Local ecological knowledge dynamics of farmers in areas which have been chronically disturbed by human actions in the Brazilian Caatinga

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Research

Abstract

Background: The diversity of plants indicated for the same use, plays important strategies which can affect the resilience of local ecological knowledge. In this context, we investigated the variation of local ecological knowledge through the richness of cited species, redundancy on an individual level and utilitarian redundancy (fuel, construction and technology) by local populations inserted in a dry forest with different environmental characteristics in northeastern Brazil.

Methods: We conducted semi-structured interviews with 120 local experts and described metrics which indicate the intensity of chronic human disturbance, defined as ongoing activities to remove natural resources, as well as the average annual rainfall in forests close to populations.

Results: We verified that there are differences between the number of species mentioned and the utilitarian redundancy between the studied areas. The richness of known species is suggested to influence redundancy on an individual level. Furthermore, we observed that information sharing about the plants among local experts is different, as some species were shared more than others.

Conclusions: Our results suggest that people living in areas of greater chronic anthropic impact and less rainfall may be subject to a lower resilience of local knowledge.

Keywords: Caatinga; ethnobotany; redundancy; chronic anthropic disorders.

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Background

Local populations have accumulated local ecological knowledge (LEK), which consists in the set of knowledge, practices and beliefs about natural resources (Berkes *et al.* 2000), that provide important strategies for the adaptation and resilience of people in different spaces (Folke 2006). Resilience is the ability of knowledge to absorb the new information that arises in the face of disturbances which cause changes, without changing its processes and functions (Walker *et al.* 2004; Ladio 2011). In this context, the resilience of a group will depend on the existing knowledge, which in turn will lead to better adaptation by the population in their environment. However, knowing the complexity of understanding resilience, some authors have suggested factors that can guide resilience for human well-being (Biggs *et al.* 2012; Ferreira-Júnior *et al.* 2015). In practice, utilitarian redundancy, related to the functional overlap of different species, so that they are used for the same use, is an exercise that indicates the adaptive capacity of local ecological knowledge (Albuquerque & Oliveira 2007). For example, the adaptive capacity of local human populations is flexible with loss of a plant species, in terms of decrease or extinction of a species in the natural environment; other species perform the same utilitarian function (Ferreira-Júnior et al., 2015).

Although most of the recent literature on resilience has focused on local medical systems (Santoro *et al.*, 2015; Zank *et al.*, 2022), little has been evaluated on the importance of individual knowledge for system resilience. From this perspective, Ferreira-Júnior *et al.* (2013) demonstrated that an individual who knows many species is less vulnerable than an individual who knows few species. Thus, individual-level redundancy also demonstrates the importance of people's ability to respond to environmental disturbances. From a spatial point of view, there may be a positive relationship between the richness of known species and redundancy on an individual level and utilitarian redundancy (Ferreira-Júnior *et al.* 2015; Díaz-Reviriego *et al.* 2016; Albuquerque *et al.* 2019), starting from the idea that local diversity and direct contact with resources can motivate greater richness of known and cited species (Naah & Guuroh 2017; Cardoso *et al.* 2017; Corroto *et al.*, 2019; Bystriakova *et al.* 2021). However, environmental fluctuations, such as the changes in vegetation caused by human impacts (Kunwar *et al.* 2018; Ali *et al.* 2022) have the ability to influence the diversity of plants available in the natural environment and this in turn can lead to variation in the adaptive capacity of one community (Brown *et al.* 2011).

The landscapes of several regions close to rural communities in northeastern Brazil undergo constant changes. Forest damage represents a worrying scenario for plant diversity in Seasonally Dry Tropical Forests (SDTFs) (Portilla-Alonso *et al.* 2011; Ribeiro *et al.* 2015). If chronic anthropogenic disturbances (CADs), defined by the continuous and gradual removal of small fragments in the vegetation, influence the reduction of heterogeneity (Singh 1998; Ribeiro *et al.* 2015), the richness of known species becomes an interesting variable for understanding. Chronic anthropic disturbance to vegetation is responsible for reducing the provision of ecosystem services and generates high socio-environmental costs (Araújo et al., 2021). Thus, a functionalist interpretation (see Ferreira-Júnior *et al.* 2015) related to aspects of resilience is important, as it manages to access how people maintain their activities in contrasting environments, such as dry forests.

Local human populations in the semi-arid region of Brazil generally collect wood resources from the dry forest (Caatinga) for energy demands (firewood and charcoal) and construction (rural and domestic) in order to perform local subsistence activities (Specht *et al.* 2019; Hora *et al.* 2021). Small farmers who occupy the Caatinga usually carry out activities to raise small herds, since agricultural practices occur seasonally due to water deficit, which determines collections guided by availability patterns (Lucena *et al.* 2012; Gonçalves *et al.* 2016), given the irregularity and may shape the use of plants by these human populations. Thus, considering the strategies of populations in dry forests, the flexibility to increase or decrease the alternatives of resources for the same utilitarian function can be a response to environmental fluctuations.

Thus, given the history of plant use in dry forest environments and the exposure of people to local environmental changes, our objective was to understand the variation of local ecological knowledge (LEK) of farmers in a semi-arid region of Brazil. The LEK variation between areas with different usage and occupation histories (chronic anthropic disturbances) can drive different responses in the resilience of ecological knowledge of local populations. From this, some guiding questions emerged: i) is there a difference in the number of plants cited by the farmers between the study areas? ii) The number of species cited by local farmers predict greater redundancy on individual level? iii) Is there a difference in the redundancy on an individual level of farmers living in areas with different environmental scenarios (vegetation structure, climate and chronic anthropic disturbances)? And iv) Is there a difference in utilitarian redundancy among the study areas?

Material and Methods

Description of the study area

This study was conducted in of the Brazilian semi-arid region (Cariri region) in the state of Paraíba, Brazil. The study involved local human populations consisting of in five rural communities distributed in different parts of Cariri (Fig.1). The rural communities involved were Riacho Fundo (7°23'47.6''S, 36°27'04.5"W), located in the municipality of São João do Cariri; Caiçara (07°23'8.12"S, 36 °23'36.74"W), located in the municipality of Cabaceiras; Alto dos Cordeiros (7°30'53.6"S, °59'46.6"W), located in the municipality of Barra de Santana; Viveiro (7°25'33.5" S, 36°48'43.0"W), located in the municipality of São José dos Cordeiros, and Olho d'água (7°54'56.6"S, 37°17'09.2" W) located in the municipality of Monteiro (Fig.1); from this point forward they will be called: Area 1 (A1), Area 2 (A2), Area 2 (A3), Area 4 (A4), and Area 5 (A5), respectively.

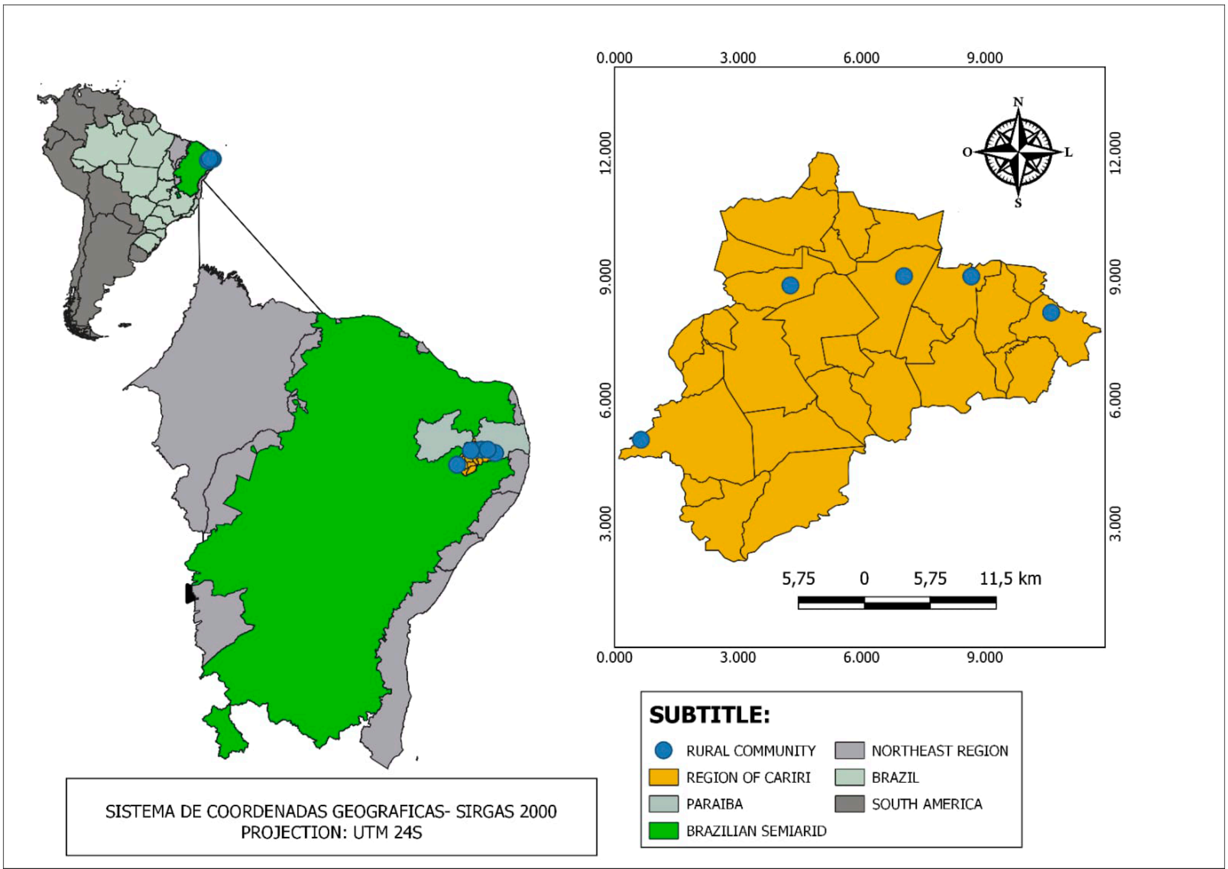

Fig. 1. Location of the communities studied, Paraíba state, northeast Brazil.

The climate of the Cariri region is (Bswh) hot to hot-semi-arid according to the Koppen classification, and it stands out for having the lowest rainfall regime in Brazil with 350 to 600 mm (Álvares *et al.* 2013). The rains are concentrated in the months of February to April, but there is great interannual variation. The average annual temperature and humidity are 25°C and 65%, respectively. Environmental characteristics determine a Seasonally Dry Tropical Forest with vast endemic biodiversity, considered the largest SDTF in the world. The vegetation is composed of a mosaic of physiognomies, with 3,347 species of flowering plants, endowed with a set of morphophysiological adaptations to climatic conditions (presence of thorns, leaf deciduousness) (Fernandes *et al.* 2019; Queiroz *et al.* 2017).

The human populations included in the Caatinga environments of the present study are small farmers, descendants of older groups of indigenous peoples, *quilombolas* and European settlers as a result of the European colonization process that expanded throughout the 16th century (Catalog of manuscripts of the Captaincy of Paraiba, 2015). Small farmers practice agricultural activities (during the rainy season) and raise small herds of goats, sheep and cattle (all year round) to supplement their families' economic income.

Ethical and legal aspects

The study was conducted in accordance with the guidelines required by the National Health Council of Brazil through the Research Ethics Committee (resolution no. 466/12/CNS/MS; project approval protocol: 30657119.3.0000.5187). After explaining the purpose of the study to each of participants, we invited them to sign the Free and Informed Consent Form (ICF). We requested authorization from the Chico Mendes Institute for Biodiversity Conservation (*ICMBio/SISBIO*), an agency linked to the Ministry of the Environment (*MMA*) (registration: 73540-1), to collect the botanical material. The species were identified through specialists according to the APG IV system (APG IV *et al.* 2016). All collected species cited by participants were deposited into the Manuel de Arruda Câmara Herbarium, State University of Paraíba, Campus I, Campina Grande, Paraíba, Brazil.

Collection of information on local ecological knowledge

The study areas were visited before conducting the interviews in order to establish a relationship of rapport and trust with the research participants (Triviños 1987). The first contact with the communities was organized by health agents and presidents of rural associations that work in the region. The professionals introduced us to some residents of the communities. The survey of local knowledge about the plants took place between August 2018 and February 2020 (on average twice a week). We chose to carry out a non-probabilistic selection of informants using the snowball technique (Bailey 1982) in order to select local experts. The Snowball method is when one participant recommends quoting another participant of similar competence, repeating the process until saturation or until reaching the desired sample size. Men and women who practice subsistence activities in agriculture and raising domestic animals were invited, as they know and use plants on a daily basis. Participants under 18 years of age were not included. The local experts represent a sample of local human population who are located in the rural communities of present study. For this reason, the results and conclusions of research will be under perspective of local experts.

Plant use data were obtained through interviews and free lists (Albuquerque *et al.*, 2014). From the free list, each participant was asked to list all species known. The free list method was complementary to interviews to elucidate the name and uses (fuel, construction and technology) of species cited by participants (Albuquerque *et al.*, 2014). Semi-structured questionnaires were used for the interviews. The questions in the questionnaires sought to record people's knowledge of plants, for example: Which plants do you know? What plants are known for rural construction and home construction? What plants are known as firewood? What plants are known for coal? Which plants are known as technologies (more complex productions)? All uses recorded for the species from the semi-structured interviews and free list were classified into categories and subcategories of use in ethnobotany based on Lucena *et al.* (2007), namely: Fuel (firewood, coal), construction (wire fence, stick fence, hedge and roof) and technology (tool handles and household items). From this information, it was possible to analyze the number of plants cited among the study areas and to estimate the utilitarian redundancy. All information obtained was recorded in a field notebook.

We used complementary techniques to enrich the plant lists, such as rereading, visual aids, and guided tours (Albuquerque *et al.* 2014). The rereading technique consists of the researcher orally enunciating the plants mentioned by the participant in order to provide the recall of more plants (Albuquerque *et al.* 2014). We used a visual resource of photographs in two different moments: first, for those participants who claimed not to know the plants; and second, for the participants who mentioned forgetting at the time of the interviews (Medeiros *et al.* 2014). The photographs had images of fruits, leaves, flowers and stems of plants with the habit of trees and shrubs that were recorded during the vegetation survey in the communities. We also carried out guided tours to verify the botanical identity of the species mentioned by the participants, and to collect taxonomic material (Albuquerque *et al.* 2014).

A total of 120 people participated in the study, represented by: Riacho Fundo community=30 (16 women and 14 men, with an average age of 58 years); Caiçara community=32 (20 men and 10 women, with an average age of 55 years; Alta dos Cordeiros community=24 (19 men and five women, with an average age of 45 years); Viveiro community=23 (15 men and eight women, with a mean age of 41 years); and Olho d'Água community=11 (seven men and four women, with a mean age of 48 years).

Sampling of ecological data and botanical collection

We selected a phytosociological plot of 1000 m^2 (20 x 50 m) for each rural community, totaling five plots. We sampled all tree/shrub species in each of these plots with height ≥ 1 meter and stem diameter at ground level (DGL) ≥ 3 cm, as they characterize plants in adult stages. Then, we identified the number of plant species in each study area from the vegetation survey. The average annual precipitation for each area was obtained through the WorldClim global climate data repository, updated in monthly and general average data in the total of the years 1970 to 2000, with a spatial resolution of about 30'' (www.worldclim. org) using the *raster* package (Hijmans, 2016) in R (R Core Team, 2019). The average annual rainfall in the plots ranged from 379 to 690 mm.

Next, we used a disturbance index which comprises the integration of important disturbance metrics for Seasonally Dry Tropical Forests to estimate the intensity of chronic man-made disturbances (Martorell and Peters 2005; Arnan *et al*., 2018). We then identified two main types of disturbances based on the eight metrics recorded, namely livestock pressure and human activities. Cattle pressure is a direct metric measured in the field that refers to the estimate of total biomass per plot using feces from cattle, horses and goats. Human activities are an indirect metric and refers to the evidence of land use left by people. Then, we selected three 100 m² subplots within each 20×50 m plot to collect livestock pressure metrics, and counted the number of fecal pellets from cattle, horses, donkeys, and goats/sheep. We subsequently collected, dried and weighed three pellet samples for each of these groups to calculate the average weight per plot and estimate the total biomass per plot from the feces of cattle, horses and goats/sheep (Supplementary data 1).

We used satellite images through Google Earth® (GE, 2016) to estimate human pressure indicators. We quantified the proximity to the urban center as the distance from the center of the plot to the nearest city (DC); proximity to the nearest rural property (PH); Trail density (TD). The density of households around the plot (DS) and land use (LUSE) were measured within a 2 km radius buffer from the center of the plot (Supplemental Table 1). All households were counted for DS, and the density of houses for the area was calculated. LUSE was visually estimated by the percentage of land with evidence of use, such as land cover dedicated to plantations, pastures and residences.

Data referring to the number of plants in the plant community, chronic anthropic disturbances and average annual precipitation enabled characterizing each plant community close to the local human populations.

Estimating Redundancy on an individual level and utility redundancy

The data from all local experts was used to answer whether the number of species cited by local farmers affects the redundancy on an individual level. We chose to use the species richness cited by each participant for each use to obtain the utilitarian redundancy per participant (redundancy on individual level). Each participant cites a framework of species in general, but not necessarily all of them are suitable for a given use. For example, one participant cites 25 plants as fuel, but only 10 are indicated for coal use. Thus, we are assuming that the redundancy of each participant is the number of species cited for a given use, while the number of species cited in general will be treated as the individual richness of the participant.

We chose to calculate the utilitarian redundancy index (uredit "utilitarian redundancy for therapeutic indication") (Medeiros *et al.* 2020) *a*t the system level in terms of usage categories for each use and for the community. We used the index for the categories and their local subcategories: fuel (firewood and coal), construction (hedge fence, wire fence, stick fence and roof) and technology (tool handles and household items). We only used the uses that had more than one cited species for the calculation since the cited uses with only one species do not contribute to the generation of redundancy. Therefore, we removed the structuring, door and window uses in the construction subcategory. Next, we calculated the utility redundancy values using the following index: $Uredit = NSp + Cr$; in which: Nsp is the total number of species cited for use, and Cr is the contribution of the species to generate redundancy. The contribution of the species to generate redundancy (Cr) was calculated using the following formula: $\sum si/N$, in which: si represents the number of people who cited the species i in use, and N represents the total number of people interviewed. The index considers information sharing about used plants. Therefore, by increasing the redundancy value, there is a greater number of species used for a particular use, and greater information sharing by people in a rural community (Medeiros *et al.* 2020). Thus, we calculated the Uredit for the uses in each study area. In a hypothetical scenario, Medeiros et al. (2020) exemplified the Uredit calculation through the knowledge of 100 people for the treatment of a disease. In this case four plants (a, b, c and d) are indicated, where plants a and b were mentioned by 50 people and plants c and d were mentioned by 40 and 10 people, respectively. The calculation would be: 4 + [(50 + 50 + 40 + 10)/100].

Statistical analysis

In order to verify if there was a difference in the number of known plants among the study areas the cited species richness was initially tested for normality using the Shapiro-Wilk test to answer our first question whether there are differences in the species richness cited by farmers between the study areas. We subsequently used the Kruskal-

Wallis test (data did not show a normal distribution, $p<0.05$). We then performed a post-hoc Dunn test to compare how much the group means differed. A Non-Metric Multidimensional Scaling (NMDS) analysis was performed to assess the composition of species cited between the areas using the Jaccard coefficient through the *vegan* package (Oksanen *et al.* 2018). The ordering was carried out from a matrix with the interviewees' code and respective location, and the presence and absence data of the mentioned species. We then used a Permutational Multivariate Analysis of Variance (PERMANOVA) with 9999 random permutations to test whether the groups segregated by the NMDS were significant.

Next, we fitted univariate mixed-effect generalized linear models (GLMM) with Binomial Negative distribution in the R package lme4 to test whether cited species affect the redundancy on an individual level in each usage category (redundancy on an individual level - response variables, count data) (Bates *et al.,* 2015). We considered the community/village predictor as a random effect variable, while the cited species was considered as fixed effect. We compared the complete model with the null models for all GLMM models and selected the best model based on AIC. We also used the Kruskal-Wallis test to analyze whether there was a difference in redundancy at the individual farmer level between the study areas.

We used Principal Component Analysis (PCA) to integrate anthropogenic disturbance measures (Arnan *et al.*, 2018) using the *vegan* (Oksanen *et al.* 2018) and *psych* (Revelle, 2022) package in the R program to identify the level of impact of each study area. PCA was used to reduce the dimensionality of the data through a correlation matrix. All variables were standardized and therefore we used a correlation matrix. The variables used in PCA were biomass of cattle dung; biomass of dung from horses; biomass of goats and sheep; distance from plot center to town); proximity to rural property; density of residences; density of trails; land use (Supplemental Table 1). All analyzes were performed in the R version 4.0.4 environment (R Core Team, 2019), and all the aforementioned packages were executed on this platform.

Results

A total of 61 plant species were recorded, belonging to 44 genera and 19 botanical families, destined for construction, fuel and technology uses by local populations (Supplementary Data 2). The construction category had the highest number of plant species cited, with 44 plants distributed in 15 families, followed by the technology category with 41 species distributed in 17 families. Finally, the fuel category presented 37 plants mentioned belonging to 13 families. *Astronium urundeuva* Allemão (Aroeira), *Croton blanchetianus* Baill. (Marmeleiro) *Cenostigma pyramidale* (Tul.) Gagnon & G.P. Lewis (Catingueira), *Aspidosperma pyrifolium* Mart (Pereiro), *Mimosa ophthalmocentra* Benth (Jurema-branca), *Mimosa tenuiflora* (Willd.) Poir (Jurema-preta) and *Prosopis juliflora* (Sw.) DC. (Algaroba) were the most cited species by all local experts. In addition, the most used species among the usage categories were different; for example, *A. pyrifolium* for the construction category, *C. blanchetianus* for fuel and *Commiphora leptophloeos* (Mart.) JB Gillett for technology.

Significant differences between the species richness cited between the study areas were found ($K= 47.678$; $p<0.05$), Furthermore, we verified a separation of communities in the multidimensional space in analyzing the composition of cited species ($F=0.24$; $p< 0.001$) (Fig. 2), demonstrating similarity between the groups of cited species, with the exception of A5, which was different from the other areas. A5 has higher average annual precipitation, higher plant species richness and a lower CAD value (Table 1; Supplementary Data 1). On the other hand, A1 was the most impacted in terms of chronic anthropogenic disturbances (CADs) (Table 1; Supplementary Data 1), as well as having the lowest number of species cited by local experts (Table 1).

The richness of plants cited per person suggested influencing the redundancy on an individual level. When analyzing the richness of plants known for each area, we also verified the influence of the richness of the cited species on the redundancy on an individual level used as fuel, construction and technology ($p < 0.05$) (Fig.4; table 2). We also found that individual-level redundancy was different across study areas for fuel ($K= 17.418$; $p = 0.0001$), technology ($K= 32.831$; $p < 0.05$) and construction ($K= 25.668$; $p < 0.05$). Specifically, we found that individual-level redundancy differed significantly between the low (A3 and A4) and medium (A2 and A5) impact areas for fuel, technology and construction in the low ($p < 0.05$) and medium ($p = 0.038$; $p=0.004$; $p=0.02$), respectively (Fig. 3).

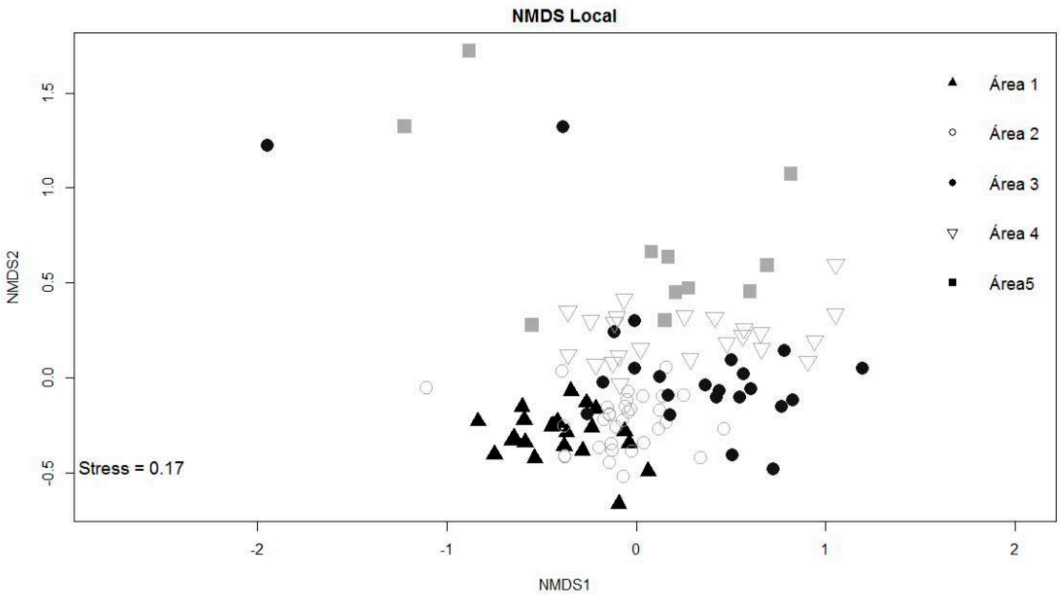

Fig. 2. Non-metric Scaling Method (Nmds) ordering, based on Jaccard's distance matrix, with the groupings for plant citation in the five study areas, northeastern Brazil, Paraíba state.

Table 1. Characterization of the environmental context of five rural communities studied in the Cariri region, northeastern Brazil, state of Paraíba. CAD (chronic anthropic disturbance); MAP (mean annual precipitation); plant species richness.

Parameters					
Communities	**A1**	**A2**	**A3**	**A4**	**A5**
CAD	2.0420	-0.6631	-0.3656	-0.3739	-0.6393
MAP (mm)	379	384	419	525	681
Plant Species Richness	8	13	20	9	33

A total of eight subcategories belonging to the fuel use, construction and technology categories were reported by the local experts (Table 3). We observed that the uses of firewood and wire fence had the greatest utilitarian redundancy (Table 4). In addition, we verified that the contribution of species to generate redundancy (in terms of knowledge sharing) was different, with greater representation of indication by people for a specific set of species (Table 3).

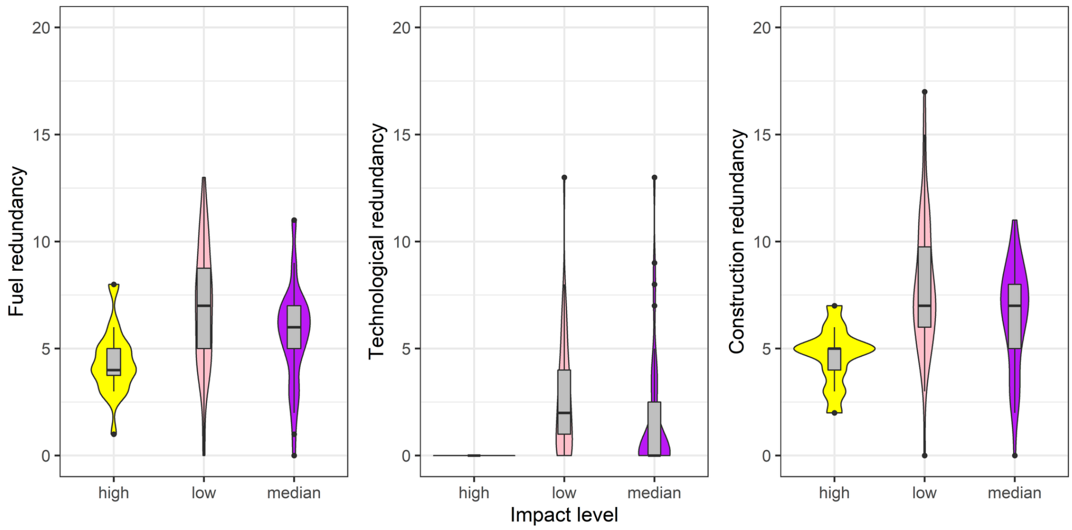

Fig. 3. Fiddle graphs showing individual farmers' redundancy as a function of level of chronic anthropic disturbance recorded in rural communities in the Cariri region, Paraíba state, northeastern Brazil. The high, low and medium predictor variables represent the level of disturbance recorded in each study area, where communities are represented: High (A1), low (A3 and A4) and medium (A2 and A5).

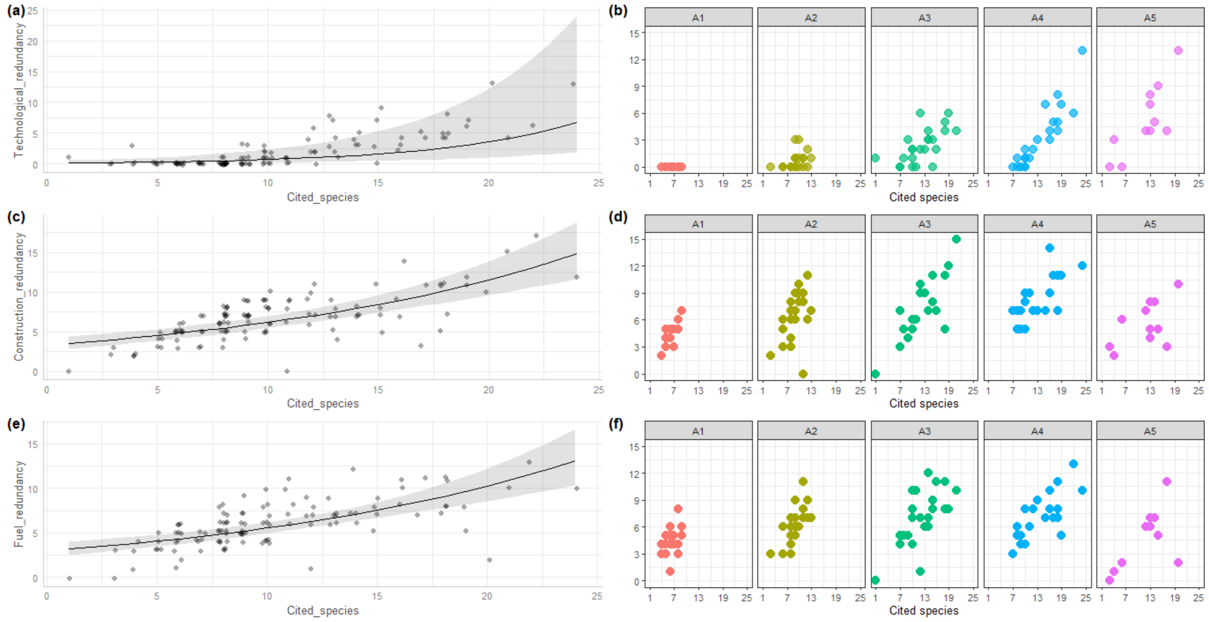

Fig. 4. Linear Generalized Mixed Models (GLMMs) to assess whether the number of species cited by local farmers affects individual-level redundancy across study areas in the Cariri region, Paraíba state, Brazil.

Table 2. Univariate mixed generalized linear model estimates.

Predictor variable	Response Variable	Estimate	Std. Error	Z-value	Pr (>|z|)	AIC
species richness cited	Technological redundancy at the individual level	0.16102	0.01693	9.513	< 2e-16 ***	290.52
	Fuel redundancy at the individual level	0.061662	0.009282	6.644	3.06e-11 ***	532.51
	Construction redundancy at the individual level	0.062331	0.008607	7.242	4.42e-13 ***	499.49

Table 3. Species with the highest number of sharing by survey participants for generating utility redundancy.

	Areas of study				
Use	**Area 1**	**Area 2**	**Area 3**	**Area 4**	**Area 5**
Firewood	**Use**	*C. pyramidale*	*C. pyramidale*	*C. pyramidale*	*C. pyramidale*
Coal	*A. urundeuva*	*C. pyramidale*	*C. pyramidale*	*M. tenuiflora*	*C. pyramidale*
Wire fence	*P. juliflora*	*A. urundeuva*	*M. tenuiflora*	*P. juliflora*	*A. colubrina*
stick fence	*C. blanchetianus*	*C. blanchetianus*	*C. blanchetianus*	*C. blanchetianus*	*C. blanchetianus*
Living fence	*C. leptophloeos*	*C. leptophloeos*	*C. leptophloeos*	*A. cearensis*	*C. leptophloeos*
Roof	*A. urundeuva*	*A. urundeuva*	*A. pyrifolium*	*C. leptophloeos*	*A. urundeuva*
Tool handle	-	-	*A. pyrifolium*	*S. obtusifolium*	*C. trichotoma*
Household Utensils	-	*C.leptophloeos*	*E. velutina*	*C. glaziovii*	*C. glaziovii*

Table **4.** Uredit values (utility redundancy) for each use mentioned by local experts in each study area.

Uses	Uredit values of each use for each rural community				
	A1	**A2**	**A3**	**A4**	**A5**
Firewood	14.7	22.9	30.95	32.60	25.8
Coal	4.1	11.5	14.12	11.34	9.8
Wire fence	19.43	23.36	36.0	30.65	18.73
Stick fence	8.2	11.13	8.95	18.91	6.53
Living fence	5.36	9.79	2.08	2.0	2.0
Roof	2.06	6.4	8.33	3.20	8.91
Tool handles	-	-	10.95	19.43	12.66
Household items	-	2.22	4.66	2.23	2.23

Discussion

In this work we evaluated the local ecological knowledge dynamics of farmers located near forest fragments chronically disturbed by human activities. Our study confirms some trends observed in the literature, namely that local human populations inserted in environments of greater environmental heterogeneity have their possibilities of use increased, possibly motivated by the greater diversity of species in plant communities (Naah and Guuroh 2017; Barros *et al*., 2019; Bystriakova *et al*., 2021), while environments with a lower supply of plant species may restrict local use (Barros *et al*., 2019). In this context, considering the environmental characteristics, our data show that the general richness of the cited plants was lower in an area of greater anthropic impact and less rainfall, while the composition of cited species was different in the area of greater rainfall. The botanical knowledge of groups inserted in the Caatinga generally shows similarity in the number of known plants for both those living in more conserved environments and for those living close to anthropogenic areas (Lucena *et al.* 2012; Gonçalves *et al.* 2021 b). The reasons that explain our results may be associated with the diversity of plant community in response to the average annual precipitation level, which can modulate the distribution of more drought-tolerant plants (Esquivel-Muelbert *et al.* 2017), because the vegetation can recover faster even in an impacted environment.

Our data suggest that there was a relationship between plant richness cited by the participants and redundancy on an individual level. This result indicates that the greater the number of plants known to a person, the greater the redundancy value on an individual level. Our objective in analyzing cited species richness and redundancy on an individual level was to clarify that the total number of known plants does not necessarily imply that all species are indicated in the same uses. In some cases, the richness of the cited species can generate a greater weight for specific uses, as was the case with the use of construction. Moreover, these inferences are important for understanding the role of individuals' local ecological knowledge in resilience, since according to previous studies (Thorsen and Pouliot, 2016), people are able to autonomously respond to their needs.

We found some evidence to support explaining our third question that is there a difference in the redundancy on an individual level of farmers living in areas with different environmental scenarios (vegetation structure, climate and chronic anthropic disturbances). We observed that local experts inserted in areas of more stressful environments (less rainfall and greater intensity of chronic anthropic disturbances) cite a low number of species and present a difference regarding redundancy on an individual level. The reduced number of species may mean that these local specialists do not adopt different plants for the same purpose. As discussed earlier, because of the lower plant diversity. If the low redundancy on an individual level and number of species cited is being driven by anthropogenic disturbances in vegetation observed during the survey, then local populations in areas with higher CAD (chronic anthropogenic disturbances) intensity may be reducing the number of useful species. As only one area (less rainfall and greater impact) showed a relationship of less redundancy on an individual level and number of species cited by people, this result should be interpreted as a suggestion of a relationship, not as strong evidence. Knowing that local residents are socially vulnerable and dependent on natural resources, one of implications of the previous results is that low redundancy on an individual level and number of species cited can become a challenge for the community if the environment continues to receive stimuli which direct the loss of species in the plant community (Ladio 2011).

Other dry forest environments have also experienced an increase in the degree of chronic anthropic disturbances (Sfair *et al.* 2018; Kaushik *et al.* 2021) and show that drier areas (in terms of water availability) are more sensitive to the effects of chronic disorders (Ribeiro *et al.* 2015). Anthropogenic disturbances in the researched region expanded throughout the process of European "colonization" in the 16th century (Catalog of manuscripts of the Captaincy of Paraíba, 2015). European territorial usurpation advanced in the semi-arid region of Brazil, land donations through *sesmaria* letters promoted expansion of agricultural production and the migration of cattle increased fires to remove arboreal vegetation (Catalogue of manuscripts of the Captaincy of Paraíba, 2015). Farmers practice their agricultural activities on privately owned land, but raising of domestic animals, especially goats, often takes place in common and open spaces in the Caatinga, such as in areas with greater native vegetation (Nunes *et al.* 2015; Marinho *et al.* 2016). These actions take place between generations and may be among those responsible for the anthropic impacts on the plant communities of the Caatinga (Gonçalves *et al.* 2021a). Moreover, in our understanding, verifying environmental changes in dry forest fragments can become the basis for understanding the usage strategies of useful plants by local people.

In this study, the utilitarian redundancy values obtained for local uses in each study area were lower in the area of high chronic anthropic impact. This phenomenon can be explained through the following hypothesis: first, that the species cited for may have different weights (in terms of information sharing between people) due to the prioritization of certain species (Medeiros *et al.* 2020), favoring few species in a given use. Our results also highlight the importance of uses for firewood and wire fencing, a pattern also observed in forests in Madagascar (Brown *et al.* 2011), Caatinga (Oliveira *et al.* 2019) and Chaco (Jiménez-Escobar *et al.* 2021), especially for firewood. The contribution of species to these uses is considered important due to the greater information sharing among local experts. The knowledge of these uses may be associated with the demand for greater amounts of native wood repair (as was the case with *A. colubrina*, *C. pyramidale* and *A. pyrifolium*), mainly for the production of fences that are damaged by the domestic herd. This suggests that the local need for some uses tends to motivate people to select a greater number of species. For example, in a diachronic study, Santoro and Albuquerque, (2020) showed that people increase redundancy (over time) only in the categories which are locally perceived as most important. On the other hand, the other uses proved to be less redundant. The possible lower importance of some activities in some rural communities compared to others may be associated with the supply of other products for producing artifacts, such as roofs. These uses do not require constant repairs, with little need for replacement (Ramos *et al.*, 2015), which may be responsible for lower redundancy.

However, one positive result was the information sharing between people. The contribution of the mentioned plants to generating redundancy was different, but there were exceptions. We observed that the most shared plants among the areas were the same for firewood and fences. This becomes interesting from the point of view of utilitarian redundancy, as it can indicate that some species are prioritized over others. The high number of citations for the prioritized species perhaps tends to indicate the efficiency of the plant for use. The literature has revealed that there is a predominance of species from the Caatinga which are more likely to be used for logging purposes due to durability (Hora *et al.* 2021), wood ignition (Cruz *et al.* 2020) and in some cases due to similar morphological characteristics of the species (Pedrosa *et al.* 2021). However, although it is important for utilitarian redundancy, our data do not allow us to identify the usage intensity of each species generate redundancy. Thus, it is to be expected that future studies will insert local perception to understand why some species are more used than others. However, even with species prioritization, some uses are more salient in terms of redundant plants. Some reports during the interviews illustrate that the most shared species among the participants are recognized for presenting characteristics that refer to an advantage for use. For example, *C. pyramidale* used as firewood was represented as follows:

> *"It's a good wood, it's heavy, it has a core, it shines, it's warm and it doesn't smoke a lot"* (Female, 47 years old, Cabaceiras).

> *"It doesn't smoke, takes a long time to put out, hard and resistant coals"* (Female, 50 years old, São João do Cariri).

Ideas about sharing information for a given use are generally similar to the explanation proposed by the socioecological theory of maximization, in which local ecological knowledge contributes to the maximum performance of human groups in the environment (Albuquerque *et al.*, 2019). Our results seem to be related to the utilitarian redundancy generation model which proposes that local knowledge is organized to be redundant, but the redundancy can vary in time and space (Albuquerque *et al.*, 2019). This can be observed in our study when local specialists inserted in more stressful environments tend to reduce the number of species indicated in a given use. Thus, it would be interesting to investigate the intensity of sharing of each redundant species in a use in order to verify its impact on generating utilitarian redundancy. However, we would like to point out that our results correspond to a sample, and therefore our inferences about local knowledge are from the perspective of local experts.

Although our results do not intend to verify the use of species according to the collection intensity, local specialists seem to know a diverse number of plant species to maintain their daily activities from the functionalist point of view of redundancy on an individual level and number of species cited. This suggests that even in an environment with frequent chronic anthropic disturbances which can lead to the decline of a plant, other species will perform the same function. However, considering all the results, people inserted in more impacted areas are perhaps more likely to change their functional identity, while areas of greater plant richness (higher average annual precipitation and lower CAD) are more important for the resilience of local knowledge. At the same time, the idea that local ecological knowledge can adapt to these disturbances becomes interesting, as redundancy can increase resilience in these contexts of environmental change (Noble *et al.*, 2015).

We hope that this look at local populations can alert us to the importance of employing their knowledge in global conservation challenges, as the use of species will tend to be increasingly motivated by changes in local and global scales over the next few decades, which can become a great challenge since small losses in species richness in plant communities can result in reductions in utilitarian diversity (Brown *et al.*, 2011). Thus, one of the possible solutions is to protect the capacity of semi-arid lands to provide ecosystem services and to develop sustainable agricultural landscapes to enable the daily practice of human populations living in rural areas (Araújo *et al.*, 2021).

Conclusion

In general, local experts in the studied areas indicate a greater number of plants for construction uses. We described chronic disturbance metrics in plant communities close to the study areas in order to support the environmental characterization. Thus, we observed that areas of greater chronic impact suggest less species richness cited. The richness of known species is suggested to influence the redundancy on an individual level. We found that firewood and wire fence had greater utilitarian redundancy among local experts. In contrast to the concerns associated with the effects of wood harvesting by local populations, our inferences contribute to better understand the local ecological knowledge dynamics of Caatinga peoples in face of advancement of chronic anthropic impacts in these dry forest regions.

Declarations

List of abbreviations: LEC = local ecological knowledge, SDTFs = Seasonally Dry Tropical Forests, CAD = Chronic Anthropogenic Disturbances, A1; A2; A3; A4 and A5 = Study areas, ICF = Informed Consent Form, ICMBio/SISBIO = Chico Mendes Institute for Biodiversity Conservation, MMA = Ministry of the Environment, APG = Angiosperm Phylogeny Group, EcoTrocpis = Neotropical Ecology Laboratory, DGL = Diameter at Ground Level, DC = Nearest city, PH = Proximity to the Nearest rural property, TD = Trail density, DS = The density of households around the plot, LUSE = land use, NMDS = Non-Metric Multidimensional Scaling, UREDIT = Utility redundancy values, PERMANOVA = Permutational Multivariate Analysis of Variance, PCA = Principal Component Analysis and GLMM = Mixed-Effect Generalized Linear Models.

Ethics approval and consent to participate: The study was conducted in accordance with the guidelines required by the National Health Council of Brazil through the Research Ethics Committee (resolution no. 466/12/CNS/MS; project approval protocol: 30657119.3.0000.5187).

Consent for publication: Not applicable in this section.

Consent for publication: Not applicable in this section.

Availability of data and materials: Plant materials were prepared and deposited in the herbarium the Manuel de Arruda Câmara Herbarium, State University of Paraíba, Campus I, Campina Grande, Paraíba, Brazil.

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Author contributions: KMP, MBR and SFL conceived the research idea. KMP, MBR, SSC, SMS and MGRM did the data collection. KMP analyzed and interpreted the data. HKLS Statistical analysis review. KMP, SFL and MALTC revised and improved the manuscript. All the authors read, reviewed, and approved the final version of the manuscript.

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Supplemental Table 1: Parameters related to species richness cited (sp_cited) and utility redundancy (red_fuel; red_tec; red_const) by local experts, within the five study areas, northeastern Brazil. This was followed by information regarding the environmental context, MAP (mean annual precipitation) and chronic anthropic disturbance metrics: CATTLE (Biomass of cattle dung); EQUINE (Biomass of dung from horses, horses and donkeys); GOAT (Biomass of goats and sheep); DC (distance from plot center to town); PH (proximity to rural property); DS (density of residences); TD (density of trails); LS (land use).

Site	People	sp_cited	red_fuel	red_tecn	red_const	MAP	CAD	impacto	goat	cattle	equine	DC	PH	DS	TD	LS
1	1	9	6	0	7	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	2	7	4	0	3	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	3	5	4	0	3	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	4	5	3	0	3	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	5	6	4	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	6	6	4	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	7	6	5	0	4	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	8	4	4	0	2	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	9	6	5	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	10	6	5	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	11	6	6	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	14	5	5	0	4	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	15	8	8	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	16	7	4	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	17	6	1	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	18	4	3	0	2	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	19	5	3	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	20	5	3	0	4	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	22	9	5	0	7	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	26	8	8	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	27	8	4	0	6	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	28	8	3	0	6	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	29	7	5	0	5	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
1	30	8	4	0	6	384	CAD1	high	2762	127	4873	8.79	5.89	493	2.56	7
2	31	12	7	2	11	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	32	9	7	1	7	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	33	9	6	0	9	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	34	8	3	0	8	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	35	8	7	0	3	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	36	8	6	0	6	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	37	8	5	0	7	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	38	8	5	0	8	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	39	11	7	1	9	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	40	12	9	0	6	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	41	13	7	1	7	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	42	8	6	0	8	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3

2	43	6	3	0	5	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	44	8	3	0	8	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	45	10	6	1	9	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	46	8	4	0	7	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	47	8	6	0	7	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	48	9	7	1	9	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	49	9	5	1	6	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	50	9	5	0	9	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	51	11	8	1	8	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	52	8	4	0	7	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	53	9	9	3	7	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	54	10	6	3	8	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	55	6	6	0	6	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	56	8	7	0	4	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	57	8	5	0	6	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	58	10	6	0	10	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	59	9	5	0	7	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	60	11	11	0	0	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	61	6	6	0	3	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
2	62	3	3	0	2	379	CAD2	medium	0	22896	25	7.06	1.59	730	1.92	3
3	63	7	5	0	3	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	64	10	8	1	6	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	65	10	10	0	5	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	66	10	7	2	5	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	67	1	0	1	0	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	68	11	10	0	6	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	69	8	5	1	5	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	70	7	4	0	7	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	71	13	6	2	9	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	72	14	12	3	7	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	73	14	6	4	7	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	74	12	7	2	10	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	75	21	10	4	15	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	76	18	8	5	11	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	77	16	11	2	7	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	78	14	7	3	7	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	79	18	11	4	5	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	81	15	9	0	11	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	82	15	8	3	8	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	83	12	1	6	9	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	84	10	4	2	6	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9
3	85	9	5	3	4	419	CAD3	low	0	4859	0	0.87	2.31	354	0	9

3	86	19	8	6	12	419	CAD3	low	0	4859	0	0.87	2.31	354		0	9
4	87	10	4	2	8	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	88	12	8	2	7	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	89	18	8	4	11	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	90	9	4	0	7	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	91	19	5	7	11	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	92	17	7	5	11	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	93	15	7	7	7	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	94	10	4	0	9	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	95	18	7	8	7	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	96	16	10	3	14	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	97	8	6	0	7	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	98	16	8	4	9	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	99	10	4	1	9	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	100	9	5	0	5	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	101	10	8	1	5	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	102	11	6	1	9	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	103	10	4	0	8	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	104	8	5	1	5	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	105	18	11	5	11	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	106	7	3	0	7	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	107	24	10	13	12	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	108	13	9	3	7	525	CAD3	low	0	0	0	3.87	2.79	562	0.32		5
4	109	22	13	6	17	525	CAD4	low	0	0	0	3.87	2.79	562	0.32		5
5	110	13	6	8	4	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	111	13	7	4	8	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	112	13	7	7	5	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	113	12	6	4	7	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	114	20	2	13	10	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	115	3	0	0	3	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	116	14	7	5	8	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	117	17	11	4	3	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	118	4	1	3	2	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	119	6	2	0	6	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3
5	120	15	5	9	5	681	CAD4	medium	0	0	0	18.4	2.23	451		0	3

Supplemental Table 2. Species recorded for different use categories in rural communities of Cariri, Paraíba, northeastern Brazil. Followed by vernacular name, Voucher and communities (referring to species cited in each study area) 1 (species cited) and 0 (species not cited) represented by ACAM (Herbarium Manuel de Arruda Câmara), NC (not collected).

			Communities					
Family	**Species**	**Vernacular names**	**A1**	**A2**	**A3**	**A4**	**A5**	**Voucher**
			Species citation by local experts in the study areas					
Anacardiaceae	*Astronium urundeuva* (M.Allemão) Engl.	Aroeira	1	1	1	1	1	ACAM 1991
	Schinopsis brasiliensis Engl	Baraúna	1	1	1	1	1	ACAM 2009
	Spondias tuberosa Arruda	Umbuzeiro	0	0	1	1	1	ACAM 1579
Annonaceae	*Annona leptopetala* (R.E.Fr.) H.Rainer	Pinha-Brava	0	0	0	1	1	
Apocynaceae	*Aspidosperma pyrifolium* Mart. & Zucc.	Pereiro	1	1	1	1	1	ACAM 1995
Bignoniaceae	*Handroanthus albus* (Cham.) Mattos	Pau-d'arco-Amarelo	0	0	1	1	1	To define
	Handroanthus impetiginosus (Mart. ex DC.) Mattos	Pau-d'arco-Rocho	0	0	0	1	1	To define
	Tabebuia aurea (Silva Manso) Benth.& Hook.f. ex S.Moore	Craibeira	1	1	1	1	1	To define
Boraginaceae	*Cordia trichotoma* (Vell.) Arráb. ex Steud.	Frei-Jorge	0	0	1	0	1	To define
Burseraceae	*Commiphora leptophloeos* (Mart.) J.B. Gillett	Umburana	1	1	1	1	1	To define
Cactaceae	*Cereus jamacaru DC. subsp. jamacaru*	Mandacarú	0	1	1	1	1	To define
	Pilosocereus pachycladus F. Ritter	Facheiro	1	1	1	1	0	To define
Capparaceae	*Cynophalla flexuosa* (L.) J.Presl	Feijão-Bravo	0	1	1	0	0	ACAM 2014
	Crateva tapia L.	Trapiá	0	0	1	0	0	To define
Combretaceae	*Combretum leprosum* Mart.	Mufumbo	0	0	0	1	0	ACAM 1990
Euphorbiaceae	*Cnidoscolus quercifolius* Pohl	Favela	0	0	0	1	0	ACAM 1996
	Croton blanchetianus Baill.	Marmeleiro	1	1	1	1	1	To define
	Croton heliotropiifolius Kunth	Marmeleiro-branco	1	0	1	1	1	ACAM 1983
	Euphorbia tirucalli L.	Aveloz	1	1	1	1	0	To define

	Hymenaea courbaril L	Jatoba	0	0	0	1	1	To define
	Jatropha mollissima (Pohl) Baill.	Pinhão-Bravo	1	1	1	1	0	ACAM 1984
	Manihot glaziovii Müll.Arg.	Maniçoba	0	1	1	1	0	To define
	Sapium glandulosum (L.) Morong	Burra-Leiteira	0	1	0	0	0	ACAM 2010
Fabaceae	*Amburana cearensis* (Allemão) A.C.Sm.	Cumarú	0	0	0	1	1	ACAM 1981
	Anadenanthera colubrina (Vell.) Brenan	Angico	1	1	1	1	1	ACAM 1982
	Bauhinia cheilantha (Bong.) Steud.	Mororó	0	1	1	1	1	ACAM 1986
	Libidibia ferrea (Mart. ex Tul.) L.P.Queiroz var. *ferrea*	Jucá	1	0	1	1	1	ACAM 1996
	Cenostigma pyramidale (Tul.) Gagnon & G.P. Lewis	Catingueira	1	1	1	1	1	ACAM 1988
	Chloroleucon foliolosum (Benth.) G.P.Lewis	Jurema-de-coronha	0	1	1	0	0	ACAM 2011
	Dahlstedtia araripensis (Benth.) M.J. Silva & A.M.G. Azevedo	Sucupira	0	0	0	0	1	ACAM 2007
	Desmanthus virgatus (L.) Willd.	Jureminha	0	0	0	0	1	ACAM 2006
	Enterolobium contortisiliquum (Vell.) Morong	Tambor	0	0	0	1	1	ACAM 2000
	Erythrina velutina Willd.	Mulungu	0	1	1	1	1	To define
	luetzelburgia auriculata (Allemão) Ducke	Pau-de-Serrote	0	0	0	1	0	ACAM 1997
	Mimosa arenosa (Willd.) Poir.	Unha-de-gato	0	1	1	1	0	To define
	Mimosa caesalpiniifolia Benth	Sabiá	0	0	1	0	0	To define
	Mimosa lewisii Barneby	Jurema-amorosa	0	1	0	1	1	To define
	Mimosa ophthalmocentra Mart. ex Benth.	Jurema-de-embira	1	1	1	1	1	ACAM 1992
	Mimosa tenuiflora (Willd.) Poir.	Jurema-Preta	1	1	1	1	1	ACAM 1989
	Piptadenia retusa (Jacq.) P.G.Ribeiro, Seigler & Ebinger	Jurema branca	1	1	1	1	1	ACAM 1978
	Prosopis juliflora (Sw.) DC.	Algaroba	1	1	1	1	1	To define
	Senna spectabilis (DC.) H.S.Irwin & Barneby	Canafístula	0	0	1	1	1	ACAM 2005

Malvaceae	*Ceiba glaziovii* (Kuntze) K.Schum.	Barriguda	0	0	1	1	1	ACAM 1993
Meliaceae	*Cedrela odorata* L.	Cedro	0	0	0	1	0	To define
Nyctaginaceae	*Guapira hirsuta* (Choisy) Lundell	João-Mole	0	0	1	0	0	To define
	Guapira laxa (Netto) Furlan	Pau-Piranha	0	0	0	1	1	To define
Olacaceae	*Ximenia americana L.*	Ameixa	0	0	1	1	1	To define
Rhamnaceae	*Sarcomphalus joazeiro* (Mart.) Hauenshild	Juazeiro	1	0	1	1	1	ACAM 1933
Rubiaceae	*Coutarea hexandra* (Jacq.) K. Schum	Quina-Quina	0	0	0	1	1	To define
Rutaceae	*Zanthoxylum rhoifolium* Lam.	Limãzinho	0	0	0	1	1	To define
Sapotaceae	*Sideroxylon obtusifolium* (Roem. & Schult.) TDPenn.	Quixabeira	1	1	1	1	1	ACAM 1994
Unidentified	Morfo1	Bálssamo	0	0	0	1	1	NC
	Morfo10	Quebra-Faca	0	0	0	1	1	NC
	Morfo11	Rabo-de-Cavalo	0	0	1	1	1	NC
	Morfo2	Cipaúba	0	0	1	0	0	NC
	Morfo3	Guachumba	0	0	0	1	1	NC
	Morfo5	Jurema-Brava	0	1	1	0	0	NC
	Morfo6	Jurema-Mulatinha	0	1	0	0	0	NC
	Morfo8	Louro	0	0	0	1	0	NC
	Morfo9	Pau-Cachão	0	0	0	0	1	NC
	Morof4	Jurema-de-Caboblo	0	1	1	0	0	NC