlo.

BIBLIOGRAPHIC REFERENCES

- Berhaut, J. (1971). Flore illustrée du Sénégal. Gouvernement du Sénégal, Ministère du développement rural, Direction des eaux et forêts, 644p.
- Boudet, G. (1984). L'exploitation des parcours et la conduite des troupeaux dans les systèmes d'élevage. Les Cahiers de La Recherche-Développement, 3(4), 97-101.
- Chamard, P. C., & Courel, M. F. (1999). La forêt sahélienne menacée. Sécheresse, 10(1), 11-18.
- Dendoncker, M., & Vincke, C. (2020). Low topographic positions enhance woody vegetation stability in the Ferlo (Senegalese Sahel). Journal of Arid Environments, 175, 104087.
- Diallo, A., Faye, N., Sylla, D., Sagna, M. B., Badji, E. S., Kébé, I., Guissé. (2023). Structure et dynamique de la végétation ligneuse des plantations d'Acacia senegal (L.) Willd dans la zone sylvopastorale. Journal of Animal & Plant Sciences / 57(3) : 10565 -10583. DOI: <https://doi.org/10.35759/JAnmPLSci.v57-3.3>
- Diallo, A, Faye, M., Ndiaye, O., & Guisse, A. (2011). Variations de la composition de la végétation herbacée des plantations d'Acacia senegal (L.) Willd de la zone de Dahra (Ferlo). International Journal of Biological and Chemical Sciences, 5(3), 1250–1264.
- Faye, N., Talla, R., Ndong, A. T., Sagna, M. B., Sylla, D., *et al.*, (2025). Ponds as Ecological Refuges : Dynamics of Woody Vegetation in Ferlo (1972–2016). Am. J. Remote Sens. 2025, 13(2), 110-120. DOI: 10.11648/j.ajrs.20251302.15
- Faye, N., Diallo, A., Sagna, M. B., Sarr, P. S., Peiry, J. L., & Guisse A. (2021). Influence of anthropic and eco-hydrological factors on the floristic diversity of the herbaceous vegetation around the temporary ponds in Ferlo, Northern Senegal. Journal of Plant Ecology, 15(1), 26-38. DOI: 10.1093/jpe/rtab053
- Faye, N., Diallo, A., Sagna, M. B., Sarr, O., Talla, R., Badji, E. S., Peiry, J. L., & Guisse A. (2020a). Répartition spatiale de la végétation herbacée autour des mares temporaires : Influence des facteurs anthropiques et topographiques à WIDOU THIENGOLY (Ferlo, Nord-Sénégal). International Journal of Biological and Chemical Sciences, 14(6), 2077–2093. DOI: 10.4314/ijbcs.v14i6.12
- Faye, N., Diallo, M. D., Peiry, J. L., Diallo, A., & Guisse, A. (2020b). Influence of Anthropic and Topographic Factors on the Physicochemical, Properties of the Soil around Temporary Pools in Ferlo, North Senegal. International Journal of Plant & Soil Science, 26–40. DOI: <https://doi.org/10.9734/ijpss/2020/v32i730302>
- Kottek, M., Grieser, J., Beck, C., Rudolf, B., & Rubel, F. (2006). World Map of the Köppen-Geiger climate classification updated. Meteorologische Zeitschrift, 15(3), 259–263.
- Laurent, J.-Y., & Brossard, M. (1991). Etude comparée de la détermination du phosphore total de sols tropicaux. Cah. ORSTOM, Sér. Pédol, 26(3), 281–285.
- Ndiaye, O, Diop, A., Akpo, L. E., & Diène, M. (2014). Dynamique de la teneur en carbone et en azote des sols dans les systèmes d'exploitation du Ferlo: Cas du CRZ de Dahra. Journal of Applied Biosciences, 83, 7554– 7569.
- Ndiaye, Ousmane, Aly, D., Bassimbé, S. M., & Aliou, G. (2013). Diversité floristique des peuplements ligneux du Ferlo, Sénégal. VertigO, 13(3), 1–2.
- Ndour, N. (1998). Analyse de la flore et de la végétation de la rive et du lac de guiers (Nord du Sénégal) [Mémoire de DEA] 51p.
- Niang, K. (2009). L'arbre dans les parcours communautaires du Ferlo-Nord (Sénégal) (p. 68) [Memoire D'étude Approfondie (Dea) De Biologie Vegetale]. Laboratoire d'écologie végétale et d'écohydrologie 69p.
- Ngom, D, Charahabil, M. M., Sarr, O., Bakhoum, A., & Akpo, L. E. (2014). Perceptions communautaires sur les services écosystémiques d'approvisionnement fournis par le peuplement ligneux de la Réserve de Biosphère du Ferlo (Sénégal). VertigO, 14(2), 1-18.

18. Pielou, E. C. (1966). The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology*, 13, 131–144.
19. Sagna, M.B., Thiam, A.N., Niang, K., Sarr, O., Diallo, A., Diatta, S., Ngom, D. and Guissé, A. (2024). Influence of Topography on the Distribution and Structure of Woody Plants in the Senegalese Sahel (Sandy Ferlo). *American Journal of Plant Sciences*, 15, 14-28. <https://doi.org/10.4236/ajps.2024.151002>
20. Sarr, O. (2013). *Gestion Des Ligneux Fourragers Dans Un Axe De Transhumance De Saison Seche Au Senegal (cas De La Région De Kaffrine)* [Biologie, Productions et Pathologies Animales]. UCAD, 110p.
21. Shannon, C. E., & Weaver, W. (1963). *The Mathematical Theory of Communication*. University of Illinois Press, 148p.
22. Sylla, D. (2020). *Conservation des aires protégées au Ferlo: Cas de la réserve de Biosphère et la réserve Sylvo-pastorale des six forages* [Thèse de doctorat Spécialité : Ecologie et Agroforesterie]. UCAD, 201p.
23. Talla, R., Sagna, M. B., Diallo, M. D., Diallo, A., Faye, N., Sarr, O., Badji, E. S., Diatta, S., Ngom, D., & Guisse, A. (2020). Population Structure and Toposequence Distribution of *Boscia senegalensis* (Pers.) Lam. Ex *Poir* and *Sclerocarya birrea* (A. Rich) Hoscht in the Ferlo (Senegal). *Journal of Plant Sciences*, 8(5), 167–176. DOI: 10.11648/j.jps.20200805.19
24. Touré, A. A., Guillon, R., Garba, Z., Rajot, J.L., Petit, C., Bichet, V., Durand, A., & Sebag, D. (2010). Evolution des paysages Sahéliennes au cours des six dernières décennies dans la région de Niamey: De la disparition de la brousse tigrée à l'encrouement de surface des sols. *Sahelian landscape evolution during the six last decades in the Niamey vicinity: From the tiger bush disappearing to the soil crusting*. *Pangea*, 47(48), 35-40.