Recursos Rurais (2023) nº 19 : 55-66
IBADER: Instituto de Biodiversidade Agraria e Desenvolvemento Rural
ISSN 1885-5547 - e-ISSN 2255-5994

Artigo

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Floristic and structural characterization of forest communities in different physiographic units, El Dorado - Tumeremo, Bolívar – Venezuela

Recibido: 2 maio 2023 / Aceptado: 23 outubro 2023

Abstract The objective of this work was to identify forest communities in the different physiographic units in the El Dorado-Tumeremo Forest, to evaluate its structure and its floristic composition. Nine 1 ha plots (three for each forest type) were selected and established according to a restricted random design. In each plot, all individuals of tree species with diameter at breast height (DBH ≥ 10 cm) were measured. Several diversity indexes were used to estimate the alpha and beta diversities, as well as the Importance Value Index (IVI). A cluster analysis was carried out to find out if there were floristic similitudes among the forest types. 5462 individuals were surveyed, 38 families, 77 genera and 95 species. The highest values of Fisher alpha (17,77), Shannon (3,44) and Simpson (0,95) index. The average forest density was 606 ind/ha The family Fabaceae was the most represented. In all physiographic units were identified *Lepidocordia punctata, Peltogyne venosa* and *Spondias mombin.* Comments about floristic and ecological aspects are included, and information where these species were found is also presented.

Key words El Dorado-Tumeremo, physiographic units, alpha and beta diversity, forest type, Venezuela

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https://doi.org/10.15304/rr.id9568

Caracterización florística y estructural de comunidades de bosques en diferentes unidades fisiográficas, El Dorado - Tumeremo, Bolívar – Venezuela

Resumen El objetivo de este trabajo fue identificar comunidades de bosques en las diferentes unidades fisiográficas en El Dorado-Tumeremo, para evaluar su estructura y su composición florística. Se seleccionaron nueve parcelas de 1 ha (tres por cada tipo de bosque) y se establecieron de acuerdo a un diseño aleatorio restringido. En cada parcela, se midieron todos los individuos de especies arbóreas con diámetro a la altura del pecho (DBH ≥ 10 cm). Se utilizaron varios índices de diversidad para estimar las diversidades alfa y beta, así como el Índice de Valor de Importancia (IVI). Se realizó un análisis de conglomerados para averiguar si había similitudes florísticas entre los tipos de bosques. Se evaluaron 5462 individuos, pertenecientes a 38 familias, 77 géneros y 95 especies. Los valores más altos del índice Fisher Alfa (17,77), Shannon (3,44) y Simpson (0,95). La densidad forestal promedio fue de 606 ind/ha. La familia Fabaceae fue la más representada. En todas las unidades fisiográficas se identificaron *Lepidocordia punctata*, *Peltogyne venosa* y *Spondias mombin*. Se incluyen comentarios sobre aspectos florísticos y ecológicos, también se presenta información del área donde se encontraron estas especies.

Palabras clave El Dorado-Tumeremo, unidades fisiográficas, diversidad alfa y beta, tipo de bosque, Venezuela

Introduction

Tropical Dry Forests (TDF) comprise 42% of all tropical forests (Murphy and Lugo 1986; Van Bloem et al. 2004; Stan and Sanchez-Azofeifa 2019). Tropical dry forests are also called tropical seasonal forest (Holzman 2008), seasonally dry tropical forests (Mooney, Bullock, & Medina, 1995), tropical broadleaf woodland, (Whittaker 1975). This forest type provides critical habitat for large mammals and

migratory birds, and patches of dry forest can support a high proportion of endemic plant and animal species, as well as being highly valued for agricultural and production forestry uses. They can be found as large continuous tracts, particularly in India, Mexico, eastern South America, northern Australia, and Africa, or in smaller, more local areas (Van Bloem et al. 2004).

Tropical dry forests in Venezuela are mainly distributed in the lowlands at the northern part on the country, principally above 6°N (MARN, 2000). The region is dominated by a tropical climate, with mean annual temperatures over 25°C, and a seasonal rainfall that can vary between 700 and 2500 mm/yr. The duration of the dry season ranges between 3 and 8 months, and the number of dry months decreases gradually along the north-south axis. This type of forest is distributed along several geomorphologic landscapes, including low mountains (< 600 m), hills, plateaus, and an extensive, flat, forest savanna mosaic within The Orinoco River floodplain, locally know as (Llanos) (Fajardo et al. 2005).

The conversion of dense forests into open forests, grasslands to agriculture systems might result in loss of biodiversity and also release large amount of C into the atmosphere. The floristic composition, diversity and vegetation structure are key elements to characterize the anthropogenic activities as well as environmental factors affecting the vegetation and further understanding status of tree population, regeneration, and diversity for prioritizing measures of conservation (Harischandra et al. 2020). Therefore, the present study is conducted to assess the floristic and structural characterization of forest communities in different physiographic units, El Dorado – Tumeremo, Venezuela and so could contribute in the future to the spread and restoration and conservation of these valuable but endangered ecosystems.

Material and Methods

Study area

This study was carried out in one fragment of Tropical Dry Forest (Ewel et al. 1969), located in the municipality of Sifontes (6° 47’ 05” - 7° 01’ 31” N and 61° 30’ 02” - 51° 19’ 35” W) in the Bolívar state of Venezuela. It is a Legal Reserve Area (SVIDB, 2020) and has an approximate area of 5662 ha (Figure 1) with altitudes varying from 100 to 300 m (Andrades-Grassi et al. 2021). The climate of the region is Köppen type Awui (Tropical rainy monsoon, Köppen, 1948), with average temperature 26,7° C. The average annual rainfall is 1565 mm (EMB, 2020). The soils are Colluvial, alluvial and even residual, presents rock´s outcropping and predominantly Ultisols, Entisols to Inceptisols. The area of the forest corresponds according to Holdridge to a “Tropical Dry Forest” (Ewel et al. 1969). The arboreal vegetation present, constitutes in general, three types of associations or forests: Low and Grassy Forest. Among its main species they found: *Hymenaea courbaril, Piranhea longepedunculata, Tabebuia impetiginosa, Tetragastris panamensis, Lepidocordia punctata, Peltogyne paniculata, Pouteria caimito* (Hernández et al. 2007; EMB, 2020).

Vegetation sampling

An ecological interpretation transect was used as a reference (1000 x 10m; 1 ha, Figure 2, Lozada et al. 2007; Lozada et al. 2011), with a North-West orientation, is in turn along an area of 40 ha selected for the study. As restrictions, at least 25 m separation between sampling units (SU) were allowed and the physiographic unit (Summit (S), Slope (SL) and Base (B)) for the SU location had a minimum length of 150 m. In each physiographic units, 3 plots of 100 × 100 m were installed, totalling nine hectares of area sampled. The plots were randomly allocated following the protocol proposed by (Rangel et al. 2021; Rangel et al. 2022), they point out that this size is adequate according to the method´s species-area curve. Each plot was subdivided into four 25 m x 25 m quadrats for easy sampling and to study all species of understory spermatophytes were established 3 sampling sub-units within each sampling units of 10x10m (100 m^2).

Floristics

A quantitative ecological inventory of all trees and lianas with circumference ≥ 10 cm DBH (diameter at breast height 1.3 m above ground) (Vincent et al. 2000), was carried out across nine hectares, comprising three 1-ha plots in each physiographic unit (S, SL, B). In each tree was taking into account the following parameters: species identification, sampling unit, sampling sub-unit, diameter at breast height (DBH in cm), heights (total, shaft and cup in m). When it was not possible to determine the botanical identity of the individuals in situ, the botanical material was collected and later deposited in the Herbarium Dendrologist’s Universidad de Los Andes, Faculty of Forest and Environmental Sciences. For the verification of spelling and nomenclature synonymies, the (Díaz 2013; EMB 2020; WF 2023) were used.

Data analyses

An exploratory data analysis was performed with multiple regressions on the different features. Pearson’s correlation coefficient, histograms and dispersion plots were applied. The phytosociological parameters calculed for each sample plot were: Species Density, Frequency and Relative Dominance, and Importance Value Index (IVI) (Curtis y McIntosh, 1951, García et al. 2021; Quiroga et al. 2019; Rangel et al. 2021); the Family Value Index (FVI) (Pino et al. 2021), the Taxa Index (S), the Individuals, the Simpson Diversity Index (1-D), the Shannon Diversity Index (H’), the Margalef Diversity Index, the Fisher-Alpha Diversity Index, Venn Diagram and Dendrogram (Bray – Curtis) showing floristic similarities (Saavedra-Romero et al. 2019; González

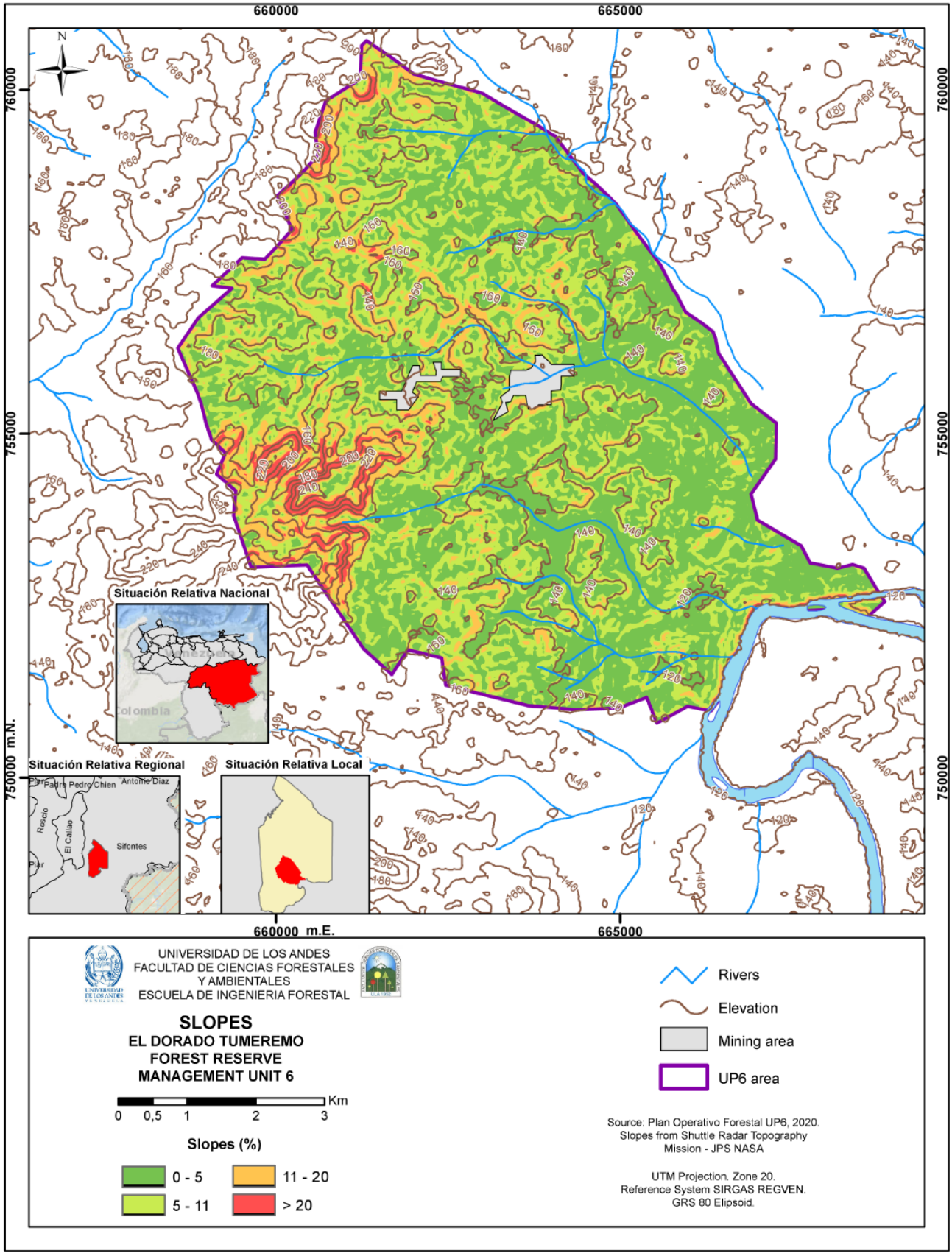

Figure 1.- Relative National, Regional and Local Location, El Dorado – Tumeremo, Bolívar, Venezuela

et al. 2018; Graciano-Ávila et al. 2017). To similarity were calculed: Jaccard Index and Sorensen Index (García-Q. et al. 2021; Guerrero et al. 2020; Moreno et al. 2018). Calculations were made with the use the software Past3 (version 1.0.0.0) and R (version 4.2.2).

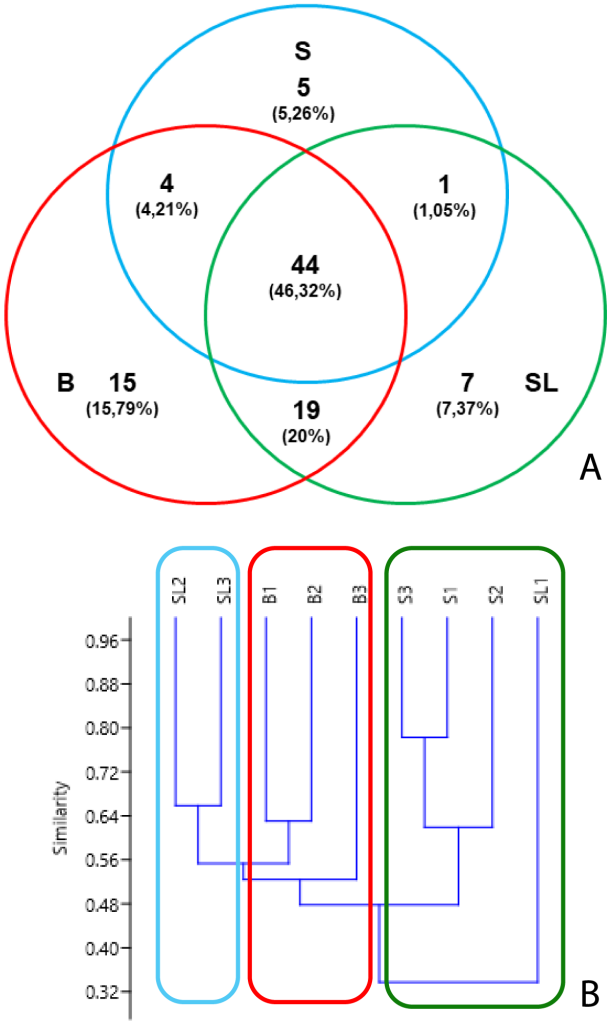

Figure 2.- A) Venn diagram. B) Bray-Curtis Cluster, of the floristic composition of forests by physiographic units, El Dorado – Tumeremo, Bolívar, Venezuela. Note: S: summit; SL: slope and B: base; S1, S2 and S3: physiographic unit Summit plots 1, 2 and 3; SL1, SL2 and SL3: physiographic unit Slope plots 1, 2 and 3; B1, B2 and B3: physiographic unit Base plots 1, 2 and 3

Results

A total of 5462 individuals were sampled corresponding to 95 woody species, 77 genera and 38 botanical families (Table 1). In Summit, 2007 individuals were found, representing 89.3390 m² of basal area (29.7796 m².h-1), distributed in 54 species, 48 genera and 33 families. In Slope, 1726 individuals were found, with 75.2704 m² of basal area (25.0901 m².h-1), distributed in 71 species, 60 genera and 38 families. In Base, 1729 individuals were found, having 87.6910 m² of basal area (29.2303 m² .h-1), distributed in 82 species, 71 genera and 35 families.

In all physiographic units (S, SL and B), *Lepidocordia punctata* had the highest IVI. In Summit, the species *Lepidocordia punctata* (21.98%), *Lonchocarpus sericeus* (11.82%), *Peltogyne venosa* (9.33%), *Sloanea* sp. (7.05%) and *Calliandra* sp. (5.85%), represented 56.03% of the IVI found for the unit, these values of importance are due to the high density of the species (> 140 individuals). In Slope, 51.91% (IVI), *Lepidocordia punctata* (10.10%), *Peltogyne venosa* (8.70%), *Lonchocarpus sericeus* (5.83%), *Chimarrhis cubensis* (5.50%), *Myrcia* sp. (4.62%), *Sloanea* sp. (3.96%%), *Brownea latifolia* (3.42%), *Spondias mombin* (3.38%), *Vitex stahelii* (3.31%), *Calliandra* sp. (3.09%). All those species presented high density (> 55 individuals) and the highest values of relative dominance (> 2.40 m²). In Base, *Lepidocordia punctata* (9.67%), *Myrcia* sp. (6,25%), *Sloanea* sp. (5.88%), *Coccoloba caurana* (5.40%), *Spondias mombin* (5.20%), *Chimarrhis cubensis* (4.58%), *Peltogyne venosa* (4.28%), *Vitex stahelii* (4.11%), *Cordia bicolor* (3.95%), *Torrubia cuspidate* (3.39%), represented 52.72% (IVI) with density (> 60 individuals). The total density and basal area of tree saplings showed no statistically significant differences between the different physiographic units (Table 2A).

In Figure 3A, on the diagonal we can see the distribution of the features with the histograms where we can see that *Peltogyne venosa* species does not have a normal distribution in the heights of the trees and the coordinates north and east show groupings that refer to the distribution of their plots. On the one hand there are a direct relationship between: a) total height and diameter at breast height, b) diameter at breast height and east coordinate, c) total height and north coordinate, d) diameter at breast height and north coordinate. On the other hand, there are inverse relationships between: a) north coordinate and diameter at breast height, b) total height and north coordinate, c) north coordinate and east coordinate. There are no relationships between: a) total height and east coordinate. In Summit (Figure 3A), the highest densities (131-509 individuals) were observed are characterized by trees of small diameter (mean DBH 21,43 cm) and mean height (9.91 m) in species *Lepidocordia punctata*, *Lonchocarpus sericeus*, *Sloanea* sp., *Peltogyne venosa*, *Calliandra* sp.

In Figure 3B, on the diagonal we can see the distribution of the features with the histograms where we can see that *Lepidocordia punctata* species does not have a normal distribution in DBH of the trees and the coordinates north and east show groupings that refer to the distribution of their plots. On the one hand there are a direct relationship between: a) total height and (north and east coordinate, DBH), b) diameter at breast height and (north and east coordinate). On the other hand, there are inverse relationships between: a) north coordinate and (diameter at breast and total height), b) east coordinate and (diameter at breast and total height). In Slope (Figure 3B), were observed trees of small diameter (mean DBH 21,09 cm) with densities (108-179 individuals) and mean height (9.54 m) in species *Chimarrhis cubensis*, *Lepidocordia punctata*, *Lonchocarpus sericeus*, *Myrcia* sp., *Peltogyne venosa.*

Species	Family	C.N.	G.E.
Duquetia sp.	Annonaceae	Yara yara	P
Dyospiros sp.	Ebenaceae	Campon	T
Ecclinusa guianensis Eyma	Sapotaceae	Chicle	T
Eperua jenmanii Oliv.	Fabaceae	Algarrobo rebalsero	T
Erythrina pallida Britton	Fabaceae	Peonio	T
Eschweilera subglandulosa (Steud. ex O.Berg) Miers	Lecythidaceae	Majaguillo	T
Eugenia compta Rich. ex O.Berg	Myrtaceae	Guayabito	T
Fagara schinifolia f. *macrocarpa* Loes.	Rutaceae	Mapurite blanco	T
Ficus orinocensis Pittier	Moraceae	Higueron	T
Genipa caruto Kunth	Rubiaceae	Caruto	T
Guazuma guazuma var. *Ulmifolia* (Lam.) Kuntze	Malvaceae	Guácimo	T
Gustavia augusta L.	Lecythidaceae	Melvul/Melvuo	T
Himatanthus articulatus (Vahl) Woodson	Apocynaceae	Mapolo	T
Hymenaea courbaril var. *courbaril* L.	Fabaceae	Algarrobo	T
Inga alba (Sw.) Willd.	Fabaceae	Guamo	T
Inga heterophylla Willd.	Fabaceae	Guamo pata de morrocoy	T
Inga myriantha Poepp.	Fabaceae	Guamo cimbrapotro	T
Inga sp.	Mimosacea	Guamo rabo de mono	T
Inga splendens Willd.	Fabaceae	Guamo blanco	T
Serjania atrolineata C.Wright	Sapindaceae	Bejuco 7 capas	L
Schnella scala-simiae (Sandwith) Trethowan & R. Clark	Fabaceae	Bejuco cadena	L
Sloanea sp.	Elaecarpaceae	Cabeza de negro blanco	T
Smilax maypurensis Humb. & Bonpl. ex Willd.	Smilacaceae	Bejuco spina de corona	L
Spondias mombin L.	Anacardiaceae	Jobo	T
Stryphnodendron polystachyum (Miq.) Kleinhoonte	Fabaceae	Pilón	T
Stryphnodendron purpureum Ducke	Fabaceae	Josefino	T
Tabebuia capitata (Bureau & K.Schum.) Sandwith	Bignoniaceae	Araguaney	T
Talisia cupularis Radlk.	Sapindaceae	Cotoperiz	T
Talisia guianensis Aubl.	Sapindaceae	Carapa blanco	T
Terminalia amazonia (J.F.Gmel.) Exell	Combretaceae	Pata de danto	T
Tetragastris panamensis (Engl.) Kuntze	Burseraceae	Caraño	T
Torrubia cuspidata (Heimerl) Standl.	Nyctaginanceae	Casabe	T
Trichilia propinqua C.DC.	Meliaceae	Pilon rebalsero	T
Triplaris surinamensis Cham.	Polygonaceae	Santa maria	T
Uncaria guianensis (Aubl.) J.F.Gmel.	Rubiaceae	Bejuco uña de gato	L
Vismia cayennensis (Jacq.) Pers.	Hypericaceae	Lacre	T
Vitex capitata Vahl	Verbenaceae	Guaratare	T
Vitex stahelii Moldenke	Lamiaceae	Totumillo	T
Zanthoxylym martinicense DC.	Rutaceae	Bocsúo	T

Table 1.- List of species found in the floristic survey for El Dorado - Tumeremo, Bolívar, Venezuela. Note: C.N: Comun name; G.E: Ecological Group; T: Tree; L: Liana, P: Palm

Figure 3.- Boxplot, histograms, Pearson's correlation coefficient and dispersion plots, of the floristic composition of forests by physiographic units: A) Summit, B) Slope, C) Base. El Dorado – Tumeremo, Bolívar, Venezuela. Note: spp: species; DAP: diameter at breast height (DBH in cm); AT: total height; N: north coordinate; E: east coordinate; *C.* sp.: *Calliandra* sp.; *C. microcarpa*: *Chimarrhis macrocarpa; C. caucarana: Coccoloba caucarana; L. punctata: Lepidocordia punctata; L. sericeus: Lonchocarpus sericeus; M.* sp.: *Myrcia* sp.; *P. venosa: Peltogyne venosa; S* sp.: *Sloanea* sp

SUMMIT									
	Ai	**Ai%**	**Fi**	**Fi%**	**ABi**	**ABi%**	**IVI**	**IVI%**	**R**
Lepidocordia punctata	509	25,36	95,83	7,55	29,5152	33,04	65,95	21,98	1
Lonchocarpus sericeus	337	16,79	89,58	7,06	10,3839	11,62	35,47	11,82	2
Peltogyne venosa	171	8,52	87,50	6,90	11,2303	12,57	27,99	9,33	3
Sloanea sp.	131	6,53	85,42	6,73	7,0411	7,88	21,14	7,05	4
Calliandra sp.	142	7,08	72,92	5,75	4,2200	4,72	17,55	5,85	5
Torrubia cuspidata	109	5,43	83,33	6,57	2,8161	3,15	15,15	5,05	6
Machaerium acuminatum	86	4,29	75,00	5,91	2,5070	2,81	13,00	4,33	7
Myrcia sp.	106	5,28	68,75	5,42	2,0339	2,28	12,98	4,33	8
Spondias mombin	24	1,20	35,42	2,79	3,6705	4,11	8,10	2,70	9
Tabebuia capitata	33	1,64	52,08	4,11	0,9121	1,02	6,77	2,26	10
Subtotal 10 species	**1648**	**82,11**	**745,83**	**58,78**	**74,3301**	**83,20**	**224,10**	**74,70**	
Subtotal 44 species	**359**	**17,89**	**523,17**	**41,22**	**15,0090**	**16,80**	**75,90**	**25,30**	
Total 54 species	**2007**	**100**	**1269**	**100**	**89,3390**	**100**	**300**	**100**	

SLOPE									
	Ai	**Ai%**	**Fi**	**Fi%**	**ABi**	**ABi%**	**IVI**	**IVI%**	**R**
Lepidocordia punctata	179	10,37	64,58	4,27	11,7906	15,66	30,31	10,10	1
Peltogyne venosa	155	8,98	66,67	4,41	9,5691	12,71	26,10	8,70	2
Lonchocarpus sericeus	147	8,52	62,50	4,13	3,6395	4,84	17,48	5,83	3
Chimarrhis cubensis	136	7,88	68,75	4,55	3,0563	4,06	16,49	5,50	4
Myrcia sp.	108	6,26	70,83	4,68	2,2015	2,92	13,87	4,62	5
Sloanea sp.	61	3,53	68,75	4,55	2,8665	3,81	11,89	3,96	6
Brownea latifolia	73	4,23	62,50	4,13	1,4379	1,91	10,27	3,42	7
Spondias mombin	33	1,91	43,75	2,89	4,0065	5,32	10,13	3,38	8
Vitex stahelii	52	3,01	62,50	4,13	2,1049	2,80	9,94	3,31	9
Calliandra sp.	55	3,19	43,75	2,89	2,4005	3,19	9,27	3,09	10
Subtotal 10 species	**999**	**57,88**	**614,58**	**40,63**	**43,0733**	**57,22**	**155,74**	**51,91**	
Subtotal 61 species	**727**	**42,12**	**898,42**	**59,37**	**32,1971**	**42,78**	**144,26**	**48,09**	
Total 71 species	**1726**	**100**	**1513**	**100**	**75,2704**	**100**	**300**	**100**	

BASE									
	Ai	**Ai%**	**Fi**	**Fi%**	**ABi**	**ABi%**	**IVI**	**IVI%**	**R**
Lepidocordia punctata	154	8,91	77,08	4,56	13,6193	15,53	29,00	9,67	1
Myrcia sp.	177	10,24	79,17	4,69	3,3562	3,83	18,75	6,25	2
Sloanea sp.	111	6,42	81,25	4,81	5,6345	6,43	17,65	5,88	3
Coccoloba caurana	139	8,04	87,50	5,18	2,6279	3,00	16,21	5,40	4
Spondias mombin	54	3,12	64,58	3,82	7,5958	8,66	15,61	5,20	5
Chimarrhis cubensis	101	5,84	81,25	4,81	2,6972	3,08	13,73	4,58	6
Peltogyne venosa	77	4,45	41,67	2,47	5,1841	5,91	12,83	4,28	7
Vitex stahelii	62	3,59	70,83	4,19	4,0003	4,56	12,34	4,11	8
Cordia bicolor	62	3,59	70,83	4,19	3,5677	4,07	11,85	3,95	9
Torrubia cuspidata	61	3,53	62,50	3,70	2,5890	2,95	10,18	3,39	10
Subtotal 10 species	**998**	**57,72**	**716,67**	**42,42**	**50,8719**	**58,01**	**158,15**	**52,72**	
Subtotal 72 species	**731**	**42,30**	**972,91**	**57,58**	**36,8190**	**42,00**	**142,00**	**47,30**	
Total 82 species	**1729**	**100**	**1689,58**	**100**	**87,6910**	**100**	**300**	**100**	

Table 2 A.- Importance Value Index (IVI) for the different species found by physiographic units, in the floristic survey for El Dorado, Tumeremo, Bolívar, Venezuela. Note: Ai: absolute abundance; Fi: absolute frequency; Di: absolute dominance; Ai%: relative abundance; Fi%: relative frequency; Di%: relative dominance; IVI%: Importance Value Index; R IVI%: Range's Importance Value Index

In Figure 3C, on the diagonal we can see the distribution of the features with the histograms where we can see that *Lepidocordia punctata* species does not have a normal distribution in DBH of the trees and the coordinates north and east show groupings that refer to the distribution of their plots. On the one hand there are a direct relationship

between: a) total height and (east coordinate and DBH), b) diameter at breast height and (north and east coordinate). On the other hand, there are inverse relationships between: a) north coordinate and (DBH, eats coordinate and total height), b) east coordinate and (DBH and total height). There are no relationships between: a) north coordinate and (DBH and total height). In Base (Figure 3C), were observed trees of small diameter (mean DBH 22,54 cm) with densities (101-177 individuals) and mean height (9.53 m) in species *Chimarrhis cubensis*, *Lepidocordia punctata*, *Myrcia* sp., *Coccoloba caurana*, *Sloanea* sp.

In all physiographic units (S, SL and B, Figure 3A, 3B, 3C), a dominance of *Lepidocordia punctata* was noted. With the distribution of individuals in diameter classes (DBH 10-77

SUMMIT

Family	Species	Individuals	Basal área (m2)	FVI(%)
Boraginaceae	1	509	29,5152	20,07
Fabaceae	10	487	15,7649	20,03
Caesalpinaceae	2	176	11,3383	8,37
Mimosacea	3	152	4,7895	6,13
Elaecarpaceae	1	131	7,0411	5,41
Myrtaceae	2	115	2,7492	4,15
Anacardiaceae	3	26	3,7754	3,66
Nyctaginanceae	1	109	2,8161	3,47
Sapindaceae	3	30	1,7388	2,97
Rubiaceae	2	37	1,0333	2,21
Subtotal 10 families	**28**	**1772**	**80,5619**	**76,46**
Subtotal 23 families	**27**	**235**	**8,7771**	**23,54**
Total 33 families	**55**	**2007**	**89,3390**	**100**

SLOPE

Family	Species	Individuals	Basal área (m2)	FVI(%)
Fabaceae	10	331	10,5480	15,51
Caesalpinaceae	3	209	11,0152	10,25
Boraginaceae	2	186	12,4785	10,01
Rubiaceae	3	141	3,2038	5,48
Mimosacea	4	67	3,4643	4,61
Sapotaceae	4	67	3,1766	4,48
Anacardiaceae	3	47	4,9000	4,41
Myrtaceae	2	116	2,3163	4,15
Sapindaceae	5	46	1,6263	3,83
Verbenaceae	3	55	2,1493	3,35
Subtotal 10 families	**39**	**1265**	**54,8784**	**66,07**
Subtotal 28 families	**36**	**461**	**20,3920**	**33,93**
Total 38 families	**75**	**1726**	**75,2704**	**100**

BASE

Family	Species	Individuals	Basal área (m2)	FVI (%)
Fabaceae	13	202	9,0564	12,56
Boraginaceae	2	169	15,1692	9,83
Myrtaceae	3	216	4,2001	6,97
Polyginaceae	4	150	3,1690	5,70
Mimosacea	6	83	4,3728	5,67
Anacardiaceae	3	58	8,2069	5,44
Caesalpinaceae	3	87	5,5084	4,98
Elaecarpaceae	1	111	5,6345	4,68
Sapindaceae	5	67	2,9599	4,42
Rubiaceae	3	106	2,8039	4,31
Subtotal 10 families	**43**	**1249**	**61,0810**	**64,57**
Subtotal 25 families	**40**	**480**	**26,6100**	**35,43**
Total 35 families	**83**	**1729**	**87,6910**	**100**

Table 2 B.- Family Value Index (FVI), for the different species found by physiographic units, in the floristic survey for El Dorado, Tumeremo, Bolívar, Venezuela. Note: Ai: absolute abundance; Fi: absolute frequency; Di: absolute dominance; Ai%: relative abundance; Fi%: relative frequency; Di%: relative dominance; IVI%: Importance Value Index; R IVI%: Range's Importance Value Index

cm), a higher contribution of the species in the upper class (≥10) was observed, with densities (154-509 individuals) and heights (5-17 m).

Fabaceae was the most representative family in (S, SL, B) physiographic units, with a range 10-13 species, followed by the other families with 1-6 species (Table 2B). The Boraginaceae family surpasses Fabaceae in the FVI within the top physiographic position for the density of individuals it presents (509 individuals). In addition, Nyctaginaceae appears within the top 10 families only in the physiographic units (S) with one (1) specie and (109 individuals). The families Sapotaceae y Verbenaceae appears within the top 10 families only in the physiographic units (SL) with four (4) species and (67) individuals and three (3) species and (55) individuals respectively. The family Polygonaceae appears within the top 10 families only in the physiographic units (B) with four (4) species and (150) individuals. The first 10 families represented values greater than 60% (FVI) and values greater than 50% of the total species sampled in physiographic units (Table 2B).

Diversity α and β

The Kruskal-Wallis test did not detect a significant difference between the diversity indices in the plots of the physiographic units (Table 3). Shannon diversity indices were 2.32 and 3.44 nats.ind-1 for the physiographic units (S2) and (B1), respectively. Following that, (B1) has the highest values of Fisher alpha and Simpson index and the most abundant species with (59). The Venn diagram (Figure 2A) showed a high percentage of species shared between the areas (46.32%). Regarding the exclusive species, 5 (5,26%) were identified in Summit, 7 (7,37%) in Slope and 15 (15,79%) species in Base.

Cluster analyses (Bray-Curtis) revealed the formation of three floristics groups, four pairs of plots (S1, S2, S3 and SL1) with a similarity (34%), three pairs of plots (B1, B2 and B3) with (52%) and the other group of plots (SL2 and SL3) with (63%) respectively (Figure 2B). The higher values found for the similarity index of Jaccard (95% in S2/SL3) and

A

	SUMMIT			SLOPE			BASE		
	S1	**S2**	**S3**	**SL1**	**SL2**	**SL3**	**B1**	**B2**	**B3**
Taxa_S	51	27	38	52	46	57	59	52	56
Individuals	642	773	592	392	708	626	474	631	624
Simpson_1-D	0,90	0,85	0,86	0,95	0,93	0,93	0,95	0,93	0,93
Shannon_H	2,86	2,32	2,51	3,40	3,03	3,10	3,44	3,13	3,28
Margalef	7,73	3,91	5,80	8,54	6,86	8,70	9,41	7,91	8,55
Fisher_alpha	13,01	5,44	9,06	16,08	11,01	15,24	17,77	13,43	14,90

B

Índex			Índex		
Physiografics units	**Jaccard**	**Sorence**	**Physiografics units**	**Jaccard**	**Sorence**
B1 y B2	42,30	59,45	B3 y SL1	72,22	96,29
B1 y B3	49,35	66,08	B3y SL2	70,76	90,19
B1 y S1	52,77	69,09	B3 y SL3	83,82	80,35
B1 y S2	38,70	55,81	S1 y S2	51,92	69,23
B1 y S3	42,64	59,79	S1 y S3	67,85	85,39
B1 y SL1	52,05	68,46	S1 y SL1	73,23	99,10
B1 y SL2	50,00	66,66	S1 y SL2	70,76	94,84
B1 y SL3	52,63	68,96	S1 y SL3	83,82	78,43
B2 y B3	50,00	66,66	S2 y S3	92,68	88,88
B2 y S1	43,95	87,91	S2 y SL1	92,85	85,18
B2 y S2	49,09	68,35	S2 y SL2	92,00	85,18
B2 y S3	67,85	84,44	S2 y SL3	95,00	88,88
B2 y SL1	73,23	**100**	S3 y SL1	81,25	68,42
B2 y SL2	69,69	93,87	S3 y SL2	85,18	78,94
B2 y SL3	79,16	71,15	S3 y SL3	95,00	92,10
B3 y S1	71,83	95,32	SL1 y SL2	67,64	93,87
B3 y S2	45,00	65,05	SL1 y SL3	79,16	64,91
B3 y S3	62,29	80,85	SL2 y SL3	87,69	82,60

Table 3.- **A)** Alpha Diversity Indices' **B)** Beta Diversity per plot, physiographic units evaluated in Forest Reserve El Dorado-Tumeremo, Bolívar-Venezuela. Note: S1, S2 and S3: physiographic unit Summit plots 1, 2 and 3; SL1, SL2 and SL3: physiographic unit Slope plots 1, 2 and 3; B1, B2 and B3: physiographic unit Base plots 1, 2 and 3

Sorensen (100% in B2/SL1) (Table 3B). These indices vary from 0 to 1, with a similarity less than 0.5 considered low (Lopes et al. 2009).

Discussion

In the floristic inventory found that the study area in the different physiographic units was representative of TDF ecosystems and still conserve a large and valuable degree of diversity similar to other works carried out (Lanuza et al. 2023; Onyekwelu et al. 2022), the same species (*Spondias mombin*, Lanuza et al. 2023; Onyekwelu et al. 2022) were observed in the study area in a group of 10 act as the most significant contributors to the (IVI%).

In the present study the species

Lepidocordia punctata, Lonchocarpus sericeus, Peltogyne venosa, Sloanea sp., *Calliandra* sp., *Chimarrhis cubensis, Coccoloba caurana, Cordia bicolor, Myrcia* sp. *Brownea latifolia, Spondias mombin, Torrubia cuspidate, Vitex stahelii,* are the most representative of the IVI found (> 50%) for all physiographic units, being therefore the parameter that presents the best definition for the ecological importance of the species, observing its distribution (CIENTEC 2006; Souza et al. 2007), and in the structure and dynamics of a forest the specie has a presence assured when it is represented in all the strata (Longhi et al. 1992).

The best favourable environments for different physiographic units were observed in Base, which presented the highest mean height (22 m) and diameter (22,54 cm), being justified by the distant location which reduces the impacts of the anthropogenic actions.

In the present study, the distribution of individuals in diameter classes (10-79 cm) shows a behaviour similar to that observed by Quiroga et al. (2019) in the structure of tropical dry forest fragments in the south of the department of Tolima, Colombia and Ruiz y Saab, (2020) in the floristic diversity of the tropical dry forest in the lower and middle Sinú subregion, Córdoba, Colombia.

Conclusions

The forest communities in different physiographic units presented heterogeneity in the structural and diversity, because of the distribution and architecture of the species and also to the environmental characteristics present in the area.

There is a variety of species in all physiographic units (*Calliandra* sp., *Chimarrhis cubensis*, *Coccoloba caurana*, *Lepidocordia punctata*, *Lonchocarpus sericeus*, *Myrcia* sp., *Peltogyne venosa*, *Sloanea* sp.) who are developing small forests probably influencing by Interspecific competition and the spatial distribution of plant species in the region.

Lepidocordia punctata was the dominant specie in all physiographic units, presenting the highest phytosociological indexes.

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