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MARIA JOANA DA SILVA SPECHT

RELAÇÕES SOCIOECONÔMICAS E CONSEQUÊNCIAS ECOLÓGICAS DA UTILIZAÇÃO DE PLANTAS POR POPULAÇÕES TRADICIONAIS NO SERTÃO PERNAMBUCANO

Recife
2018

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Tese submetida ao Programa de Pós-graduação em Biologia Vegetal da Universidade Federal de Pernambuco como um dos requisitos ao curso de Doutorado.

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Orientador: Dr. Bráulio Almeida dos Santos
Co-orientadora: Dra. Cristina Baldauf

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Dedico essa tese a todas as pessoas que querem fazer do mundo um lugar melhor seja através da ciência, da arte ou de qualquer outro meio.

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RESUMO

Esta tese teve como objetivo investigar os determinantes de uso das espécies vegetais por populações rurais e as implicações ecológicas deste uso para a manutenção da biodiversidade de florestas secas utilizando a Caatinga como modelo de sistema socioecológico. Inicialmente apresentamos uma introdução ao tema discutindo sobre a importância biológica, socioeconômica e status de conservação das florestas secas e porquê estudá-las. Também levantamos informações sobre os impactos socioeconômicos das mudanças climáticas e das áreas protegidas sobre populações locais e sobre como a Caatinga representa um bom modelo para estudos socioecológicos e etnoecológicos em florestas secas. Utilizamos para a elaboração dos dois capítulos desta tese dados provenientes de 81 entrevistas semiestruturadas realizadas entre janeiro e julho de 2016 com moradores do Parque Nacional Catimbau e entorno para avaliar variáveis socioeconômicas, de gerenciamento de recursos e de uso do solo. No primeiro capítulo, nossos resultados mostram que as pessoas que vivem dentro do parque estavam enfrentando piores condições socioeconômicas, incluindo disponibilidade de água mais limitada, pior infraestrutura das casas, menor renda familiar e alta dependência de lenha, quando comparadas com famílias que viviam fora ou em condição de moradia dupla (dentro e fora dos limites do parque). As famílias que vivem dentro do parque estão estagnadas em um ciclo de dependência do apoio financeiro externo por programas de renda mínima e exploração de recursos naturais, com manejo ineficiente de terras e com cera de 76% vivendo abaixo da linha de pobreza com poucas oportunidades de mudança de cenário. No segundo capítulo, descobrimos que as famílias de baixa renda usavam mais espécies nativas coletadas de áreas naturais que famílias de renda mais alta. Famílias com mais disponibilidade de adultos para trabalho agrícola e famílias mais educadas usavam mais espécies de áreas florestais, indicando maior potencial para explorar a floresta. Além disso, encontramos um sinal filogenético nas categorias de alimentos e lenha, mostrando que as pessoas tendem a usar espécies estreitamente relacionadas nessas categorias. Nossos resultados mostram que a pobreza é um importante fator socioeconômico que impulsiona a intensificação do uso de espécies nativas. Essas atividades podem levar à perda da história evolutiva da comunidade vegetal por sobre-exploração, porque o padrão de seleção de plantas úteis pelas comunidades tradicionais de alimentos e lenha não é distribuído aleatoriamente sobre a filogenia. Os resultados desta tese demonstram que as relações entre uso de plantas por seres humanos e a conservação da biodiversidade na Caatinga não podem ser negligenciadas especialmente quando as populações humanas estão em situação de pobreza e irregularidade fundiária dentro de Unidades de Conservação. Estas situações conferem efeitos negativos importantes à flora local atual e pode gerar implicações na história evolutiva de clados. Dessa forma, estratégias de manejo que conciliem o uso dessas florestas e a manutenção da biodiversidade da Caatinga e dos modos de vida tradicionais são urgentes.

Palavras-chaves: Caatinga. Conservação. Populações tradicionais.

ABSTRACT

This thesis aimed to investigate the determinants of plants species use by rural populations and the ecological implications for biodiversity maintenance of dry forests using the Caatinga as a socioecological system model. First, we present an introduction discussing about the biological and socioeconomic importance and conservation status of dry forests and why they are studied. We also reported on the socioeconomic impacts of climate change and protected areas on local populations and how the Caatinga is a good model for socioecological and ethnoecological studies in dry forests. We used, for the two chapters, data from 81 semi-structured interviews conducted between January and July 2016 with residents of the Catimbau National Park and surrounding areas to evaluate socioeconomic variables, resource management and land use. On the first chapter, our results shows that people living within the park were facing lower socioeconomic conditions, including more limited water availability, lower house infrastructure, lower family income and high dependence on firewood compared to families living outside the Park or in double dwelling conditions (inside and outside of the Park boundaries). Families living within the park are stagnating in a cycle of dependence on external financial support, programs of minimum income and exploitation of natural resources. 76% were living below the poverty line with few opportunities for change. On the second chapter, we found that low-income families used more native species from forest areas than higher income families. Families with more availability of adults for farm labor and families with more educated households used more species from forest areas, indicating more potential to explore the forest. Additionally, we found a phylogenetic signal in the food and firewood categories, showing that people tend to use closely related species in these categories. Our results show that poverty is an important socioeconomic factor that drives the intensification of native species use. These activities may lead to the loss of the evolutionary history of the plant community by overexploitation, because the selection pattern of useful plants by traditional communities for food and firewood is not randomly distributed over the phylogeny. The results of this thesis show that the relationships between plant use by humans and biodiversity conservation in Caatinga can not be neglected, especially when human populations are living illegally on land within Protected Areas. These situations can confer significant negative effects on the current local flora and may have implications for the evolutionary history of clades. Thus, management strategies that reconcile the use of these forests and the maintenance of the Caatinga biodiversity and traditional livelihoods are urgent.

Keywords: Caatinga. Conservation. Traditional populations.

SUMÁRIO

1 INTRODUÇÃO

As florestas secas são importantes por sustentar populações humanas, principalmente as de baixa renda, que dependem da biodiversidade para alívio da pobreza e desenvolvimento econômico (DAVIDAR et al., 2010; PORTILLO-QUINTERO; SÁNCHEZ-AZOFEIFA, 2010; RIBEIRO et al., 2015). Espécies vegetais coletadas diretamente das florestas ou cultivadas são utilizadas para fins diversos como alimentício, medicinal e energético sendo, inclusive a lenha e carvão são a principal fonte energética para satisfação das necessidades diárias de populações rurais (MEDEIROS et al., 2012a; SPECHT et al., 2015). O manejo da terra e seleção das espécies florestais para uso pelos humanos passam por diversos filtros determinantes como por exemplo questões culturais, socioeconômicas, disponibilidade de pessoas para aquisição do recurso ou status de proteção do recurso assim como condições ambientais e atributos das espécies que as fazem atrativas ou não. Entretanto, o uso das espécies pode levar a alterações significativas no conjunto de espécies localmente inclusive gerar um padrão de seleção das mesmas em diferentes clados. As etnociências e a ecologia aplicada têm um papel fundamental e de importância crescente ao longo dos anos no entendimento destas relações entre o uso dos recursos naturais pelos seres humanos e na proposição de soluções amigáveis a ambas as partes (GAOUE et al., 2017).

A Caatinga é considerada a floresta sazonalmente seca mais populosa do mundo com cerca de 40% da sua população rural, sendo grande parte dessa composta por pequenos agricultores que vivem historicamente dependentes de recursos naturais para sua subsistência. Estima que cerca de 46% da área da Caatinga já foi desmatada devido ao uso inapropriado da terra (BEUCHLE et al., 2015; SILVA; LEAL; TABARELLI, 2018). E apesar do alto número de espécies endêmicas e da necessidade de conservação biodiversidade, apenas 7,5% da Caatinga está protegida por Unidades de Conservação, em menos de 2% está sobre proteção integral (MMA; IBAMA, 2011). Ainda, estudos apontam que pouca atenção foi reservada aos impactos das mudanças climáticas no modo de vida de populações tradicionais e rurais que possuem o modo de subsistência a agricultura camponesa (BAKKEGAARD et al., 2016), sendo famílias camponesas em florestas secas ainda mais suscetíveis a estas mudanças. Desta forma, esta tese está organizada em dois capítulos que em conjunto têm como finalidade entender os determinantes de uso das espécies vegetais por populações rurais e as implicações ecológicas para a manutenção da biodiversidade de florestas secas utilizando a Caatinga como modelo. A tese está baseada nos seguintes objetivos específicos: 1) Entender e descrever o sistema socioecológico do Parque Nacional Catimbau e utilizá-lo como modelo para testar se os parques nacionais podem gerar ou aliviar a pobreza e dependência de recursos naturais dentro do contexto de florestas secas; 2) Conduzir um estudo etnobotânico das plantas utilizadas pela população do Parque e acessar como condições ambientais e socioeconômicas influenciam no uso das espécies e quais as consequências para conservação. Por fim, apresentaremos as conclusões e implicações do nosso estudo com a finalidade de apontar lacunas do conhecimento e auxiliar no desenho de projetos futuros.

2 FUNDAMENTAÇÃO TEÓRICA

2.1 Importância das Florestas Tropicais Sazonalmente Secas

Cerca de 40% da superfície do globo terrestre (excluindo os polos) é coberta por terras áridas (terras secas, semiáridas, áridas e hiper-áridas), definidas pela "*escassez de água e caracterizadas por extremos climáticos sazonais e padrões de precipitação irregulares*" (PERNETTA, 2014; WHITE; NACKONEY, 2003). Cerca de 50% das florestas do mundo são tropicais, e destas, 42 % são classificadas com florestas secas (HOLDRIDGE, 1967). Dentro desta definição de Florestas Tropicais Sazonalmente Secas (FTSS) incluem diferentes fitofisionomias que podem variar de florestas de porte mais alto assim como florestas com predominância de arbustos e suculentas. Portanto, o volume precipitado, a sazonalidade das chuvas e o balanço hídrico são as características que as definem melhor: precipitação menor que 1800 mm por ano com aproximadamente 5-6 meses recebendo menos de 100 mm (PENNINGTON; LAVIN; OLIVEIRA-FILHO, 2009; SILVA; LEAL; TABARELLI, 2018). As Florestas Tropicais Sazonalmente Secas nos neotrópicos são distribuídas em cerca de 2.700.000 km^2, sendo 800.898 km^2 distribuídos na Mesoamérica, 88.472 km^2 no Caribe e os restantes 1.811.741 km^2 na América do Sul (QUEIROZ et al., 2017). Devido ao grande número de espécies raras e endêmicas adaptadas a escassez e imprevisibilidade hídrica, as FTSS são extremamente importantes do ponto de vista da conservação da diversidade biológica e muitas lacunas do conhecimento ainda precisam ser preenchidas sobre esse assunto (BLACKIE et al., 2014; SANTOS et al., 2011).

Diante do histórico de ocupação humana nas florestas secas, estas são também fundamentalmente importantes na manutenção destas populações, tradicionais ou não, que dependem direta ou indiretamente da biodiversidade para alívio da pobreza e suporte do desenvolvimento econômico (DAVIDAR et al., 2010; PENNINGTON; LAVIN; OLIVEIRA-FILHO, 2009; RIBEIRO et al., 2015; SÁNCHEZ-AZOFEIFA et al., 2005; SMITH et al., 2010). As populações humanas que vivem em florestas secas também desenvolveram estratégias de sobrevivência para se adaptar as condições climáticas limitantes (LADIO; LOZADA, 2004). As FTSS fornecem diversos bens para alimentação de populações locais incluindo frutas nativas, mel, castanhas e carne de caça como fontes de proteínas (ALVES et al., 2009; SUNDERLAND et al., 2015; SUNDERLIN et al., 2008). Da mesma forma plantas nativas são utilizadas para diversos fins como por exemplo, alimentício, medicinais e energéticos. Lenha e carvão ainda continuam sendo as principais fontes energéticas das populações de baixa renda nos trópicos, atuando na maioria dos casos como substitutos aos combustíveis derivados de petróleo aliviando, desta forma, a pobreza uma vez que recursos madeireiros são normalmente adquiridos de forma gratuita ou a baixo custo (LATHAM et al., 2017; SHACKLETON et al., 2011; WUNDER, 2001).

SHACKLETON et al (2007) utilizaram as florestas secas da África do Sul como estudo de caso para relatar a importância destas florestas para a manutenção dos meios de vida de populações indígenas locais e alívio da pobreza através de uso direto dos recursos e da geração de empregos no setor florestal. As florestas suportam diretamente o modo de vida da população rural em todo mundo e geram de acordo com a FAO, emprego para mais de 100 milhões de pessoas (BAKKEGAARD et al., 2016). Nas FTSS, inclusive no Brasil, já foram descobertos diversos fármacos através de estudos de bioprospecção em comunidades tradicionais que usam ancestralmente e em muitos casos vendem espécimes vegetais para tratamentos de saúde (PETERS, 2011). Além do suporte de cunho medicinal e espiritual (i.e. uso em rituais e celebrações) que as FTSS fornecem a diversas etnias em todo mundo, estas também mantém o fornecimento de serviços ecossistêmicos (i.e. polinização, regulação hídrica) para populações locais e pequenos agricultores (CALVO-RODRIGUEZ et al., 2017; DAVE; TOMPKINS; SCHRECKENBERG, 2017).

Entretanto, apesar de toda importância já documentada, quando comparadas a florestas úmidas, as florestas secas receberam ao longo dos anos menos esforços de pesquisa fazendo com que existam ainda diversas lacunas do conhecimento a serem preenchidas sobre biodiversidade, socioeconômica e conservação destas florestas (SUNDERLAND et al., 2015). Em uma análise global sobre as florestas secas, o CIFOR apontou as prioridades de pesquisas na América Latina e Caribe: "*o papel das florestas para alimentação e nutrição de populações locais e indígenas; estudos não apenas sobre como as pessoas "limpam" a floresta para agricultura, mas mais esforços precisam ser direcionados aos usos e usuários das florestas, pequenas empresas florestais, adaptação às alterações climáticas e a gestão da produção florestal*" (BLACKIE et al., 2014). Numa escala global, quase metade e cerca de 2/3 das florestas secas originais das américas já foram convertidas em outros tipos de uso (HOEKSTRA et al., 2005; PORTILLO-QUINTERO; SÁNCHEZ-AZOFEIFA, 2010).

As perturbações de origem antrópica têm crescido gerando a maior crise da diversidade biológica em uma escala global, mas também os impactos estão presentes nas escalas regional e local (LAURANCE et al., 2012). Nas florestas secas da América do Sul a maior parte da conversão de florestas se deu pela expansão de atividades relacionadas a agricultura e criação de animais (STOLTON et al., 1999). O desmatamento é a maior causa de conversão de solo nas áreas das florestas tropicais. Este tipo de perturbação envolve a remoção de grandes quantidades de biomassa, notáveis na maioria das vezes vistas o por imagens aéreas por exemplo (LAURANCE; PERES, 2006; PERES; BARLOW; LAURANCE, 2006). Um outro tipo de perturbação bastante frequente nas florestas tropicais são as perturbações antrópicas crônicas (do inglês, *Chronic Anthropogenic Disturbances* - CAD), que implicam na remoção contínua e gradual de pequenas quantidades de biomassa (SINGH, 1998). Alguns exemplos destas perturbações crônicas, incluem coleta de produtos não madeireiros (i.e. frutos, cascas, folhas, etc.), extração seletiva de madeira e criação extensiva de rebanhos (MARTORELL; PETERS, 2005). Estes distúrbios têm sido documentados como responsáveis por gerar empobrecimento e por alterações nas estruturas das florestas secas tropicais (RIBEIRO-NETO et al., 2016; RIBEIRO et al., 2015; RITO; TABARELLI; LEAL, 2017; SINGH, 1998).

2.2 Impactos socioeconômicos das mudanças climáticas e das áreas protegidas sobre populações locais e sobre a biodiversidade

Com o aumento da população mundial e as necessidades de expansão de áreas para o desenvolvimento de atividades para satisfação de necessidades humanas, estratégias de conservação da biodiversidade precisam cada vez mais serem efetivas (FAO, 2014). Com a principal finalidade de conservação da biodiversidade, as áreas protegidas foram criadas em diversas partes do mundo. A IUCN definiu sete categorias de áreas protegidas onde algumas permitem a presença de assentamentos humanas (áreas de uso sustentável) e outras não (completa proteção) (STOLTON et al., 1999). Entretanto, a maioria das áreas protegidas criadas já possuíam assentamentos humanos, muitas vezes comunidades tradicionais que tem utilizado as áreas por muitas gerações para desenvolvimento de seus meios de vida e sua reprodução cultural (DIEGUES, 1998). Assim, o processo de criação e implantação de áreas protegidas pode gerar conflitos de natureza socioecológica e trazer como consequências benefícios ou prejuízo às populações humanas que viviam ou vivem no local ou próximas onde as estas áreas (FAO, 2014; NAKAMURA; HANAZAKI, 2016). Portillo-Quintero & Sánchez-Azofeifa (2010) encontraram em seus estudos o valor de apenas 6.6% das florestas secas da América do Sul estão inseridas dentro de algum tipo de áreas protegidas.

Desde a criação do primeiro Parque Nacional em Yellowstone em 1872, muitas áreas em todo mundo foram convertidas em Parques Nacionais sem a presença de assentamentos humanos (LANGHAMMER, 2007). Esse modelo de área protegida primeiramente adotado pelos Estados Unidos, foi seguido por muitos países em desenvolvimento incluindo o Brasil com a criação do primeiro Parque em 1937, em Itatiaia. Da mesma forma de Yellowstone, na maioria dos parques existiam famílias que viviam antes de sua criação o que gera conflitos de interesse entre as agendas de desenvolvimento social e da conservação da biodiversidade (ADAMS; HUTTON, 2007; BROCKINGTON; IGOE; SCHMIDT-SOLTAU, 2006; BROCKINGTON; WILKIE, 2015; HOLLAND et al., 2010; SUNDERLAND, 2011). Esse é um tema polêmico que tem sido estudado há décadas em áreas protegidas em todo mundo (BERNARD; PENNA; ARAÚJO, 2014; WATSON et al., 2014).

A retirada das pessoas das áreas onde originalmente moravam pode afetar moralmente as pessoas ferindo seus direitos humanos e a restrição ao acesso de recursos naturais anteriormente utilizados pode afetá-los socioeconomicamente (BLANEY; BEAUDRY; LATHAM, 2009; GBETNKOM, 2008; NAKAMURA; HANAZAKI, 2016). Vedeld et al., (2012) encontraram que a implementação de Parques na Tanzânia gerou o de conflitos do uso dos recursos devido ao aumento da escassez de terras somado em áreas mais densamente povoadas e desiguais. No sul do Brasil, a implantação de uma área protegida de proteção completa em uma porção de floresta úmida influenciou a dieta das famílias tanto pela restrição de acesso aos recursos naturais como pela mudança nas atividades locais geradoras de renda (NAKAMURA; HANAZAKI, 2016). KIPURI (2006) relatou a violação dos direitos humanos pela criação de áreas protegidas no Quênia. Diegues levantou a questão em seu livro "*The myth of untamed nature in the Brazilian rainforest*" sobre a negligenciada presença de humanos vivendo em parques na Floresta Atlântica (DIEGUES, 1998). Essa ainda é uma realidade frequente nas áreas protegidas no território brasileiro e que traz consequências diretas para as populações locais, embora não se tenham números exatos e este é um assunto muito debatido na ciência atualmente.

Por outro lado, as áreas protegidas a nível global prestam benefícios diretos (i.e. alimentação, lenha) e indiretos (i.e. empregos e serviços ecossistêmicos) a milhões de pessoas para a manutenção de seus meios de subsistência (FAO, 2014). Existem inúmeros estudos apontando os benefícios áreas de conservação para a biodiversidade (EDGAR et al., 2014). Ferraro & Hanauer (2014) encontraram aumento na renda das comunidades com a implantação de áreas protegidas na Costa Rica devido ao envolvimento em atividades de turismo. Da mesma forma, na Tailândia, outro estudo apontou a redução da pobreza de populações que vivem nas áreas de entornos de áreas protegidas (HOLLAND et al., 2010).

Assim, não existe consenso a nível mundial se a pobreza é reduzida ou as condições socioeconômicas de populações locais são melhoradas com a implantação de áreas protegidas devido as diferentes condições políticas e socioeconômicas de dos países (BROCKINGTON; WILKIE, 2015). Entretanto, os Estudos que reportam casos de implantação de áreas protegidas com benefícios para comunidades locais como por exemplo o alívio da pobreza, associam o sucesso ao envolvimento da comunidade como atores chaves do processo (BAIRD, 2014). Exemplos bem-sucedidos implementação de áreas protegidas envolvem a participação direta das comunidades, governos e organizações (ADAMS et al., 2004). Muitos dos exemplos positivos de resolução de conflitos incluem estratégias manejo de base comunitária, investimentos em saúde, educação e turismo no entorno das áreas protegidas (BARRETT; TRAVIS; DASGUPTA, 2011; FERRARO; HANAUER; SIMS, 2011; NOLTE et al., 2013). A União Internacional para a Conservação da Natureza e dos Recursos Naturais (IUCN) e parceiros implementaram uma plataforma online para o compartilhamento de soluções e histórias de sucesso em quatro áreas temáticas sendo uma delas, áreas protegidas (http://www.panorama.solutions/en).

Além dos conflitos em áreas protegidas, as comunidades rurais e tradicionais, estão sobre grande ameaça das alterações climáticas previstas principalmente as que habitam florestas secas. As mudanças climáticas têm sido tema de debate pelos cientistas há décadas e são apontadas atualmente por serem uma ameaça à vida no planeta (IPCC, 2014a). Entretanto, estudos apontam que pouca atenção foi reservada aos impactos das mudanças climáticas no modo de vida de populações tradicionais e rurais de modo de subsistência a agricultura camponesa (BAKKEGAARD et al., 2016). Já foram reportados de acordo com o IPCC (Painel Intergovenamental sobre Mudanças Climáticas), efeitos adversos das mudanças climáticas por exemplo na produção de grãos, na saúde humana, biodiversidade e estoques pesqueiros (IPCC, 2014b). Inclusive, dados apontam que a segurança alimentar das populações humanas poderá ser prejudicada devido ao empobrecimento na composição nutricional dos grãos com os eventos climáticos extremos esperados (BAKKEGAARD et al., 2016). A falta de água diminui a capacidade de produção dos pequenos produtores e de acordo com Instituto de Pesquisas Internacionais em Política Alimentar (IFPRI) estima que as mudanças climáticas irão afetar negativamente mais de 50 milhões de pessoas pela geração de desnutrição. Com a redução de áreas propícias para o plantio, é também esperado que existam mais conflitos entre uso de terras e de recursos naturais com áreas protegidas. Sendo estudos que elucidam essas relações mais que nunca de extrema importância nas florestas secas.

2.3 Caatinga como modelo para estudos socioecológicos e etnoecológicos em florestas secas

A Caatinga está representada em aproximadamente 10% do território brasileiro com 912,529 km² distribuídos por 1,213 municípios entre os nove estados brasileiros (Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Piauí, Alagoas, Sergipe, Bahia e Minas Gerais) (MMA; IBAMA, 2011). A Caatinga se extende aproximadamente de 2°54’ a 17°21 S, é composta por diferentes fitofisionomias e caracteristicamente por mosaicos de arbustos espinhosos e florestas sazonalmente secas. A distribuição da Caatinga é sobreposta à região semiárida no Brasil, de clima tropical quente com baixa pluviosidade, com duas estações distintas, a chuvosa que varia de 3 a 5 meses por ano, e a seca de 7 a 9 meses que pode variar dependendo da localidade. As chuvas interanuais são bastante variáveis e desta forma, as populações locais podem experienciar as secas perduram por anos. A maior parte da Caatinga recebe entre 600 a 1000 mm de chuva anuais, porém em algumas áreas pode receber menos de 400 e em algumas montanhas a chuva orográfica pode atingir até cerca de 1800 mm (SILVA; LEAL; TABARELLI, 2018).

Apesar da Caatinga ser uma floresta seca, esta abriga uma substancial biodiversidade. São estimadas cerca de 3.150 espécies de plantas fanerógamas nativas, mais de 200 espécies de formigas, mais de 380 espécies de peixe, quase 100 espécies de anfíbios, 79 espécies de lagartos, mais de 500 espécies de aves e 183 de mamíferos (SANTOS et al., 2011; SILVA; LEAL; TABARELLI, 2018). Muitas das espécies descritas são endêmicas e cientistas continuam a descrever espécies novas em diferentes grupos biológicos. As famílias botânicas que são mais representativas na flora da Caatinga são as cactáceas, as leguminosas e euforbiáceas embora existam diferenças na composição florística das diferentes fitofisionomias (MORO et al., 2014). A Caatinga também possui grande valor na manutenção de serviços ecológicos e culturais que beneficiam diretamente e indiretamente milhares de sertanejos (nome dado aos nativos da Caatinga).

As espécies da flora da Caatinga são adaptadas ao clima semiárido são utilizadas pela população local para diversas finalidades (ALBUQUERQUE; ANDRADE, 2002). Albuquerque et al., (2005) encontraram que aproximadamente 80% das espécies disponíveis na flora local de uma área de Caatinga possuíam usos conhecidos para alimentação, construção, lenha ou medicina tradicional. Ao longo dos anos mais estudos têm sido realizados sobre as espécies da flora da Caatinga devido seu crescente potencial biotecnológico, alimentício, forrageiro e bioenergético (ALBUQUERQUE; RAMOS; MELO, 2012; DE MELO et al., 2011;

NUNES et al., 2016; OLIVEIRA et al., 2012; RAMOS et al., 2008). Algumas espécies nativas possuem atributos chaves que as tornam atrativas tanto para animais como para o consumo humano. O umbu, fruto do umbuzeiro (*Spondias tuberosus*) é dos frutos mais apreciados pela população sertaneja além de servir de base de subsistência e econômica para muitas famílias do semiárido brasileiro (Neto et al 2010). Diferentes espécies de palmeiras como o licuri/ouricuri/licuri (*Syagrus coronata*) são amplamente utilizadas pela população sertaneja, desde suas folhas para a produção de artesanato assim com os frutos de muitas espécies são usados para alimentação humana (RUFINO et al., 2008). A aroeira (*Myracrodruon urundeuva*) é uma árvore nativa que possui em suas cascas e folhas propriedades medicinais bastante apreciadas para tratamento de diversas enfermidades tais como infecções uterinas, úlceras e gastrites (LINS NETO et al., 2008).

Dessa forma, a Caatinga é um grande sistema socioecológico que possui um histórico de ocupação marcado pela escassez de água, pobreza e uso da terra. Atualmente é a região semiárida do mundo com maior densidade populacional (cerca de 20-30 habitantes/km^2), possuindo cerca de 28 milhões de habitantes, sendo aproximadamente 43,5% dessa população rural, onde a maioria das famílias dependem diretamente dos recursos naturais para sobrevivência (MEDEIROS et al., 2012b; SILVA; LEAL; TABARELLI, 2018). A biodiversidade é a base de amparo dos sertanejos para diversas atividades econômicas principalmente do ramo agrosilvopastoril. A agricultura que geralmente implica em manejo da terra através de coivara (corte seguido de queima da vegetação) e a criação extensiva de rebanhos são as atividades mais praticadas por pelos sertanejos como atividade de subsistência. Mais estudos e políticas devem ser realizadas para que a Caatinga seja explorada de forma sustentável devido ao grande potencial para desenvolvimento da região que essa floresta possui (MMA; IBAMA, 2011). Entretanto, ainda recebe pouca atenção do ponto de vista da conservação da biodiversidade e do conhecimento tradicional local quando comparado às florestas úmidas como a Amazônia e Mata Atlântica por exemplo (LEAL et al., 2005; SANTOS et al., 2011).

A biodiversidade da Caatinga está ameaçada pelas mudanças climáticas e pela conversão de áreas naturais. Reportes do Painel Intergovernamental sobre Mudanças Climáticas, baseados em previsões estatísticas, afirmam que a Caatinga é uma das áreas do globo que serão diretamente afetas pelas mudanças no clima pela redução da precipitação e aumento da temperatura. Algumas previsões estimam para o final do século XXI a redução de 22% na precipitação da Caatinga (IPCC, 2014a). São esperados para Caatinga, o aumento na duração das secas, aumento da evapotranspiração, aumento de áreas desertificadas. Essas alterações trarão consequências negativas relativas ao empobrecimento de fauna e flora da Caatinga, e a populações humanas dependente dos recursos naturais.

Grandes áreas de Caatinga já foram convertidas devido ao desmatamento para agricultura, obras de transposição do Rio São Francisco, abastecimento de indústrias com carvão e lenha são responsáveis por boa parte da conversão de. Estima–se que 46% das áreas naturais de Caatinga já foram convertidas em paisagens antrópicas (BEUCHLE et al., 2015). Tornando a Caatinga um bioma necessitado de investimento em projetos de reflorestamento (SEGAN; MURRAY; WATSON, 2016). Alguns autores também apontam para o risco de desertificação da Caatinga por uso inadequado do solo somado a condições ambientais (COSTA et al., 2016). São estimados que mais de 75% da região sofre com riscos de desertificação (SÁ; ANGELOTTI, 2009). Além disso, apenas menos de 10% de áreas da Caatinga estão cobertas por algum tipo de Unidade de Conservação, que em teoria tem a função de proteger a biodiversidade e regulamentar o uso da terra (MMA; IBAMA, 2011). Adicionalmente, diversos autores vêm documentando o empobrecimento da vegetação, perda de diversidade funcional e filogenética através devido ao uso dos recursos naturais de forma não sustentável (RIBEIRO-NETO et al., 2016; RIBEIRO et al., 2015; RITO et al., 2016; RITO; TABARELLI; LEAL, 2017).

A etnobotânica é uma das etnociências que têm sido utilizadas cada vez mais como uma ferramenta no auxílio de resolução de conflitos de uso de recursos naturais por comunidades tradicionais (GAOUE et al., 2017; LUCENA et al., 2007). Apesar de ter iniciado como uma ciência mais ligada a sistemática devido a descrição das espécies uteis o principal objetivo dos primeiros estudos, esta ciência tem se desenvolvido e se apropriado de diversas áreas do conhecimento, inclusive sendo bastante utilizada em estudos quantitativos com enfoque de conservação da biodiversidade (BALICK; COX, 1996; ETKIN, 1988; JESUS; OLIVEIRA, 2014). Por exemplo, (GAOUE et al., 2017) publicaram uma revisão sobre as 17 principais teorias e hipóteses em etnobotânica e apontaram lacuna e avanços na pesquisa etnobotânica. Estes autores discutem sobre a teoria amplamente testada da seleção não aleatória de plantas para o uso medicinal, onde plantas pertencentes a certas famílias botânicas possuem mais atratividade devido a sua composição química quando comparada a outras. SASLIS-LAGOUDAKIS ET AL. (2011) encontraram um padrão filogenético não aleatório de seleção de plantas para uso medicinal, onde famílias mais próximas possuíam mais espécies utilizadas que outras. Dessa forma, análises filogenéticas são ferramentas adicionais aos estudos etnobotânicos para auxiliar no entendimento das relações de parentesco entre espécies tradicionalmente utilizadas com fins de conservação da diversidade não só de espécies, mas de linhagens genéticas inteiras (YESSOUFOU; DARU; MUASYA, 2015). Disciplinas recentes como a Biologia da Conservação também surgiram com o intuito de resolver a crise atual da biodiversidade (RODRIGUES; PRIMACK, 2001). Assim, a interdisciplinaridade tem sido a chave para o entendimento de problemas complexos que envolvem o uso de recursos naturais por populações humanas.

Existe de modo geral, uma tendência crescente das publicações sobre etnobotânica na Caatinga. LIPORACCI et al. (2017) em revisão, encontrou 66 artigos publicados antes de 2015 na Caatinga que tratassem de etnobotânica mas com foco em uso e conhecimento de plantas medicinais e plantas alimentícias devido ao grande potencial biotecnológico. De modo geral, a maioria destes estudos têm como objetivo a descrição geral do uso e conhecimento das espécies como por exemplo o estudo de Neto & Jesus (1999) desenvolvido há quase 20 anos e até alguns como os de Lima et al., (2016) e Silva et al. (2014) recentemente desenvolvidos. Desta forma, a importância das plantas da Caatinga para uso este uso, tem sido bem documentada nas últimas décadas inclusive várias hipóteses têm sido testadas a partir de dados coletados exclusivamente sobre esta categoria de uso (GAOUE et al., 2017). Peters (2011) escolheu revisar estudos sobre 30 plantas úteis medicinais de importância para populações humanas das florestas secas neotropicais onde pelo menos 12 dessas são plantas utilizadas por populações sertanejas na Caatinga demonstrando a importância das plantas deste domínio para estudos de bioprospeção.

Não foram realizados muitos estudos em outras categorias como o uso de madeira para fins energéticos na Caatinga embora exista uma grande população dependente desse recurso. Quatro estudos têm enfoque especificamente nessa categoria dois desenvolvidos na Paraíba e dois em Pernambuco: Ramos (2015); Ramos et al., (2008b); Ramos and Albuquerque (2012); Sá E Silva et al. (2009). Estes estudos em conjunto buscaram entender quais as espécies utilizadas e conhecidas, assim como o que gera o padrão de coleta e como a sazonalidade interfere no uso dos recursos. Nascimento et al. (2009) reportou o uso de espécies vegetais nativas em cercas e ressaltou a importância de se estimular a o uso de cercas vivas para a conservação da biodiversidade na Caatinga. Florentino et al. (2007) documentou a importância contribuição dos quintais para a conservação da Caatinga. No estudo com 25 quintais, os autores reportaram 84 espécies empregadas para diversos usos além da importância das lenhosas para uso como lenha, o que implica em redução do impacto na vegetação local.

Abordamos até o momento de forma geral, a importância das florestas secas do ponto de vista biológico e social, e como ao status de proteção, mudanças climáticas previstas e uso não sustentável dos recursos podem afetar estas florestas. Também, como as ciências tem evoluído para tratar de questões que envolvem sistemas socioecológicos complexos onde a biodiversidade e o bem-estar humano estão envolvidos. A FAO e CIFOR recomendam estudos sobre o impacto das mudanças climáticas nas populações humanas residentes em florestas secas. Devido ao risco à biodiversidade destas florestas por atividades humanas, mudanças climáticas e ainda a necessidade de entendimento destes ecossistemas secos, a Caatinga é um complexo sistema que oferece essa oportunidade de estudos. Desta forma, nesta tese iremos preencher algumas lacunas do conhecimento sobre a relação dos seres humanos com a biodiversidade na Caatinga, especialmente no que diz respeito aos determinantes socioeconômicos e ambientais do uso de plantas e suas consequências ecológicas.

3 RESULTADOS

3.1 Socioeconomic differences among resident, users and neighbour populations of a protected area in the Brazilian dry forest

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Research article

Socioeconomic differences among resident, users and neighbour populations of a protected area in the Brazilian dry forest

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ABSTRACT

Protected areas are an important strategy to safeguard biodiversity. However, if social development is not considered, biological conservation targets may not be achieved. In this empirical study, we assess the relationship between poverty and conservation goals in dry forests within a 62,000-ha Brazilian National Park (Caatinga biome). We conducted 81 structured household interviews between January and July of 2016 to assess socioeconomic, resource management and land-use variables. We used non-parametric analysis of variance to test for differences in socioecological variables among families living inside and outside the Park and both (double dwelling). The majority of families (76%) residing inside the Park were living below the poverty line while less than 14% in outside and double dwelling residences faced the same issue. Families living inside the park had lower socioeconomic conditions such as limited water availability, poor house infrastructure, low income, and high dependence on firewood than outside and double dwelling families. They were also more dependent on external financial support and natural resources. We found that failures in protected areas inception and implementation have driven people towards a mutually reinforcing and declining situation in which negative socioeconomic outcomes are associated with nature degradation. Therefore, our results suggest that the future of dry forests, characterized worldwide by the presence of low-income populations, will be largely dependent on conservation strategies that address poverty alleviation and human well-being.

1. Introduction

Protected areas (PAs) have been the main strategy to safeguard biodiversity worldwide (Brockington and Wilkie, 2015; Laurance et al., 2012; Myers et al., 2000; Naughton-Treves et al., 2005). Due to the current and global biodiversity crisis, high loss and species extinction rate, one of the targets of the Convention on Biological Diversity is to expand PAs to around 17% of all terrestrial areas worldwide by 2020 (http://www.cbd.int/sp/targets). However, many studies have highlighted the limitations of PAs in accomplishing species conservation and distributing benefits to humans, dwellers of PAs or not (Butchart et al., 2010; Laurance et al., 2012). Additionally, PAs have generated conflicts of interest between social goals and environmental conservation policies given that, in most cases, human settlements were present before the creation of PAs (Brockington et al., 2006; Nicolle and Leroy, 2017) and a substantial proportion of natural resource allocations upon which human population is dependent is inside PAs (Chape et al., 2005). In developing countries, the negative impacts of PAs on local communities can be significant, particularly for those living in poverty prior to PA creation (Adams and Hutton, 2007; Cernea and Schmidt-Soltau, 2006).

Many studies from the last few decades have tried to understand whether PAs have created positive or negative impacts in attempts to reduce local poverty (Adams and Hutton, 2007; Brockington et al., 2006; Ferraro and Pressey, 2015; Kepe et al., 2004; Roe and Elliott, 2004; Watson et al., 2014). In Thailand and Costa Rica, governments have been investing in policies to protect biodiversity associated with poverty reduction (Andam et al., 2010; Ferraro et al., 2011). In some cases, though, human populations inside or in PA boundaries are

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incapable of escaping poverty because they are strongly resource reliant and fall into a cycle of dependence due to few opportunities to improve their socioeconomic condition (Nakamura and Hanazaki, 2016; Vedeld et al., 2012). Poverty can drastically reduce the household's capacity to invest in land management, for example, limiting the additives, tools or irrigation purchase to improve livestock and food production (Nkonya et al., 2008; Swallow et al., 2008). Poor families can also have high dependence on natural resources harvesting (Medeiros et al., 2012; Specht et al., 2015). Usually, in forest-rich areas in remote places in developing countries, people have fewer opportunities for income improvements (Wunder, 2001), low or no access to markets, and sometimes reduced water supply (Blackie et al., 2014; Top et al., 2004). As such, the socio-economic parameters of landscapes (Papadimitriou, 2012) and the mechanisms that create and maintain poverty in PAs need consideration for a successful environmental management and a local social development (Barrett et al., 2011; Ferraro et al., 2011).

There is a consensus that PAs are more effective when they are well supported by local residents; therefore, conservation plans in these areas have been increasingly considering the protected areas as coupled human-natural systems (Chen et al., 2017) or socioecological systems - SES (Wei et al., 2018). SES are defined as complex and linked systems of people and nature composed of multiple subsystems and internal variables. The concept of SES implies that PAs do not exist in isolation: they are dependent on the broader SES in which they are inserted, driven by both socioeconomic and ecological processes; in turn, PAs can influence not only ecological processes, but also local livelihoods and human well-being (Wei et al., 2018).

Since the 1980s there has been increasing emphasis on ensuring that local communities benefit from biodiversity conservation (Emerton et al., 2006). While there is evidence of support to PAs from local communities that experienced losses related to their livelihoods (Martin et al., 2018), a meta-analysis based on data from 165 PAs revealed that positive conservation outcomes are more likely to occur where PAs lead to socioeconomic benefits for the affected communities (Oldekop et al., 2016). The quantitative analysis of these benefits suggests that tourism and recreational activities contribute most to poverty alleviation (Ferraro et al., 2014), even though they are known to be limited by the few people involved and the capabilities and infrastructure required to engage in tourism (Kiss, 2004).

Payment for ecosystem services (PES) constitutes another option that, when designed appropriately, can be an alternative for delivering conservation goals in PAs while benefiting local people (Clements and Milner-Gulland, 2015; Yang et al., 2018). The central idea of PES is that conservation costs suffered by communities in target areas should be compensated to avoid impeding socioeconomic development of those local communities (Yang et al., 2018). Nevertheless, PES programs often induce the decrease in traditional livelihood activities, which can have cultural implications and affect SES resilience, i.e., its capacity of continually change and adapt yet remains within critical thresholds (Folke et al., 2010). Therefore, the most successful PES schemes are the ones that secure the continued provisioning of a critical resource while positively contributing to local livelihoods in rural communities and PAs (Grima et al., 2016).

Brazil has approximately 220 million ha covered by PAs (Bernard et al., 2014), being one of the largest protected area systems in the world (Oliveira and Bernard, 2017). National Parks (NPs) in Brazil are strict PAs where direct natural resources exploitation is not allowed (Law 9.985/2000, Brasil, 2000). Thus, local residents established before NP creation expect to be notified of Park creation, receive assistance during the process and be fairly financially compensated to leave the area in the first five years of PA inception (MMA and IBAMA, 2011). However, compensation has failed in most cases and thousands of families remain living in Brazilian NPs (in not regularized land tenure condition). In the new conditions, where livelihood becomes particularly fragile, the biodiversity and the PA's existence themselves are threatened (Bernard et al., 2014; Bragagnolo et al., 2016; Diegues, 1998). More than 60% of the NPs in Brazil created before 2000 had problems related to land tenure involving local residents (Rocha et al., 2010; Oliveira and Bernard, 2017). Nevertheless, Brazil is not unique in sustaining "paper parks", in which the PA exists only in name (Stolton et al., 1999). Also, removing residents from PAs, although supported by law, can further represent a serious threat to human rights and exacerbate poverty especially in developing countries (Adams et al., 2004; Kipuri, 2006).

The Brazilian Caatinga is one of the world's most populated seasonally dry tropical forest. It has ~28 million inhabitants distributed over 800,000 km^2 with a history of poverty associated with water scarcity, often even for basic human needs (Barbieri et al., 2010; Redo et al., 2013; Santos et al., 2011). It is also the largest and most diverse seasonally dry tropical forest in the world (Silva et al., 2018). About 43.5% of the Caatinga population lives in rural places and most of it is comprised of small farmers living in high dependence of natural resources for their livelihoods. Thus, the socioeconomic and environmental context of the Caatinga offers an interesting opportunity to examine the relationships between poverty and conservation in PAs.

In this study, we use the Catimbau National Park, located in the Caatinga of Pernambuco state, Brazil, as a case study to assess the relationship between poverty and conservation goals. Our main objective is to evaluate whether families living inside the Park are in a worse socioeconomic condition and dependence on natural resources use more than outside families. We do this by describing socioeconomic conditions and infrastructure development, as well as use of landscape and plant resources by dwellers. We then discuss the consequences of local socioeconomic condition associated to natural resources use by local livelihoods and biodiversity conservation in the PA.

2. Materials and methods

2.1. Study area

The Caatinga's vegetation is a mosaic of xeric and thorn plant species, it is larger than the areas of Italy, Germany, and United Kingdom together (Leal et al., 2005). It harbors 3150 native species of flowering plants, although it is expected that there may be up to 40% more species that have not been sampled yet (MMA and IBAMA, 2011; Moro et al., 2014). The number of endemic biological species that offer sufficient data to make such calculations are quite astonishing, ranging from 6.0% in mammals to 52.9% in fishes (Silva et al., 2018).

Only 7.5% of Caatinga is within PAs, and less than 2% is fully protected, that means without human settlement "in theory" (MMA and IBAMA, 2011). Create and maintain those protected areas are extremely important once, nearly 46% of Caatinga's area is deforested (Beuchle et al., 2015), and it is thought that 15% of the deforested areas have been desertified due to inappropriate land use (Silva et al., 2018). The region is among the top six ecosystems with the largest intrinsic vulnerability to climate variability (Seddon et al., 2016). Caatinga's vegetation has been suffering for many decades due to the impacts of acute disturbances (i.e. habitat loss by charcoal production) and chronic anthropogenic disturbance (i.e. firewood collection and slash-and-burn agriculture) (Ribeiro et al., 2015; Segan et al., 2016; Silva et al., 2018).

Caatinga has many traditional people including "*Sertanejos* or *Catingueiros*" who are descendants of a mix between Brazilian Indigenous, European colonizers and sometimes African slaves that have lived in the region for many generations adapting to environmental restrictions, especially water irregularity. In Brazil, traditional communities use natural resources as a contribution to "their cultural, social, religious, ancestral and economic reproduction" (Brazilian Decree Nº 6.040 of 2007). The *Sertanejos* use native plants for different purposes including fuelwood, food, animal fodder and medicine (Lucena et al., 2008; Ramos et al., 2008). Most have low family income and need the social welfare and income program of the Brazilian

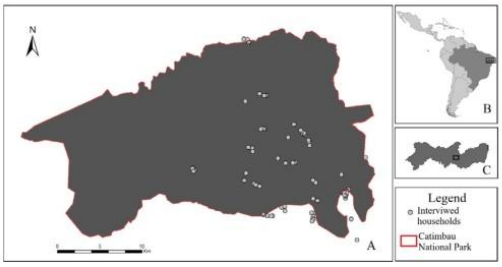

Fig. 1. Location of the study area, Catimbau National Park map (A), Pernambuco State (B), and Brazil (C). Grey dots represent households interviewed between January and July of 2016.

government the *Bolsa Família* or emergency income, to survive, especially in the dry season, when water scarcity becomes exacerbated and the food production is ceased and water storage is ending (Paiva et al., 2014). While in the Amazon there are successful PES schemes for traditional communities living within and outside PAs, such as the *Chico Mendes* law and the *Bolsa Floresta* program (Grima et al., 2016), in Brazilian dry forest PES initiatives or other economic incentives for biological conservation are absent.

Our data collection was conducted in Catimbau National Park (IUCN Category II). The park is located in Pernambuco state in Northeastern Brazil (8º24′00″ and 8º36′35″ S; 37º0′30″ and 37º1′40″ W) and it was created in 2002 to preserve its biodiversity and scenic beauty, encompassing around 62,000 ha of Caatinga vegetation (Fig. 1). The vegetation is a mosaic of low stature dry forest and shrubs, including xeric and non-xeric species with stands regenerating after slash-and-burn agriculture or livestock raising (Rito et al., 2016). The climate is semiarid, with an annual average temperature of 23 °C and annual mean precipitation ranging from 486 mm to 975 mm. Archaeological studies described traces of human occupation as cave paintings in some areas of the park dating to at least 4000 years ago (Oliveira, 2001).

There are approximately 300 *Sertanejos* families distributed among 17 studied communities living inside the Park (some families recognize themselves as indigenous) (Fig. 1). They remain because the process of expropriation of land has not been completed and is not advancing. There are three large communities (> 200 families in each) residing outside the Park within a 3 km radius of the Park boundary. Some families living outside the Park also have property inside, which we refer to in this study as double dwelling families. The main livelihoods of the people inside and outside the Park are goat raising, and subsistence agriculture including cultivation of vegetable species in gardens and wild plants harvested from the forest (Santos, 2015). Slash and burn agricultural practice, hunting, goat raising and selective cut of "green wood" are prohibited inside park, however, it was possible to observe these activities at several moments of our field research. There are some testimonials of residents who were fined for conducting illegal activities. These uses of natural resources by local residents was documented as leading to a significant reduction in woody plant diversity, especially in drier areas of the Park (Rito et al., 2016).

The Park rules for resource and land uses impose restrictions for tourists and residents, but control is insufficient. The park does not have a headquarters office and it has only one employee to manage all the bureaucracies and surveillance with sometimes no enough financial resources even for fill up the car tank with fuel. Due the delay in finish the process of expropriation and difficulties of management, we call the Catimbau National Park as a "paper park". Lawfully in Brazil, a management plan must be prepared within no more than five years after PA inception, and, until the management plan is drawn up, all activities should be limited to those aimed at guaranteeing the integrity of the natural resources and the conditions and means necessary for the satisfaction of material, social and cultural needs of the resident traditional populations (Brasil, 2000). The Catimbau National Park was created 15 years ago, *sertanejos* were barely involved in its creation, expropriation started but is stagnated with no timeline for conclusion and the management plan is yet to be designed. In that way, hundreds of people are in not regularized land tenure situation. There are also no markets within the Park, which obliges residents to shop outside. The communities were present before Park creation, however the communities have grown and more residents have arrived since its inception. Unfortunately, there is no socioeconomic data of the families before the park inception. A non-governmental organization located in Catimbau National Park boundaries was created in 2002 to help people in vulnerability situation (www.amigosdobem.org). Families has been rescued from extremely poverty since then to work in a cashew plantation to generate income to maintaining a local village where children have access to educational activities.

2.2. Data collection

The data were collected between January and July of 2016. To understand the relation between poverty and conservation, we conducted inventories on socioeconomic aspects, home infrastructure, landscape uses and plant resource uses for each family. For this, we conducted 81 structured interviews: 43 with families living inside the Park, 21 outside and 17 in double dwelling condition (see Fig. 1). More interviews were conducted in the eastern region of the park due to greater climatic and soil similarity with outside families when compared to the western portion of the park, which is drier and with a different soil composition. We interviewed household representatives (woman/man or both together). We sampled about 10–20% of the houses or less when in the larger communities. The selection criteria for the participation of families was by convenience (sampling families available to participate in the study when we arrived in each community). We excluded those younger than 18 years old and in an altered stage of consciousness (i.e. after alcohol consumption) (Bernard, 2006). This study was approved by the National Council of Ethics in Research by the Ministry of Health in accordance with the requirements of current Brazilian legislation under the numbers 52759815.9.0000.5208 and 1.451.290.

2.2.1. Socioeconomic and infrastructure inventories

In order to assess the socioeconomic status of the interviewed families, we selected variables that could best represent the socioeconomic context of Caatinga's rural residents. We asked each family for their monetary income and educational level, number of people per family, home infrastructure, community relations and water supply, scoring the answers for data analysis (Table 1).

2.2.2. Landscapes and plant use inventory

To assess families' use of natural resources, we performed an inventory of the main uses of plant species for firewood, medicine, handcraft, food and animal fodder, in each backyard that includes garden and orchard, crop cultivation and forest areas including regenerating areas (regrowth forest after slash). During interviews, we assessed the percentage of people in each family involved in land work specifically agriculture or animal raising. When possible, we estimated the amount of firewood consumed per family/day using a hand balance (average day method) (Arias-Chalico and Riegelhaupt, 2002). To calculate an approximation of monthly firewood use we multiplied the number of days per week that the amount of firewood is used by 4 weeks. The variables used to assess landscape and plant uses are described in Table 1. In addition, we participated in guided tours with local experts for recognition and collection of plants used by families and later we identified botanical material with an expert botanist.

Table 1
Socioeconomic, infrastructural home variables, landscapes and plant resource use inventory based on 43 structured interviews with households of families inside, 21 outside the Catimbau National Park, Brazil, and 17 in double dwelling conditions.

Variables per family	Type of variable	Scores/ Values
Socioeconomic and infrastructural home variables:		
Community relations (syndicate, association/ cooperative, community, school, political party or church):	Ordinal	0 to 3
0- Do not participate		
1- Participate occasionally		
2- Always participate		
3- Is associated		
Education level of household (Number of years of formal education)	Continuous	0 to 16
Home infrastructure	Ordinal	3 to 10
Plumbing:		
1-Do not have		
2- Sewage gallery		
3-Septic Tank		
4- Full sewer		
Residence type:		
1-Clay overlay on timber		
2- Mixed clay with masonry		
3 – Masonry		
Toilet:		
1- Do not have		
2 – Outside		
3 - Inside		
Monthly monetary income US$* (Salary, governmental social welfare program, retirement, farm credit, overall sales, agricultural sales, animal sales, handicraft, non-governmental projects) *Conversion rate: 1 US dollar = 3.11 BRL	Continuous	150 to 4220
Number of people	Continuous	1 to 11
Water supply		
0- Does not have water tank, externally supplied water, or artesian well in the community	Ordinal	0 to 10
3- Have water tank or community artesian well		
6- Have water tank and artesian well in the community		
10- Have sufficient water to attend the basic needs and some surplus.		
Species use and dependence variables:		
Backyard species cultivation	Continuous	0 to 24
Crop species cultivation	Continuous	0 to 13
Forest/Regeneration species	Continuous	0 to 24
Monthly firewood use (Kg/month)	Continuous	0 to 600
Land management variables:		
Number of goats raised	Continuous	0 to 200
Percentage of people involved in land work	Continuous	0 to 100

2.3. Data analysis

We conducted a Kruskal-Wallis test to compare the three residence types (double dwelling, inside and outside the Park) in terms of socioeconomy, home infrastructure, plant use and land management (all variables in Table 1). We used Chi-square tests to compare the frequency of families below poverty line, families receiving support from Non-Governmental Organizations and families receiving financial support from the government for each residence type. All analyses were performed in R 3.4.0 (Team Core, 2017).

3. Results

3.1. Socioeconomic and infrastructure description of dwellings

We found that 35% of the total 81 interviewed families were living below the World Bank poverty line 2016 ($1.90 US dollars/person/day). Almost 84% of the 81 families were involved in agricultural activities on their own land but only 1% of the household income came from agricultural sales and 11% from animal sales, mainly goats. Slash-and-burn practices were the most common type of land preparation and only two households had formal training or support to improve land management and planting. Inside the Park 76% of the families were living below the poverty line, whereas less than 14% of families living outside or double dwelling were in the same condition. Most of the inside park families (72%) were receiving both support from non-governmental organizations like food, clothes, medicine and governmental income the "*Bolsa Família* program". Those families received proportionally more social assistance from NGOs than families outside the Park, but similar governmental financial support (Table 2).

Monthly monetary income of families living inside the Park was lower and their home infrastructure was worse (more clay buildings, fewer toilets and poorer sanitary conditions in general) than those families living outside the Park or double dwellers (Table 3). About 56% of the houses inside the Park were built with clay and wood, and had no sewerage or toilets. Irrespective of the type of residence, families were composed of less than 5 people and in general the households spent less than 5 years in formal education (Table 3). Families living inside the Park were more isolated due to the longer distance to the markets and city, engaged in fewer social and community activities, and were more susceptible to water scarcity (Table 3). Most families (84%) living inside the Park had no water tank or no external water supply, sharing the water extracted from an artesian well or water tank with other families in the community, in comparison with only 13% of families living outside the Park and double dwellings living with the same water restriction.

3.2. Landscapes and plants use by dwellers description

Double dwelling and inside the park families had goatherds 35 and 5 times larger than families living outside park, respectively. The percentage of adults involved in agriculture on farms was the same across the three setups and the number of species used from the forest and cultivated species in crop plantation did not differ (Table 3). However, the backyards of the families outside the Park had on average 2.8 times more species than double dwelling families and 2.3 times more than families inside the Park (Table 3). Double dwelling families used significantly less firewood monthly than families living inside and outside families (Table 3).

4. Discussion

Our results show that people living inside the Park were

Table 2
Families situated below the World Bank poverty line 2016 (1.90 US dollars/person/day)* and receiving governmental and non-governmental assistance living outside, in double dwelling conditions and inside the Catimbau National Park, Brazil.

Families situation	Outside Park	Double dwelling	Inside Park	X	df	P
Families below poverty line	4 (13.8%)	3 (10.3%)	22 (75.9%)	23.65	2	< 0.001
Families receiving NGO support	14 (24.2%)	9 (15.5%)	35 (60.3%)	19.69	2	< 0.001
Families receiving GO support	12 (33.4%)	9 (25.0%)	15 (41.66%)	1.5	2	0.47

p = level of significance, p > 0.05 means there no difference by the chance; df = degree of freedom; x = chi-square test value.

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ethical, respectful and lawful processes.

Learnings from other case studies around the world suggest that to ensure resilience of the socioecological system of the Catimbau, local residents must be formally acknowledged as part of the system as established by Brazilian federal law 9.985/2000 (Allison and Hobbs, 2004; Carpenter and Gunderson, 2001; Folke et al., 2005; Schelhas and Pfeffer, 2009; Walker et al., 2002). Families could be fully involved in the development of any direct or indirect economic activity developed in the Park, such as recreation, ecotourism, education and research. Governmental and non-governmental organizations (profitable or not) must be deeply involved in any transition process requested for social development (e.g. education, health, justice) and income generation to improve local people social condition and reduce the dependence on natural resources. While the Catimbau management plan is developed, we also strongly recommend that Park managers uphold the law where material, social and cultural needs for the families living inside the area are guaranteed. Under this scenario, we expect to see that as families are empowered in developing the future of the region, conservation outcomes will improve. The IUCN hosts a platform at www.panorama.solutions, to share stories of success in PA to inspire future action and the understanding of the socioecological context, and the potential sources of conflicts are indispensable to achieve sustainability goals.

5. Conclusions

In synthesis, our findings call attention to the fact that cumulative failures in PAs inception and implementation have driven people towards a mutually reinforcing and declining situation in which negative socioeconomic outcomes are associated with nature degradation, not nature conservation (Oldekop et al., 2016; Rito et al., 2017). The inefficiency of the Brazilian government agency in implement successfully PAs (Oliveira and Bernard, 2017), maintaining paper parks poorly managed for many years (i.e. in Catimbau, eleven years longer than allowed by law) and imposing high social costs, can threatening biodiversity. This keeping apparent trade-off between nature conservation and human well-being may become a synergy only if socioecological science, law and public administration work together (Silva-Junior and Santos, 2017). Unfortunately, Brazil has been implementing a series of austerity measures which resulted in budget cuts for science (43%) and environment (44%) (Angelo, 2017). Without political will, a more positive scenario for conservation, including its social dimension, is unlikely to be achieved, and the social and environmental future of the region remains uncertain. Finally, our results suggest that the future of dry forests, characterized worldwide by the presence of low-income populations, will be largely dependent on conservation strategies that address poverty alleviation and human well-being.

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3.2 Phylogenetic and ethnobotany patterns of plant use by traditional populations of the Brazilian Caatinga

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Phylogenetic and ethnobotany patterns of plant use by traditional populations of the Brazilian Caatinga

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Abstract

In this empirical study, we combined socioeconomic, botanical and phylogenetic methods to understand the pattern of species use in five categories by traditional communities in a seasonally dry tropical forest of Northeast Brazil, as well as, we discuss the implications of such patterns on the species conservation. We tested using general linear models analysis the hypothesis that higher socioeconomic status reduces species uses directly from forest using data from 81 semi-structured interviews. Additionally, we tested for phylogenetic signal for uses categories in order to estimate those that reduce or maintain plant evolutionary diversity. The number of species cultivation for firewood was correlated negatively with species used from forest areas indicating the importance of backyards for conservation of dry forests, as this is the use that requires large amounts of biomass. Low-income families used more natural resources for firewood and food purposes than higher income families. Families with more availability of adults for farm labor and families with more educated households used more species from forest areas, indicating more potential to explore the forest. Additionally, we found a phylogenetic signal in the food and firewood categories, showing that people tend to use closely related species in these categories. Together, our results suggest that investments on family income and improvements on backyards can decrease the use of natural resources and, thus, can have a positive impact on plant species conservation. We suggest also the use of phylogenetic signal analysis on ethnobotany and management studies to a deep understanding decision making.

Key words: Dry forests**;** Plant evolutionary diversity; Poverty; Conservation.

Introduction

In the last decades, ethnobotany studies have focused in understand how and why people select plants for use and which are the conservation and livelihoods consequences of such uses (Gaoue et al., 2017). People use and select plant depending on several factors, such as traits, protection status, and attributes of attractiveness of species, as well as environmental conditions, and the cultural and socioeconomic aspects of human communities, i.e., availability of people to acquire the resource, *per capita* income and resource dependency (Sunderland et al., 2015; Sunderlin et al., 2008; Webb et al., 2013; Wunder, 2001). For example, for medicinal purpose, diverse organs of plants are used and the main factors that lead to use are people age, gender and knowledge (Castro et al., 2011; Ferreira Júnior et al., 2016; Gonçalves et al., 2016; Medeiros et al., 2016). In developing countries, the plant use for energetic purposes, such as firewood and charcoal, is determined mainly by a combination between resource availability, quality and *per capita* income (Medeiros et al., 2012; Specht et al., 2015; Top et al., 2004, Ramos et al., 2008). In fact, socioeconomic conditions, especially poverty, are significant drivers of use of natural resources, such as animal hunting, timber and non-timber forest products harvesting for human or animal feed (Porter et al., 2014; Shackleton et al., 2011; Sunderlin et al., 2008; Wunder, 2001).

Studies integrating use of plants species by traditional populations and ecological analysis can help to improve the understanding about the relation between species conservation and sociocultural maintenance (Kepe et al., 2004; Portillo-Quintero and Sánchez-Azofeifa, 2010; Sobral et al., 2017; Vermeulen and Sheil, 2007). However, the connections between human knowledge, plant uses and species conservation are very complex demanding an integration of hypotheses and approaches to be assessed (Gaoue et al., 2017). About four decades ago, Moerman (1979) developed the non-random selection theory only for medicinal purposes which states that the number of plants with medicinal properties in a given plant family is related to the total number of species in that family, given that, some plant families must be over-utilized for medicine while others are not. Recent studies have shown that medicinal properties of plants used for this purpose are not randomly distributed in phylogenies (Saslis-Lagoudakis et al., 2011; Yessoufou et al., 2015). These studies have helped to estimate the impact of plant use for medicinal purposes along plant species phylogenies, but the evolutionary outcome of other plant uses remains to be described and conciliated with conservation goals (Gaoue et al., 2017; Saslis-Lagoudakis et al., 2011).

The expansion of the non-random selection theory for other purposes besides medicine could reveal a phylogenetic impoverishment associated to higher pressure on particular lineages that share characteristics attractive for different uses, threating entire lineages (Saslis-Lagoudakis et al., 2011; Yessoufou et al., 2015). On the other hand, if the selected species belongs to different lineages, we can expect that the use by humans will be diluted across the phylogeny with little impacts on the phylogenetic diversity. In this sense, estimating the phylogenetic signal, i.e. "*the tendency for evolutionarily related organisms to resemble each other, with no implication as to the mechanism that might cause such process*" (Blomberg et al. 2003), may help to uncover the evolutionary fingerprint of human uses on plant diversity (see also Fritz and Purvis, 2010). This analysis has been applied as an additional ethnobotanical approach to find potential useful species and to indicate a non-random cultural pattern of plant selection by traditional communities (Saslis-Lagoudakis et al., 2011) but is still under-utilized in the evaluation of the direct impact of resource exploitation on biodiversity loss. For categorical plant traits, here considered as category of use, the phylogenetic signal can be extremely clumped, intermediately clumped (Brownian), random and overdispersed (Fritz and Purvis, 2010) (Fig. 1). If the characters, which in our study are represented by five types of plant uses, are extremely clumped, there is greater risk of losing evolutionary history (Fig 1).

Conversely, if the use is overdispersed across the phylogeny, no lineage is expected to disappear due to overexploitation.

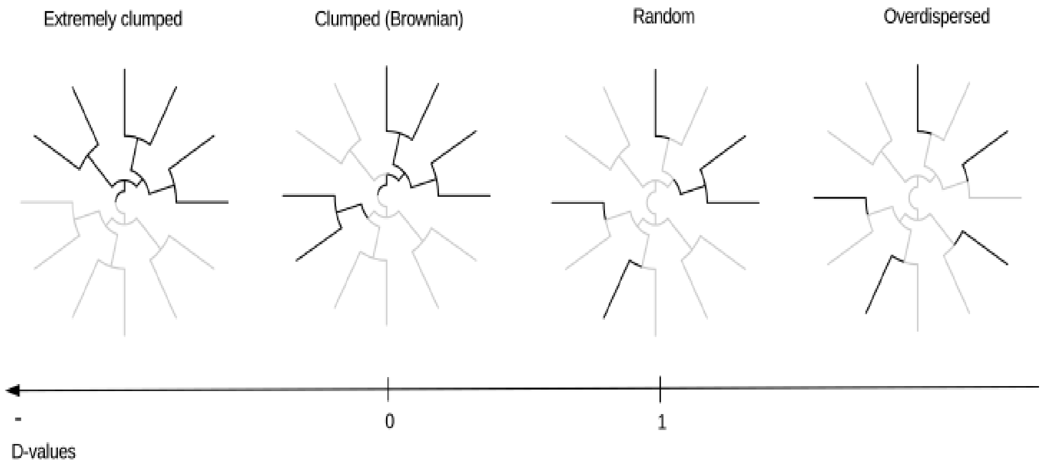

Figure 1: The phylogenetic patterns of characters dispersion on a phylogeny varying from extremely clumped to overdispersed phylogenetic pattern. D represents the phylogenetic signal of binary features, D > zero is a test for Brownian motion of trait (D closer to zero), whereas D < 1 is a test for random distribution of trait (D closer to one). Extremely clumped and Brownian patterns represents worst scenarios to useful species conservation. Modified from Fritz and Purvis (2010)

Seasonally Tropical Dry Forests (STDF) support low-income human populations that rely on biodiversity for poverty alleviation and socioeconomic development (Davidar et al., 2010; Portillo-Quintero and Sánchez-Azofeifa, 2010; Ribeiro et al., 2015; Sunderland et al., 2015). Caatinga is the largest, most biodiverse and one of the most populated STDF (Pennington et al., 2009; Silva et al., 2018). About 45% of its 28.6 million inhabitants live in rural places and most of them are small farmers having high dependence on natural resources to sustain their livelihood (Barbieri et al., 2010; Redo et al., 2013; Silva et al., 2018). The Caatinga vegetation is under pressure due to inappropriate land use including urbanization, large-scale agriculture, charcoal production supply for big enterprises but also by chronic disturbances by small farmers in the remaining vegetation (Ribeiro-Neto et al., 2016; Ribeiro et al., 2015; Rito et al., 2017). Although some studies investigated the impact of chronic human disturbance on taxonomic (Ribeiro-Neto et al., 2016; Ribeiro et al., 2015; Rito et al., 2017) and phylogenetic (Ribeiro et al. 2016) diversities of plants, the detailed use of woody plants by low-income families considering a socio-economic approach and the potential evolutionary impact of this use is still not explored for Caatinga.

In this study we answer the follow questions: What are the uses and useful species for traditional populations inhabiting an area of SDTF? Is there a phylogenetic signal considering the different types of plant use? We hypothesized that (1) higher socioeconomic status reduces species uses directly from forest, (2) more species cultivation reduces the use of species directly from the forest and (3) species uses are phylogenetically clumped, threatening more intensely and frequently used lineages. To assess these hypotheses and answer these questions, we combined socioeconomic, botanical and phylogenetic methods, calculated a local conservation priority index, constructed a molecular phylogeny and estimated the phylogenetic signal of the uses.

Methods

Study area

Catimbau National Park (8.61667°S 37.15°W) was created in 2002 to preserve its biodiversity and scenic beauty, encompassing around 62,000 hectares of Caatinga vegetation (Fig.1). The climate is semiarid, with an annual average temperature of 23°C and annual mean precipitation ranging from 486 mm to 975 mm. The vegetation is a mosaic of low stature dry forest and shrubs, including xeric and non-xeric species with stands regenerating after slash-and-burn agriculture or livestock farming (Rito et al., 2016).

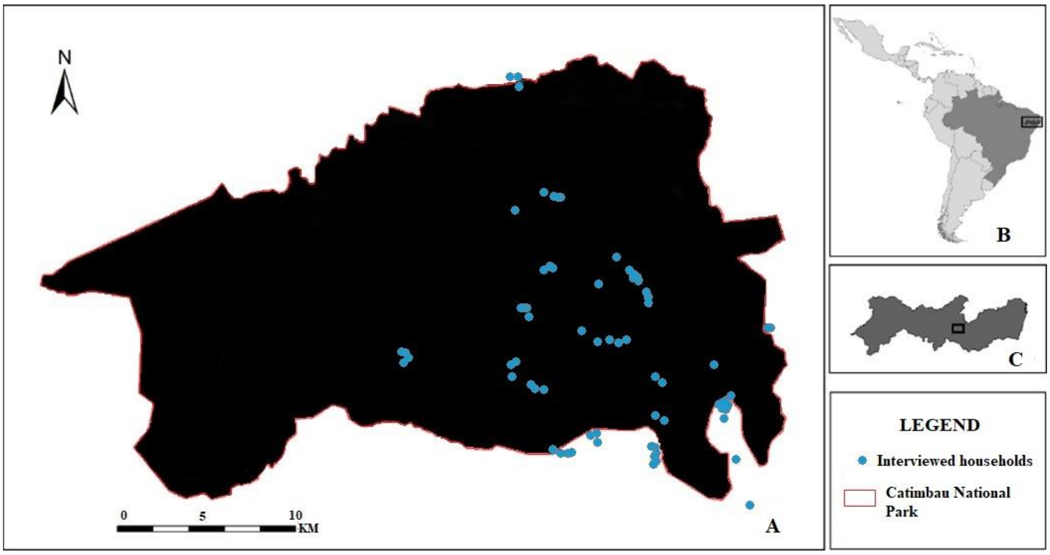

Figure 1: Catimbau National Park map (A), Brazil (B) and Pernambuco state (C). Blue dots represent households interviewed between January and July of 2016.

According to local informants, there are approximately 300 *Sertanejos* families distributed among the 17 communities living inside the Park. There are more houses among the park that could not be accessed by our study by safety and logistic reasons. There are large communities (>200 families in each) residing outside the Park within a 3 km radius of the Park boundary. Most communities were present before the park inception and archaeological studies described traces of ancient human occupation as cave paintings in some areas of the park dating to at least 4000 years ago (Oliveira, 2001). The main livelihoods of the local people are goat raising, and subsistence agriculture including cultivation of vegetable species in gardens and wild plants harvested from the forest (Santos, 2015). In some communities still possible find healers, traditional midwives and local species users of traditional medicine, that stills a current activity. Handcraft based on forest resources and ecotourism are increasing activities locally due increase of tourists in the last years.

Socioeconomic and ethnobotanical use inventory

We conducted semi-structured interviews with 81 household representative/s (man/woman but preferable with both) of the communities living inside and in park buffer area (see Figure 1) between January and July of 2016 (BERNARD, 2006). We sampled about 10 – 20 % of the houses or less when in the larger communities due the repetition of species citations and similar socioeconomic status. The criteria families' selection for participation was by convenience (sampling families available to participate in the study when we arrived at each community). All the interviews were taken in backyards or gardens to stimulate the interviewed visual memory and to check for species cultivated at their places. We excluded from the sampling persons below 18 years old and in an altered stage of consciousness (i.e. after excess alcohol consumption) (Bernard 2006).

We collected socioeconomic information of each interviewed family: Number of people currently living into the residence, total monetary income, years of formal education, % of adults involved in farm work and number of goats raised. We also performed a species use inventory in four main categories of plant species use: firewood, medicinal, handcraft, food and animal fodder purposes. Also, the origin of the species used: backyard (including garden and orchard and crop cultivation) and forest areas (including regenerating areas after logging). We access for each plant cited, the part that is used: leaves, trunk, root, flower, fruit and seed as part of the ethnobotany inventory. When was possible we participated in guided tours with local experts for the collection of botanical material to later identification with expert botanist. This study was approved by the National Council of Ethics in Research by the Ministry of Health in accordance with the requirements of current Brazilian legislation under the numbers 52759815.9.0000.5208 and 1.451.290.

Phylogenetic trees

To construct the time calibrated phylogeny of species we followed the procedure indicated by Qian and Jin, (2016). First, the names of all species were updated according to The Plant List Database (http://www.theplantlist.org/). Second, a phylogeny with species sampled was built using a supertree based sequence data of seven gene regions (18S rDNA, 26S rDNA, ITS, *matK*, *rbcL*, *atpB* and *trnL-F*) available on GenBank (http://www.ncbi.nlm.nih.gov/genbank) and returned the time of divergence of each branch. In the case of the species is not available in the supertree, we used one of the synonym or a species from the same genus that occur in a closer area. To obtain these local phylogenies we use the function S.Phylomaker in R 3.3.1 (Team Core, 2017) provided by Qian and Jin, (2016). The output of this function resulted in three types of phylogenetic trees, from which we used the S3 that uses the same approach implemented in Phylomatic and BLADJ. This tree was highly correlated ($r>0.9$) with the other two phylogenetic trees generated by the function. We constructed a phylogenetic tree considering the species that occur in the plots, excluding Cactaceae, Arecaceae and specimens without species, genus or family identification. We tested for phylogenetic signal of categories of species use (i.e. fodder, food, medicinal, handcraft and firewood).

Data analysis

To test the general hypothesis that higher socioeconomic status reduces species use we performed general linear models analysis using for the first model number of species used as a response variable and socioeconomic data as explanatories variables (per capita income, years of formal education, number of adults involved in farm work and number of goats raised). For the second model we used same explanatories variables and number of species used from forest to evaluate the relation between species cultivation and forest species use, we performed spearman correlation test between total number of species used from cultivate (backyards including garden and orchard) and total number of species used from forest areas (mature/regeneration forest). After this, we performed a Chi-square to test if the distribution of number of species used in these five main categories (firewood, fodder, food, medicinal and handcraft) differs between cultivate and forest environments.

For categories of use, we used the approach of Fritz and Purvis, (2010) for binary data, in which it is calculated *D*, a measure of phylogenetic signal derived from Blomberg K. D closer to zero indicates that the trait approaches to Brownian motion, whereas D closer to one indicates that the feature has a random distribution along the phylogeny. Therefore, values of D closer to zero indicates phylogenetic signal (Fritz and Purvis 2010). D is not strongly affected by phylogenetic resolution and is adequate for large phylogenetic trees (> 50 species) (Fritz and Purvis 2010). These analyses were performed with the function “phylo.d” in package “caper” in R (Orme, 2013).

Results

Ethnobotanical inventory

We recorded the use of 151 species derived from agriculture or forest, distributed in 112 genus, 44 botanical families and 1405 citations (Appendix 1). The most common plant families cited were Fabaceace, Myrtaceae and Euphorbiaceae. A total of 69 species are cultivated, 8 are not cultivated or natives (invasive, ruderal or exotic) and 67 are native from forest or regeneration areas. The category of use with more species citation was medicinal with 77 species in 332 (23.62%) citations, followed by food with 66 species in 752 (53.62%) citations. About 80% of the total interviewed families use firewood, 95.12% cultivate or harvest species for use as food, 59% use as medicinal, 49.38% use as fodder and only 13.58% produce handicraft with forest or cultivated species.

Vigna unguiculata (L.) Walp. was the most cited specie from cultivated areas with 78 citations, which represent 95.12% of the interviewed families (see Table in appendix). The seeds of these beans constitute a very important source of vegetable protein for the communities. *Pityrocarpa moniliformis* (Benth.) Luckow & R.W.Jobson was the second most cited as a used species, usually harvested from forests or regeneration areas with 43 citations (52.43% of interviewed families) in which the branches and steams used as firewood and the bark used as medicinal purpose. The *Senegalia bahiensis* (Benth.) Seigler & Ebinger. was the most versatile specie cited more than 10 times and are present in three categories of use at least. Two species represent almost 30% of the citations in handcraft category, the palm *Syagrus coronata* (Mart.) Bec and the tree *Commiphora leptophloeos* (Mart.) J.B.Gillett. The first one has leaves and fruits appreciated by local communities for handcraft purpose and was cited in food and fodder categories. The second one, is used for woody handcrafts, firewood, and the bark is used for medicinal purpose.

Socioeconomic inventory

Families had on average four members (± 2.28 Standard Deviation) currently living into the residence and the main family member has less than three years of formal education (± 2.29). Only 18 families do not use firewood only use gas stove (for many reasons i.e. money availability, health problems), and the others are eventual users or daily users for cook their meals. On average, each person use 44 Kg (±68 SD) of firewood/month for cooking their meals. About 90% of families were involved in agricultural and animal farming activities, for subsistence and sales. Goat raising was an activity for 37.8% of the families and an important source of animal meat and income due the sales. Approximately 35% of 81 interviewed families were living below the World Bank poverty line (US$ 1.90 /person/day). In average, the *per capita* income monthly is 133.6 US dollar (± 132.10). The family income was from 3 mains sources: retirement (56%), Brazilian minimum income program "*bolsa familia*" (11%) and animal sales (11%). The house infrastructure was mostly (61.7%) made by brickwork, 34.6 % made by clay and wood and 3.7% are mixed (bricks and clay). Almost 60% of the houses do not have tap water and proper sewer disposal.

Relation between species use from agriculture and natural areas

The total number of species cultivated was positively correlated (but not strongly) with species used from natural areas (rs=0.28; n=81; p= 0.01), rejecting the general hypothesis that more species cultivation reduces the use of species directly from the forest. However, we found an inverse relation between number of firewood species used from forest and cultivation areas (rs=-0.60; n=64; p<0.001), supporting the hypothesis. Species used for firewood usually come from natural areas (mature and regeneration forest) on average 1.69 (± 2.87) species than from backyards 0.48 (± 0.27) (X^2 = 30.10; df = 14; p = 0.001), whereas handcraft (X^2 = 24.75, df = 18, p = 0.13), medicinal (X^2 = 69.46, df = 66, p= 0.3), food (X^2= 127.82, df = 128, p = 0.4), and fodder species (X^2= 9.73, df = 12, p = 0.6), did not differ from origin.

Socioeconomic drives of species use

We found, on the first tested model, that monthly *per capita* income per family were positively related with total number of species used (from forest and cultivated) (p<0.001) (Appendix 2, Figure 2). On the second model, using data only from forest (regeneration and mature forest), we found that tree socioeconomic variables were significant related with socioeconomic drivers (Appendix 2). Species used from forest are related negatively with monthly *per capita* income per family (p<0.01), positively with the percentage of adults involved in farm work (p<0.01) and years of formal education (p=0.02) (Figure 2).

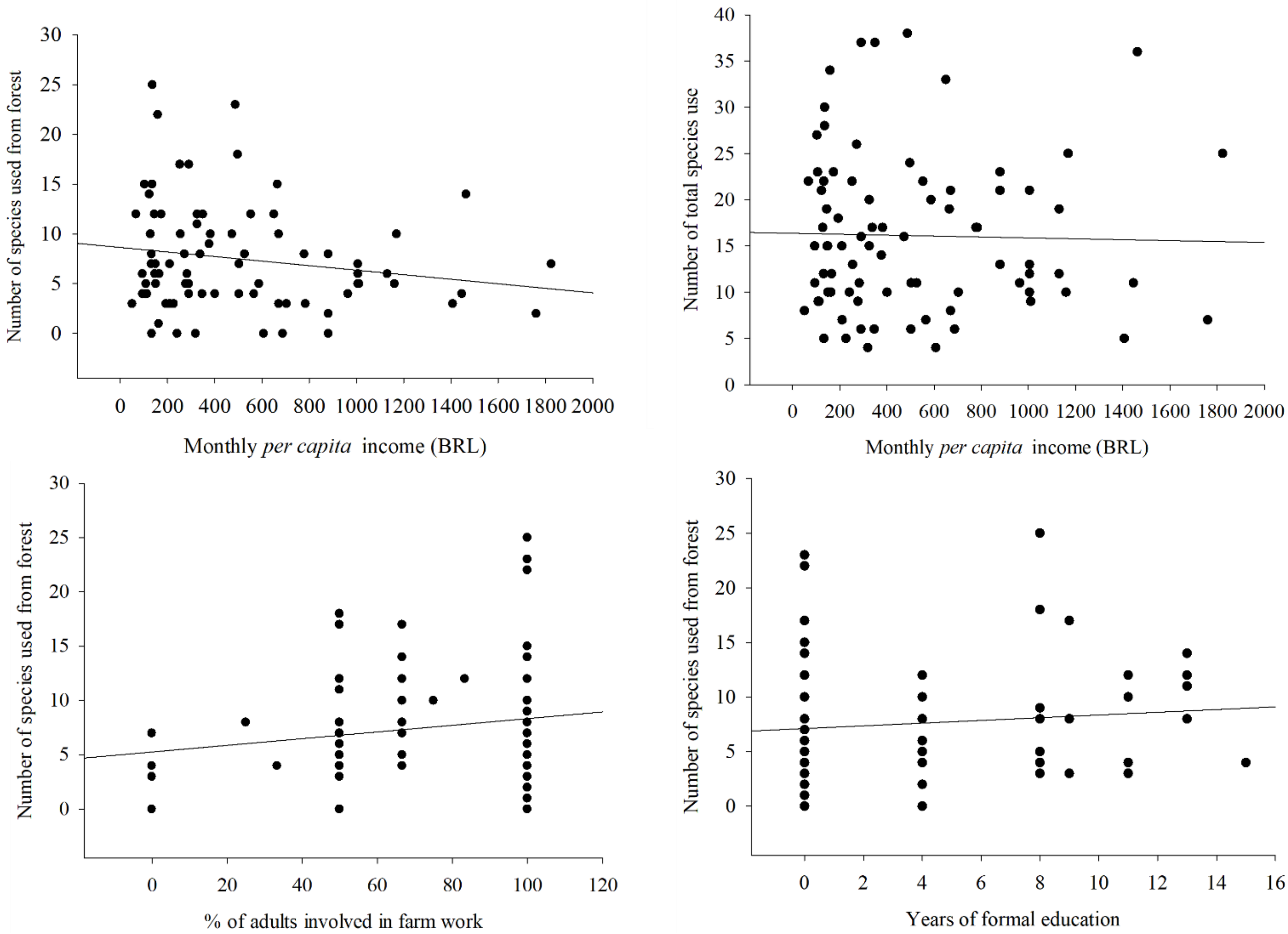

Figure 2: Significant tough weak relation between socioeconomic variables and species use per family. A- Negative relation between number of species used from forest and monthly *per capita* income in Brazilian real; B - Negative relation between number of total species used monthly *per capita* income in Brazilian real; C- Positive relation between species used from forest and percentage of adults involved in farm work; D - Positive relation between species used from forest and years of formal education. Data obtained from 81 semi structured interviews in Caatinga, Brazil.

Phylogenetic signal in use categories

Food and firewood categories of use were phylogenetically clumped in the phylogeny, with D values significantly smaller than 1 (0.68 and 0.65, respectively). In general, species from Fabaceae family were more prone to be used as firewood and food and Myrtaceae as food, generating the phylogenetic signal greater than random expectation. All other categories of use were randomly distributed along the phylogeny (i.e. did not differ significantly from 1), with D values varying from 0.74 to 1.12 (Table 3, Figure 3).

Table 3. Phylogenetic signal for the species cited as used by humans in ethnobotanical survey. We calculated D (Fritz and Purvis 2010) to test for phylogenetic signal of binary features. $D > zero$ is a test for Brownian motion of trait (D closer to zero), whereas $D < 1$ is a test for random distribution of trait (D closer to one). * $P < 0.05$.

Parameters	**D value**	**D>0 (P)**	**D<1 (P)**
Human population use			
Fodder	0.74	0.03*	0.11
Food	0.65	0*	0.002*
Medicinal	0.90	0*	0.17
Handcraft	1.12	0*	0.77
Firewood	0.68	0*	0.009*

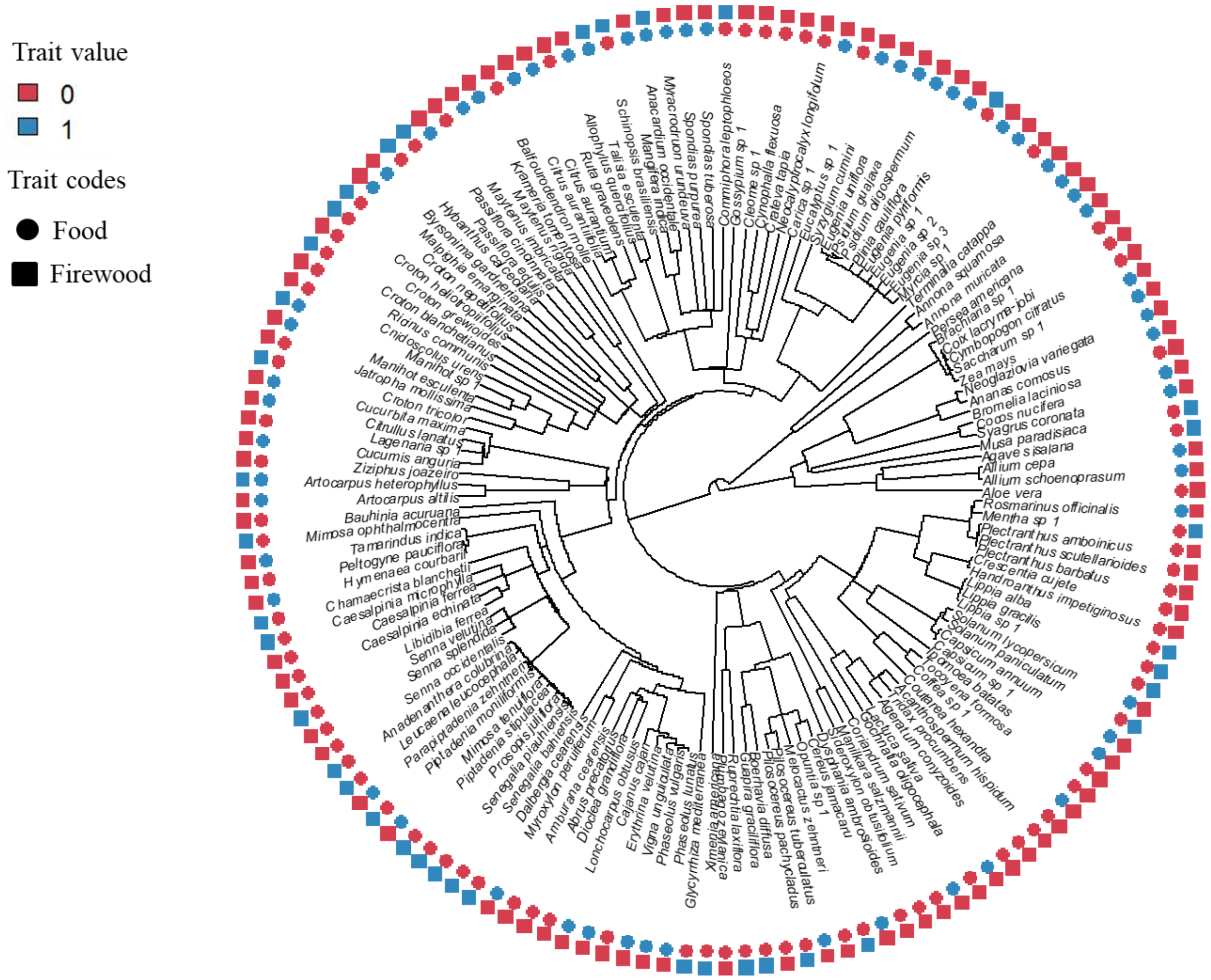

Figure 3. Phylogenetic tree of the species used by human populations in Catimbau National Park, Brazil. The filled circles represent the species used by humans food, filled squares for firewood.Trait values represents in red species not used and in blue species used.

Discussion

Our results shows that poverty is an important socioeconomic factor driving the intensification use of native species forest resources. The use of plant species by the local traditional communities for food and firewood follows a nonrandom selection pattern of useful plants. If these activities are intensified, it could lead to loss of plant community evolutionary history by overexploitation especially some groups, particularly Fabaceae and Myrtaceae. The species cultivation on backyards seems to help to decrease the pressure on forest resources, at least for firewood and medicinal purposes.

Families in poverty condition, living around forest areas, can use natural resources to alleviate and, in some cases, to escape from their condition. Poverty can reduce the potential to explore and improve the land management by limiting the household capacity to buy basic supplies as tools, seeds, irrigation systems and animals to trade or traction (Nkonya et al., 2008; Swallow et al., 2008). These factors difficult the better land utilization for food production by subsistence agriculture especially in dry forests where the water availability is restricted. Therefore, the agriculture intensification can potentially reduce pressure on native vegetation (Angelsen, 2010; DeFries and Rosenzweig, 2010). In our study, families that cultivate many species in their backyards are more prone to use less species for food and firewood from forest. Firewood dependence and low income conditions has been described as positively related in rural communities around the world (Hiemstra-van der Horst and Hovorka, 2009; Matsika et al., 2013; Specht et al., 2015; Top et al., 2006). Which it mean more money, more investments in improve their on land and less dependence on plants from forest and less firewood use (due replacement by butane gas)..

Fabaceae and Euphorbiaceae, are the most rich and abundant plant families in the studied area (Rito et al. 2017)., and in Caatinga vegetation (Moro et al., 2014) Species belonging to these families in general also more prone to be use as firewood in our study area, representing same pattern found by Ramos et al (2008) in another Caatinga area in the municipality of Caruaru. Almost half of the citations of plants use for firewood by Ramos et al., (2008) and almost 60 % of the useful species found by Guerra et al., (2015) were also used by Catimbau families in our study, giving support to the fact that widespread species are more prone to be used by humans in Caatinga. Further studies should examine more widely if there is a non-random phylogenetic pattern of species selection in Caatinga biome.

Species used for firewood by Caatinga's families are selected by the wood quality specially by the relation between wood density and water content (RAMOS et al., 2008; RAMOS; LUCENA; ALBUQUERQUE, 2015). In general (Flores and Comes 2011), and in our study area there is a strong phylogenetic conservatism concerning wood density (Sfair et al. unpublished data) and thus it is likely that humans looking for species that present high density, resembles each other in this aspect and, thus, tend to gather plants with similar traits (SOLDATI et al., 2017). The same rationale should apply for plants used as food, once the local people collect juicy fruits. This explanation is supported by other studies that show in different cultures and countries the pattern of species collection by traditional communities is not random (BENNETT; HUSBY, 2008; FORD; GAOUE, 2017; MOERMAN, 1979). From an evolutionary perspective, our findings suggest that use for fodder, medical and handcraft purposes are more likely to maintain plant evolutionary diversity than uses for food and firewood. In our study people wood plants use firewood for the same purpose and same way which is burn the wood to cook. On another hand, medicinal is broad category where shrubs and wood plants are used on different ways (i.e. infusion, rubbing on the skin, make syrup), and different parts. That is the reason we believe we could not find any pattern for this category. Fortunately, the most cited species in our study are not in the official endangered flora lists by Environmental Brazilian Ministry (MMA, 2014) although the Catimbau National Park needs a management plant to those people who live in poverty condition (Specht et al 2018).

Together, our results suggest that investments on family income and as a consequence, improvements on backyards can decrease the use of natural resource especially for firewood use, the category of use more harmful, and, therefore, will have positive impact on species conservation. Due the accelerated rate of species and the traditional knowledge loss in the last decades is urgent integrate solutions to conserve these as much as possible (Benz et al., 2000; Medeiros et al., 2017; Reyes-García, 2010). It is crucial understand the relation between human societies and biodiversity use, in accordance to ecological parameters and human needs. Studies in ethnobotany and traditional knowledge is been worldwide recognized in the last decades by the achievements in integrate adaptive management and biodiversity conservation (Baldauf and Santos, 2013; Peters, 2011). Our study showed a "shy" approach of the use phylogeny in studies involving people and natural resources use however we suggest that these tools are fundamental for a long term management where phylogenetic diversity is considered. We hope our study can contribute with preliminary information to the local managers and government to improve the life of those one in poverty condition and help to conserve the plant species of Catimbau National Park.

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Appendix 1

Table: Species cited as used by 81 traditional families living inside and in the border of Catimbau National Park, Pernambuco, Brazil. Origin: (C=Cultivation; F=Forest, R=Ruderal), Species use (Me=Medicinal; Fo=Food; Fd=Fodder; Fw= Firewood; Hd= Handcraft), Part used (Br=Branch; Bk= Bark; Fr= Fruit; Fl=Flower; La= Latex; Le=Leaves; Se=Seed; St=Steam; Ro=Root). Indet=Indeterminate.

Botanical family	**Scientific name**	**Vernacular name**	**Origin**	**Specie use**	**Total citations**	**Part used**
Amaranthaceae						
	Dysphania ambrosioides (L.) Mosyakin & Clemants	mastruz	C	Me	9	Le
Amaryllidaceae						
	Allium cepa L.	cebola	C	Fo	1	Le
	Allium schoenoprasum L.	cebolinha	C	Fo	5	Le
Anacardiaceae						
	Anacardium occidentale L.	cajueiro, cajueiro roxo, cajuí	C	Fw,Fo, Me	62	Bk, Fr, Se
	Mangifera indica L.	manga	C	Fo	15	Fr
	Myracrodroun urundeuva Allemão	aroeira	F	Fw, Me	22	Bk, Le
	Schinopsis brasiliensis Engl.	baraúna, braúna	F	Fw, Me	7	Bk, Le, St, Br
	Spondias tuberosa Arruda	umbu, imbu	F	Fo	36	Fr
	Spondias purpurea L.	siriguela	C	Fo	4	Fr
Annonaceae						
	Annona muricata L.	graviola, coração	C	Fo	4	Fr
	Annona squamosa L.	pinha	C	Fo	18	Fr
Apiaceae						
	Coriandrum sativum L.	coentro	C	Fo	16	Fr, Le
Arecaceae						
	Cocos nucifera L.	coqueiro da praia	C	Fo, Hd	18	Fr, Le
	Syagrus coronata (Mart.) Becc	licuri, oricuri, aricuri, coco de arroto	F	Fo, Fd, Hd	42	Fr, Le, Se
Aspagaraceae						

	Agave sisalana Perrine	agaze/bandeira	C	Fw	1	Fl
Asteraceae						
	Acanthospermum hispidum DC	fideração	R	Me	1	Ro
	Ageratum conyzoides L	balaio de veio	R	Me	1	Fl
	Gochnatia oligocephala (Gardner) Cabrera	candieiro branco	F	Fw	7	St, Br
	Lactuca sativa L.	alface	C	Fo	8	Le
	Tridax procumbens L.	espinho de agulha	C	Me	1	Le
Bignoniaceae						
	Crescentia cujete L.	coité	C	Hd	2	Fr
	Handroanthus impetiginosus (Mart. ex DC.) Mattos	pau d'arco, ipê roxo	F	Fw, Me, Hd	5	Bk, St, Br
Bromeliaceae						
	Ananas comosus (L.) Merril	abacaxi	C	Fo	1	Fr
	Encholirium spectabile Martius ex Schult.	macambira de flexa	F	Fd	1	Le
	Neoglaziovia variegata (Arruda) Mez	caroá	F	Hd	4	Le
Burseraceae						
	Commiphora leptophloeos (Mart.) J.B.Gillett	imburana de cambão, imburana, umburana	F	Fw, Hd, Me	13	Bk, St, Br
Cactaceae						
	Cereus jamacaru DC.	mandacaru	F	Fo, Fd, Me	5	Fr, Ro, St
	Melocactus zehntneri (Britton & Rose) Luetzelb.	coroa de frade	F	Fo, Me	2	Fr, St, Br
	Opuntia Mill.	palma, fruta de palma, palma de porco, palma orelha de elefante	C	Fd, Fo, Me	45	Fr, Le
	Pilosocereus pachycladus F. Ritter	faxeiro	F	Fw, Fd,	3	St, Br
	Pilosocereus tuberculatus (Werderm.) Byles & G.D.Rowley	caxacubri	F	Fo	1	Fr
Capparaceae						
	Crateva tapia L.	pau d'alho	F	Hd, Me	2	Bk
	Cynophalla flexuosa (L.) J.Presl	fejão bravo	F	Me	1	Le

	Neocalyptrocalyx longifolium (Mart.) Cornejo & Iltis	incó, icó	F	Fo	8	Fr
Caricaceae						
	Carica L.	mamão	C	Fo	16	Fr
Celastraceae						
	Maytenus imbricata Mart. ex Reiss.	bonominho da areia	F	Me	1	Le
	Maytenus rigida Mart.	bom nome	F	Me	6	Bk
Cleomaceae						
	Hemiscola aculeata (L.) Raf.	mussambê	R	Me	1	Ro
Combretaceae						
	Terminalia catappa L.	castanhola	C	Fo	1	Fr
Convolvulaceae						
	Ipomoea batatas (L.) Lam.	batata doce	C	Fo	1	Ro
Curcubitaceae						
	Citrullus lanatus (Thunb.) Matsum. & Nakai	melancia	C	Fo, Me	57	Fr, Se
	Citrullus lanatus var. citroides (L. H. Bailey) Mansf.	melancia de cavalo	C	Fd	14	Fr
	Cucumis anguria L.	maxixe	C	Fo	12	Fr
	Cucurbita maxima Duchesne ex Lam	abóbora, jerimum, jerimum de leite	C	Fo	32	Fr, Se
	Lagenaria Ser.	maxixe do pará	C	Fo	5	Fr
Euphorbiaceae						
	Cnidoscolus pubescens Pohl	cançanção, urtiga	F	Me	2	Le
	Croton grewioides Baill.	canela de ema, canela de nambú, canelinha do mato	F	Me	4	Bk, Le, Ro
	Croton heliotropiifolius Kunth.	marmeleiro branco, sacatinga	F	Me, Fw	2	Le, St, Br
	Croton nepetifolius Baill.	quebra faca do sertão	F	Me, Fw	11	Bk, Le, St, Br
	Croton tricolor Klotzsch ex Bail.	marmeleiro, moita de mulher	F	Me, Fw	5	Bk, La, St, Br
	Croton blanchetianus Baill.	velame, velame branco	F	Me, Fw	9	Le, St, Br

	Jatropha mollissima (Pohl) Baill..	pinhão mole, pinhão grande	F	Me	2	Bk, La
	Manihot Mill.	purnunça	C	Fo	2	Ro
	Manihot esculenta Crantz	macaxeira, mandicoca, macaxeira zabé de souza	C	Fo, Fd	29	Fr, Ro, St, Br
	Ricinus communis L.	mamona	C	S	3	Fr, Se
Fabaceae						
	Abrus precatorius L.	olho de pombo	C	Hd	3	Se
	Amburana cearensis (Allemão) A.C.Sm.	amburana de cheiro, imburana de cheiro	F	Me	7	Bk
	Anadenanthera colubrina (Vell.) Brenan	angico de caroço	F	Fw, Me	4	Bk, St, Br
	Bauhinia acuruana Moric	mororó	F	Me	8	Bk, Le, Ro
	Caesalpinia echinata Lam.	pau brasil	C	Hd	1	St, Br
	Cajanus cajan (L.) Huth	feijão andu, feijão guandu	C	Fo	24	Se
	Chamaecrista zygophylloides (Taub.) H.S.Irwin & Barneby	carrasco	F	Fw	3	St, Br
	Dalbergia cearensis Ducke	pau ferro amarelo	F	Fw	1	St, Br
	Dioclea grandiflora Mart. ex Benth.	mucunã	F	Hd	2	Se
	Erythrina velutina Willd.	mulungu	F	Hd, Me	2	Bk, Se
	Hymenaea courbaril L.	jatobá	F	Fw, Me	6	Bk, Le, St, Br
	Leucaena leucocephala (Lam.) de Wit	leucena	R	Fd	2	Fr
	Libidibia ferrea (Mart. Ex tul) L. P. Queiroz	pau ferro, jucá	F	Fw, Me	3	Bk, St, Br, Fr
	Mimosa ophthalmocentra Benth.	jurema de imbira	F	Fw	2	St, Br
	Mimosa tenuiflora (Willd.) Poir.	jurema preta	F	Fw, Hd, Me	7	Bk, Ro, St, Br

Lonchocarpus obtusus Benth	rasga beiço, sucupira, sicupira	F	Fw, Me	3	Se, St, Br
Myroxylon peruiferum L.f.	bálsamo, basco	C	Me	10	Bk, Le
Parapiptadenia zehntneri (Harms) M.P.Lima & H.C.Lima	angico, angico branco, angio manjolo	F	Fw, Hd, Me	7	Bk, St, Br
Peltogyne pauciflora Benth.	amora, coração de nego, violeta	F	Fw, Me, Hd	9	Bk, Se, St, Br
Periandra mediterranea (Vell.) Taub.	aicançú,alcançú	F	Me	10	Ro
Phaseolus lunatos L	fava, fava rajada	C	Fo	4	Se
Phaseolus vulgaris L.	feijão de arranque, feijão mulatinho	C	Fo	19	Se
Piptadenia stipulacea (Benth.) Ducke	espinheiro, espinheiro branco, rasga-beiço	F	Fw	9	St, Br
Pityrocarpa moniliformis (Benth.) Luckow & R.W.Jobson	canzenzo, folha-miúda	F	Fw, Me	43	Bk, St, Br
Cenostigma microphyllum (Mart. ex G. Don) Gagnon & G.P. Lewis	catingueira, catingueira rasteira	F	Fw, Me	27	Fl, Ro, St, Br
Prosopis juliflora (Sw.) DC.	algarroba	R	Fw, Fd, Me	14	Bk, Fr, St, Br
Senegalia bahiensis (Benth.) Seigler & Ebinger.	carcará	F	Fw, Me	16	Bk, Le, St, Br
Senegalia piauhiensis (Benth.) Seigler & Ebinger.	quebra faca, jurema de cavador	F	Fw, Me	22	Bk, Le, St, Br
Senna occidentalis (L.) Link	manjirioba	R	Me	2	Le, Ro
Senna splendida (Vogel) H.S.Irwin & Barneby	bezouro, pau de bezouro	F	Me	2	Br, St

	Senna velutina (Vogel) H.S.Irwin & Barneby	candieiro, candieiro preto	F	Fw	10	St, Br
	Tamarindus indica L.	tamarindo	C	Fo	1	Fr
	Vigna unguiculata (L.) Walp.	feijão, feijão de corda, feijão de cabrucuçu	C	Fo, Me	78	Se
Krameriaceae						
	Krameria tomentosa A. St.-Hil.	carrapixo de boi	F	Me	2	Ro
Lamiaceae						
	Mentha L.	hortelã miúdo, pueja	C	Me	4	Le
	Plectranthus amboinicus (Lour.) Spr.	hortelã graúda, hortelã garúdo, hortelã grossa	C	Me	4	Le
	Plectranthus barbatus Andr.	boldo	C	Me	1	Le
	Plectranthus scutellarioides (L.) R.Br.	crista de galo	C	Me	1	Le
	Rosmarinus officinalis L.	alecrim	C	Fo, Me	4	Le
Lauraceae						
	Persea americana L.	abacate	C	Fo	3	Fr
Malpighiaceae						
	Byrsonima gardneriana A.Juss.	murici	F	Fo	5	Fr
	Malpighia emarginata D.C.	acerola	C	Fo	13	Fr
Malvaceae						
	Gossypium L.	algodão	C	Me	1	Fr, Se
Moraceae						
	Artocarpus altilis (Parkinson) Fosberg	fruta pão	C	Fo	1	Fr
	Artocarpus heterophyllus Lam.	jaqueira	C	Fo, Fw, Fd, Hd	12	Fr, St, Br
Musaceae						
	Musa paradisiaca L.	banana	C	Fo	7	Fr
Myrtaceae						
	Eucalyptus sp.	eucalipto, acalipto, aicalipi	C	Me	5	Le
	Eugenia pyriformis Cambess.	ubaia	F	Fo	1	Fr
	Eugenia sp.	batinga	F	Fw, Hd	3	St, Br
	Eugenia. sp1	fruta de cotia	F	Fo	4	Fr

	Eugenia sp2	maçã do mato, maçãnzinha	F	Fo, Me	15	Bk, Fr
	Eugenia uniflora L.	pitanga	C	Fo	2	Fr
	Myrcia sp	cambuim	F	Fo, Me	40	Bk, Fr, Ro
	Plinia cauliflora (Mart.) Kausel	jaboticaba	C	Fo	5	Fr
	Psidium oligospermum Mart. ex DC	araçá da mata	F	Fo, Me	25	Bk, Fr
	Psidium guajava L	goiaba	C	Fo	12	Fr
	Syzygium cumini (L.) Skeels	azeitona preta, azeitona roxa	C	Fo	5	Fr
Nyctaginaceae						
	Boerhavia diffusa L.	pega pinto	R	Me	3	Ro
	Guapira graciliflora (Mart. ex Schmidt) Lundell	piranha	F	Me	7	Bk, Le,
Olacaceae						
	Ximenia americana L.	almeixa, ameixa	F	Fw, Me	25	Bk, Le, St, Br
Passifloraceae						
	Passiflora cincinnata Mast.	maracujá do mato	F	Fo, Me	6	Fr, Le
	Passiflora edulis Sims	maracujá	C	Fo	7	Fr
Plumbaginaceae						
	Plumbago scandens L.	louco	R	Me	1	Ro
Poaceae						
	Urochloa P.Beauv.	capim elefante	C	Fd	11	Le
	Coix lacryma-jobi L.	ave maria	C	Hd	1	Se
	Cymbopogon citratus (DC) Stapf.	capim santo	C	Me	7	Le
	Saccharum sp.	cana de açúcar	C	Fo	3	St, Br
	Zea mays L.	milho, milho bateté	C	Fd, Fo	66	Fr, Se
Polygonaceae						
	Ruprechtia laxiflora Meisn	caixão	F	Fw	2	St, Br
Rhamnaceae						

	Ziziphus joazeiro Mart.	juazeiro	F	Me	8	Bk, Fr, Le
Rubiaceae						
	Coffea sp.	café	C	Fo	1	Fr
	Coutarea hexandra (Jacq.) K. Schum.	quina quina	F	Me	1	Bk
	Tocoyena formosa (Cham. & Schltdl.) K.Schum	genipapo do sertão	F	Hd, Me	2	Bk, Fr
Rutaceae						
	Balfourodendron molle (Miq.) Pirani	cocão	F	Hd	1	St, Br
	Citrus x aurantium L.	limão	C	Fo	5	Fr
	Citrus × *aurantium* L.	laranja	C	Fo	10	Fr
	Ruta graveolens L.	arruda	C	Me	2	Le
Sapindaceae						
	Allophylus quercifolius (Mart.) Radlk.	zaberdia	F	Fo	1	Fr
	Talisia esculenta (Cambess.) Radlk.	pitomba	C	Fw, Fo	6	Fr, St, Br
Sapotaceae						
	Manilkara salzmannii (A. DC.) H. J. Lam	massaranduba	F	Fw, Fo, Hd	8	Fr, St, Br
	Sideroxylon obtusifolium (Roem. & Schult.) T.D.Penn.	quixabeira	C	Me, Fo	24	Bk, Fr
Solanaceae						
	Capsicum annuum L.	pimentão	C	Fo	1	Fr
	Capsicum sp.	pimento	C	Fo	3	Fr
	Solanum lycopersicum L.	tomate	C	Fo	7	Fr
	Solanum paniculatum L	jurubeba	C	Fw, Me	5	Fr, Ro, St, Br
Verbenaceae						
	Lippia alba (Mill.) N.E.Br. ex P. Wilson	chumbinho, pau branco, beladona	F	Me	24	Bk, Le
	Lippia gracilis Schauer	alecrim branco, alecrim do mato	F	Fw, Me	11	Le, St, Br
Violaceae						
	Hybanthus calceolaria (L.) Oken	papaconha	R	Me	6	Ro
Xanthorrhoeaceae						
	Aloe vera (L.) Burm.f.	babosa	C	Me	7	Le, Ro
Not identified						

Indet 1	pau de leite	F	Me	2	Bk, La
Indet 2	batata de purga	F	Me, Hd	2	Ro, Se
Indet 3	jiquiri	F	Fw	1	St, Br
Indet 4	mirô	F	Hd	1	Se
Indet 5	chachafraz	F	Me	3	Ro
Indet 6	unha de gato	F	Me	1	Br
Intet 7	batata de onça	F	Me	1	Ro

Appendix 2: General linear models tested and results.

```
#model 1
> anova(glm(sp.tot~education+income.pc+goats+adults.farm,data=quiquad, fami
ly="poisson"), test="Chisq")
Analysis of Deviance Table

Model: poisson, link: log

Response: sp.tot

Terms added sequentially (first to last)


            Df Deviance Resid. Df Resid. Dev  Pr(>Chi)
NULL                           78     229.57
education    1   0.7552        77     228.81 0.3848449
income.pc    1  12.1208        76     216.69 0.0004986 ***
goats        1   0.0940        75     216.60 0.7590989
adults.farm  1   3.4395        74     213.16 0.0636561 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

#model 2
> anova(glm(sp.forest.tot~education+income.pc+goats+adults.farm,data=quiqua
d, family="poisson"), test="Chisq")
Analysis of Deviance Table

Model: poisson, link: log

Response: sp.forest.tot

Terms added sequentially (first to last)


            Df Deviance Resid. Df Resid. Dev  Pr(>Chi)
NULL                           78     317.90
education    1   5.3296        77     312.57   *
income.pc    1  12.7151        76     299.85 0.0003627 ***
goats        1   2.3455        75     297.51 0.1256458
adults.farm  1   6.9936        74     290.51 0.0081802 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

4 CONSIDERAÇÕES FINAIS

Este estudo ofereceu importantes informações sobre a complexa relação entre uso dos recursos vegetais por populações tradicionais e as consequências deste uso na biodiversidade da Caatinga, especialmente por abordar aspectos socioecológicos, etnobotânicos e ecológicos não só os possíveis efeitos destes usos sobre a vegetação, mas também por entender os fatores que os determinam.

O primeiro capítulo, através de um estudo de caso no Parque Nacional Catimbau, revelou a problemática que as Unidades de Conservação mal implementadas / administradas podem gerar. Além de ameaçar a biodiversidade, podem influenciam negativamente o status socioeconômico das famílias, limitando o uso dos recursos da terra em um ciclo de dependência no uso de recursos naturais, principalmente o uso de madeira para fins energéticos. Além disso, nosso estudo aumenta a evidência de que, nos chamados "parques de papel", quando as demandas sociais não são alcançadas e os objetivos de conservação também não são.

O segundo capítulo, também com de um estudo de caso no Parque Nacional Catimbau, explorou-se quais variáveis socioeconômicas se relacionam como uso dos recursos vegetais em diferentes categorias e quais as consequências filogenéticas deste uso. Encontramos que as atividades de coleta de lenha e frutos para alimentação são as que podem gerar maiores perdas de linhagens genéticas, uma vez que o padrão de seleção pelas comunidades tradicionais não é aleatório. A alta intensidade do uso das espécies pode afetar alguns grupos particulares, particularmente Fabaceae e Myrtaceae.

Como recomendações para manejo que concilie o uso dos recursos naturais com a conservação da biodiversidade nós deixamos algumas sugestões: Enquanto o plano de manejo do PARNA Catimbau é desenvolvido, recomendamos que os gestores de parques respeitem a lei, onde as necessidades materiais, sociais e culturais das famílias que vivem dentro da área devem ser garantidas. Sob este cenário, esperamos ver que, à medida que as famílias estiverem sendo capacitadas para o desenvolvimento do futuro da região, os resultados na conservação da biodiversidade seguramente serão melhores. As famílias poderiam estar totalmente envolvidas no desenvolvimento de qualquer atividade econômica direta ou indireta desenvolvida no Parque, por exemplo recreação, ecoturismo, educação e pesquisa. As organizações governamentais e não governamentais devem ser profundamente envolvidas em qualquer processo de transição, como a agricultura sustentável (ou seja, agroflorestais), bem como outras ações solicitadas para o desenvolvimento social (por exemplo, educação, saúde e justiça).

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ANEXOS

Anexo A - Formulário utilizado para entrevistas.

Entrevista Nº_______ Data:____/____/_______ Coordenadas:___________________________________

Nome do(s) entrevistado(s):____

Etnia:_____________ Tamanho da propriedade: _____________ Tempo de moradia na residência:______________

Local: _______________________________________ Município:______________________________________

1.INFRAESTRUTURA

NOME Entrevistado	Sexo	Idade	Parentesco*	Escolaridade**	Ocupação Principal	
					Agrícola (na roça)	Não agrícola (qual?)

*1) Códigos: 1=esposa; 2 filho/filha; 3=enteado/enteada; 4=neto(a); 5=Mãe/pai; 6=sogra/sogro; 7=irmão ou irmã; 8=cunhado/cunhada; 9=tio/tia; 10=sobrinho/sobrinha; 11=filho/filha adotado (a); 12=outro familiar; 13=não parente

**1 Analfabeto 4 Da 5ª à 8ª série, ens.fund 7 Ens. médio completo 10 Pós grad.
2 Só Alfabetizado 5 Ens.fund. completo 8 Superior incompleto
3 Até 4ª série do ens.fund. 6 Ens.médio incompleto 9 Superior compl.

1.2 O TIPO E ESTADO GERAL DA CASA:

a) Tipo: 1 ( ) Taipa; 2 ( ) Alvenaria; 3 ( ) Mista; 4 ( ) outro___________
e) Banheiro / WC: 1 ( ) Interno; 2 ( ) Externo; 3 ( ) Não possui
f) Esgoto: 1 ( ) fossa; 2 ( ) Céu aberto; 3 ( ) Vala 4 ( ) Rede

1.3. NA CASA HÁ:

a) ( ) Água encanada. f) ( ) Televisão k) ( ) Cisterna
b) ( ) Luz elétrica. g) ( ) Refrigerador l) ( ) Internet
c) ( ) Máquina de lavar roupa h) ( ) Freezer m)( ) Celular ( ) Tele fixo
d) ( ) Automóvel ____ i) ( ) Antena parabólica n) ( ) Poço
e) ( ) Moto ______ j) ( ) Computador o) ( ) Fogão

1.4 COMO A FAMÍLIA SE RELACIONA COM A COMUNIDADE / SOCIEDADE:

a) Sindicato: É associado ( ) Participa ativamente ( ) Participa às vezes ( ) Não participa ( )
b) Associação: É associado ( ) Participa ativamente ( ) Participa às vezes ( ) Não participa ( )
c) Comunidade: É associado ( ) Participa ativamente ( ) Participa às vezes ( ) Não participa ( )
d) Escola: É associado ( ) Participa ativamente ( ) Participa às vezes ( ) Não participa ( )
e) Igreja: É associado ( ) Participa ativamente ( ) Participa às vezes ( ) Não participa ( )
f) ___________ É associado ( ) Participa ativamente ( ) Participa às vezes ( ) Não participa ( )

1.5 RENDA

Qual a renda mensal da família?

Salário _______ Bolsa família __________ Aposentadoria rural___________ Crédito rural__________

Aluguéis__________ Venda produtos em geral___________ Venda produtos agricultura_______ Artesanato___________ Amigos do bem________________________Outros______________________________

Dessas fontes de renda, qual acreditar ser a mais importante no momento? E há 10 anos atrás?___________________
____

Possui ajuda para cuidar/plantar? Quanto paga? ____

Continuação...

PRODUTIVIDADE E MANEJO, AGROBIODIVERSIDADE

3.1 O Sr (a) tem roça? ______ Desde quando? _________Qual o tamanho?______________

Já mudou a roça de lugar? _________Quando pela última vez? ___________ Muda de quanto em quanto tempo?_________

Faz rotação de cultura? ____

O sr(a) tem na propriedade: horta ( ) Pomar ( ) Roçado ( ) Capoeira ( ) Mata ( )

>>>>>>>>CROQUI<<<<<<<<<<<<

Como é feito a agricultura? O senhor vende ou é só pra abastecer a casa? ______________________________

Quais espécies são cultivadas____

____

Corte e queima de coivara ( ) Frequência de ocorrência _______ Só corte( ) frequência de ocorrência__________

Uso de defensivos? ________________________

Adubação orgânica ( ) Não ( ) Sim . Adubação química ( ) Não ( ) Sim __________________________________

Usa algum sistema de Irrigação? ( ) Não ( ) Sim, qual?____________________________

Já teve corte raso/queima total da vegetação? Quando?____

Possui algum tipo de assistência técnica para plantio? Qual? Quando? ________________________

Animais (silvestres) do mato aparecem na roça? Quais? ____

____

Quais apareciam antigamente?____

Quais animais existem na mata?____

2.1 PRODUÇÃO ANIMAL

Animal	*Utilização (venda/cons/, doméstic)*	*Raças/ espécies*	*Produção (carne, leite, ovos)/mês*	*Suplement. alimentar (kg/mês)*	*Gastos/ mês*	*Reprod*[1]	*Matrizes*[2]	*MR (1ano)*[3]	FR (1 ano)[4]	*MEng*[5]	*FEng*[6]
Caprino											
Bovino											
Galináceos											
Suínos											
Equinos											
Ovinos											
Abelhas											
Cães											
Gatos											

[1]Reprodutores machos adultos; [2]Matrizes adultas; [3]Machos recria (1 ano); [4]Fêmeas recria (1 ano); [5]MEngorda; [6]FEngorda.

Para animais que não tem rebanhos apenas coletar apenas o número

Continuação...

MAPA/CROQUI PARTICIPATIVO DA PROPRIEDADE (superfície agrícola útil, idade e tamanho das diferentes capoeiras, roças e mata é importante, tempo de deslocamento)

Continuação...

3.1 PLANTAS USADAS PARA USO COMERCIAL E NO ROÇADO. ORIGEM (ROÇA, MATA, CAPOEIRA);

Nome vernacular	destino (venda ou consu) V - C	Origem (Mata, Roça, quintal, capoeira)	USO Alimentação, lenha, forragem, venda.	Se vende, qual o valor?	Usa mão-de-obra externa? Se sim, qual o valor pago ao ajudante?	Tem custos com a coleta?	Beneficiamento do produto para venda?	Observações (manejo da planta/ Produção (ex. sacos, Litros)

ANEXO B - NORMAS PARA PUBLICAÇÕES NOS PERIÓDICOS

Periódico: Journal of Environmental Management:

https://www.elsevier.com/journals/journal-of-environmental-management/0301-4797/guide-for-authors

Periódico: Conservation biology

https://conbio.org/publications/conservation-biology/