Chapter 17
Conservation Opportunities in the Caatinga

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Abstract This chapter describes a recent participatory effort coordinated by the Brazilian Government to update the Priority Areas for conservation, sustainable use, and shared benefits of the Caatinga biodiversity, which culminated in the determination of 282 Priority Areas as defined by the MMA Law 223 of 21 June 2016. This network, determined by systematic conservation planning techniques, specifies relevant areas for 691 conservation targets, including 350 red-listed plant species, 65 threatened birds, 31 mammals, 30 reptiles, 22 amphibians, and 126 fishes, besides additional special habitats (e.g., caves) and endangered ecosystems. A landscape connectivity analysis indicated the potential of each area for restoration programs. Furthermore, other potential conservation actions were proposed for each area, including the creation of Conservation Units of Integral Protection and Conservation Units of Sustainable Use. In fact, the analysis clearly identified 53 Priority Areas that are the best cost-effective proactive conservation opportunities in existence today. This chapter highlights that Brazil now has an updated systematic conservation plan for the Caatinga biome and a historically unique window of opportunity to protect its biodiversity for the centuries to come.

Keywords Biodiversity • Caatinga • Conservation Priority Areas • Habitat loss • Fragmentation • Restoration • Systematic conservation planning

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17.1 Introduction

Brazil is a megadiverse country, being home to at least 10% of the world's species (Mittermeier et al. 1997; Lewinsohn and Prado 2005). Since the 1992 Rio Earth Summit, the Brazilian government assumed the international commitment of conserving the biodiversity of all its biomes (CDB 2016), including the Caatinga drylands, which have officially lost approximately 40% of their original cover (but see Chap. 13) and contain a large number of threatened endemic species (Chaps. 2, 3, 4, 5, 6, 7, and 8). Since 1998 the Brazilian Ministry of the Environment (MMA) has been organizing participatory workshops to define Priority Areas for biodiversity conservation and management actions.

The first plan, established by MMA Law 126 of 27 May 2004 and decree 5092 of 24 May 2005, recognized 900 Priority Areas for conservation of Brazilian biodiversity. Some years later, the MMA adopted systematic conservation planning (SCP) (Margules and Pressey 2000) as a tool to define the Priority Areas for conservation, sustainable use, and shared benefits of the Brazilian biodiversity (see Box 17.1). In 2007, the MMA updated the previous resolution throughout the MMA Law 9 of 23 January 2007 and defined 1561 Priority Areas, in addition to the Conservation Units already established. For the Caatinga, 292 Priority Areas were proposed, including 72 Conservation Units.

Box 17.1: Glossary

Systematic Conservation Planning (SCP) – Objective method of determining a minimum set of Planning Units, which will be ultimately grouped into Priority Areas, that satisfy the conservation goals determined for all chosen conservation targets at the lowest possible cost.

Priority Areas (PA) – Areas of outstanding importance for conservation, sustainable use, and shared benefits of the biodiversity that are recognized officially by a Law from the Brazilian Ministry of Environment. Priority Areas drive future conservation actions, such as the creation of Conservation Units, management regimes, and support decisions on the occupancy of the territory by the private initiative. Normally, PAs are larger than UCs.

Planning Unit (PU) – The smaller spatial scale on which all information used on a Systematic Conservation Planning analysis should be presented. In the MMA analysis, 53031 watersheds of 1537.4 ha, on average, were used as Planning Units.

Conservation Units (UC) – Biodiversity protected areas. Conservation Units are created by the federal or by the state governments. Conservation Units do not include the Indigenous Lands that are recognized due to the original rights of indigenous people. In Brazil, the term Protected Areas encompasses both Conservation Units and Indigenous Lands.

Conservation Units of Sustainable Use (UC-US) – Conservation Units that promote the sustainable use of natural resources.

Conservation Units of Integral Protection (UC-PI) – Conservation Units whose main aim is biodiversity conservation, being more restricted in relation to human use.

In 2014, the Brazilian government launched the process of reviewing the Priority Areas. For the Caatinga, the justification for such an upgrade is clear since knowledge concerning the conservation targets and their distribution, although still restricted (Santos et al. 2011), has grown considerably in the past decade with the establishment of several new universities and research groups in the Brazilian northeast(MEC 2015). In addition, land use also suffered considerable changes due to the establishment of new agribusiness activities, roads, power lines, and other infrastructure projects, such as the transposition of the São Francisco River. Furthermore, spatial data, including vegetation cover and species records, has become freely available.

The aim of this chapter is to briefly describe the participatory process and main results of the second update of the Priority Areas for conservation, sustainable use, and shared benefits of the Caatinga biodiversity. This process culminated in the determination of 282 Priority Areas defined by the MMA Law 223 of 21 June 2016. We also discuss the limits of the actual Conservation Unit network of the Caatinga biome and the urgency for the implementation of conservation actions that profit from the windows of opportunity represented by the Priority Areas.

17.2 Participatory Systematic Conservation Planning

The Priority Areas for conservation, sustainable use, and shared benefits of the Caatinga biodiversity were defined through a participatory process, coordinated by EMV and CRF, which occurred along with a series of workshops that culminated in the final proposal that were the origin of the MMA Law 223 of 21 June 2016 (Fig. 17.1). All workshops were attended by representatives from the MMA and the Secretary of Environment from the ten Brazilian states that encompass the Caatinga, in addition to other state agencies (e.g., IBGE (Brazilian Institute of Geography and Statistics), IBAMA (Brazilian Istitute of Environment and Renewable Natural Resources), Chico Mendes Institute), universities, and non-governmental organizations (NGOs). A preliminary step, however, was to perform an online evaluation of the methods, results, and use of the products generated by the work done in 2007. In this process, adjustments in relation to the methodology were proposed, new products were designed, and a better understanding was achieved on how the information on Priority Areas is used by state and federal governmental agencies, NGOs, and the private sector.

The first face-to-face meeting, called a methodological workshop, was organized in Salvador (Bahia) with representatives from 16 institutions (44 people) with the aim of discussing and determining the methodology to be applied in the 2016 Priority Areas exercise. In this meeting, the theoretical basis of SCP was discussed and major methodological decisions were undertaken. An important decision was to use natural watersheds as Planning Units (PUs) (see Box 17.1) since (i) water is the most important limiting resource for the Caatinga biome; (ii) watersheds have natural boundaries that can structure ecological, biogeographic, and evolutionary
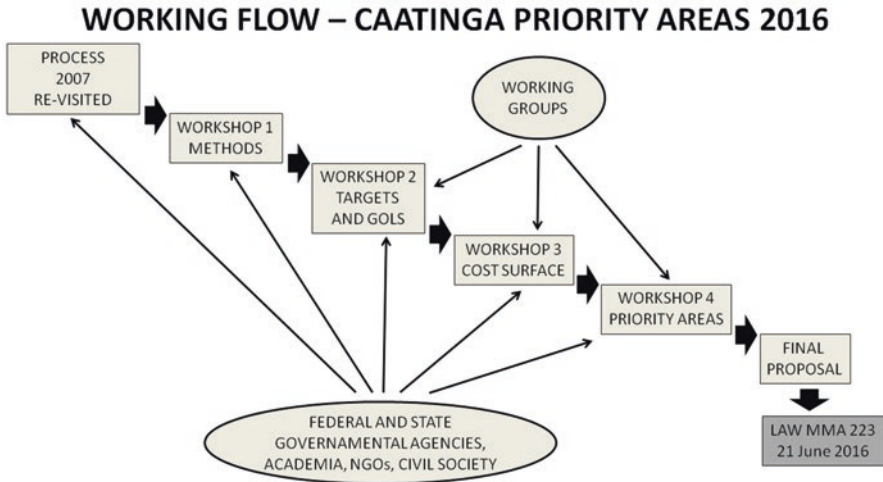
WORKING FLOW – CAATINGA PRIORITY AREAS 2016

Fig. 17.1 Working flow of the prioritization process organized by the Ministry of Environment (MMA) that culminated in the establishment of 282 Priority Areas for conservation, sustainable use, and shared benefits of the Caatinga biodiversity according to Law MMA 223 of 21 June 2016

processes; and (iii) they have politic jurisdiction represented by the watershed committees. In the end, 53,031 watersheds of, on average, 1537.4 ha were used as PUs.

The second workshop, which was organized in Recife (Pernambuco) with representatives from 20 institutions (35 people), determined the conservation targets and their associated conservation goals. In fact, this meeting was the endpoint of a 6-month process that involved 99 researchers from 42 institutions organized in several virtual working groups (e.g., birds, mammals, reptiles, amphibians, plants, fishes). Each working group had a group of two to four coordinators and a variable number of collaborators that were responsible for defining a list of conservation targets, making explicit the criteria based on which they were proposed as targets (e.g., International Union for Conservation of Nature [IUCN] or Brazilian red-listed species, endangered ecosystem), and producing a map of their geographic distribution, sometimes using niche modeling techniques (Elith and Leathwick 2009). In the workshop, the coordinators of the working groups showed their proposal which received suggestions and amendments by the participants. Finally, several criteria were established to define the representation goal for each conservation target. For all species, the representation goal was established according the criteria proposed by Rodrigues et al. (2004). For species with an extent of occurrence lower than 1000 km^2 the representation goal was established as 100% and for those species occurring in more than 250,000 km^2 the goal was set as 10%. For species with an intermediate extent of occurrence the representation goal was established by the non-linear equation $Goal = -37.53 LogArea + 212.6$. For the remaining conservation targets, such as high, arboreal Caatinga remnants, caves,

and special ecosystems (e.g., coastal dunes and mangroves) the criteria were defined democratically by the workshop members. A political agreement among the ten Brazilian states that possess Caatinga allowed the establishment of a 10% target in relation to their remaining natural vegetation, reaffirming their shared responsibility over the Caatinga biodiversity.

The third workshop, which also took place in Recife (Pernambuco) and involved 17 institutions (25 people), was designed to define a cost surface representing the relative cost, among PUs, of establishing conservation actions. The cost surface was created as the weighted mean of 21 spatially explicit primary variables representing social, economic, and environmental costs. For instance, population density was a key variable representing the social cost while the proximity to cities and paved roads, agribusiness, mining, and wood and oil extraction activities raised the economic costs. Environmental costs were associated with measures of habitat loss and fire incidence.

With the products of the previous workshop at hand, objective SCP techniques were applied to generate a preliminary proposal for Priority Areas (Margules and Pressey 2000). The simulation analysis was performed in MARXAN software (Game and Grantham 2008; Ball et al. 2009; http://marxan.net/) in such a way as to find sets of PUs able to satisfy the representation goals of all conservation targets while keeping the cost as low as possible. Although all PUs play a given role in conservation, SCP recognizes that some PUs will be more essential than others in the solution. In other words, PUs have different levels of irreplaceability. In fact, simulation analysis in MARXAN produces an irreplaceability surface showing areas more or less important for conservation. Also, MARXAN analysis identifies the set of PUs that constitutes the best solution (i.e., less costly). Based on such analysis, a preliminary proposal of the polygons of Priority Areas was established.

The final workshop, which was held in João Pessoa (Paraíba) and involved 22 institutions (46 people), had a primary aim of evaluating and proposing alterations to the preliminary proposal. Basically, deletions, additions, and changes in the limits of the polygons were proposed based on local knowledge, always respecting the representation goals of all conservation targets. At the end of this process, the Priority Areas were approved and classified in terms of their biological importance (i.e., degree of irreplaceability) and two criteria of urgency (i.e., habitat loss and desertification threat).

Also, each approved Priority Area had their potentiality evaluated in respect to potential conservation actions. For instance, some large Priority Areas with a high level of biological importance were indicated for the creation of new Conservation Units of Integral Protection. Others, depending on ongoing initiatives, were indicated for the creation of Conservation Units of Sustainable Use. Many Priority Areas were indicated for restoration projects considering their relevance to the functional connectivity of the biome (see Sect. 17.6) while others were suggested for special managing regimes (e.g., sustainable cattle ranching).

17.3   The Caatinga Conservation Targets

In total, 691 conservation targets were selected for the Caatinga biome (Table 17.1). Most of them were threatened plant species (S = 350) included in the *Red Book of the Brazilian Flora*, an updated publication produced in collaboration with around 200 taxonomists (Martinelli and Moraes 2013). In fact, 154 of the conservation targets were highly endemic (<1000 km^2) with representation goals of 100%, including many Asteraceae (24), Bromeliaceae (14), Cactaceae (9), Fabaceae (9), Xiridaceae (7), and Melastomataceae (6).

Interestingly, fishes were the taxon with the second highest number of conservation target species (S = 126) since the Caatinga biome contained a large number of highly endemic fishes distributed in several families, including Rivulidae (32), Loricariidae (15), Characidae (13), Trichomycteridae (8), and Heptapteridae (5). Such species were frequently restricted to a few PUs within the major watershed zones of the Caatinga biome. This group was included for the first time in the Caatinga prioritization process and benefited significantly from the decision to use watersheds as PUs.

Most of the 65 bird conservation targets had a less restricted distribution. In fact, 23 occurred in more than 250,000 km^2 with representation goals set as 10%. Several species, however, are considered critically endangered (*Antilophia bokermanni*—Pipridae, *Pyrrhura griseipectus*—Psittacidae) and endangered (e.g., *Formicivora grantsaui*—Thamnophilidae, *Scytalopus diamantinensis* and *Phylloscartes beckeri*—Rhinocryptidae, and *Lepidocolaptes wagleri* and *Xiphocolaptes falcirostris*—Dendrocolaptidae).Several sub-species were also selected as conservation targets (e.g., *Stigmatura napensis bahiae*—Tyrannidae and *Thectocercus acuticaudatus haemorrhous*—Psittacidae).

Table 17.1 Caatinga conservation targets and their distribution among the Brazilian states

Target type	AL	BA	CE	MA	MG	PB	PE	PI	RN	SE	Caatinga
Plants	28	307	44	6	21	39	58	31	18	12	350
Birds	48	65	58	28	49	57	62	56	49	40	65
Mammals	15	27	13	10	11	15	20	16	13	13	31
Reptiles	8	27	11	2	6	8	14	16	9	8	30
Amphibians	0	16	9	0	2	3	4	1	2	0	22
Fishes	10	72	31	19	21	10	20	31	10	16	126
Natural caves	1	4	3	1	1	1	2	2	3	1	18
Geodiversity	12	20	23	10	13	14	18	23	18	15	26
Coastal habitats	1	0	8	3	0	0	0	5	9	0	12
High Caatinga	1	1	1	1	1	1	1	1	1	1	1
State Caatinga	1	1	1	1	1	1	1	1	1	1	10
Total number	125	540	202	81	126	149	200	183	133	107	691

AL Alagoas, *BA* Bahia, *CE* Ceará, *MA* Maranhão, *MG* Minas Gerais, *PB* Paraíba, *PE* Pernambuco, *PI* Piauí, *RN* Rio Grande do Norte, *SE* Sergipe

Among the 31 mammal conservation targets, several species of primates are among the major concerns, since *Sapajus flavius*, *Callicebus barbarabrownae*, and *S. xanthosternos* are critically threatened, *Alouatta ululate* is threatened, and *Callithrix kuhlii* has a near threatened status according to the IUCN. Among the Carnivora, *Leopardus wiedii* and *Speothos venaticus* are classified as near threatened. *Lontra longicaudis* was virtually unknown in the Caatinga until recently and is classified as data deficient. The bristle-spined rat *Chaetomys subspinosus* (Rodentia) and the small marsupial *Monodelphis rubida* (Didelphimorphia) have also very limited geographic distributions. Other species have a widespread distribution, such as the Caatinga endemic *Kerodon rupestris*, but are threatened everywhere by hunting.

Among the 22 amphibian conservation targets, ten were highly endemic: *Siphonops annulatus* (Caeciliidae), *Proceratophrys aridus*, *P. minuta*, *P. redacta* (Cycloramphidae), *Adelophryne maranguapensis* (Eleutherodactylidae), *Bokermannohyla diamantine*, *B. juiju*, *B. flavopictus*, *Corythomantis galeata* (Hylidae), and *Chthonerpeton arii* (Typhlonectidae).

Among the 30 reptiles conservation targets, the highly endemic species (<1000 km^2) were *Mesoclemmys perplexa* (Chelidae), *Gymnodactylus vanzolini* (Gekkonidae), *Acratosaura spinosa*, *Heterodactylus septentrionalis*, *Procellosaurinus tetradactylus*, *Scriptosaura catimbau* (Gymnophthalmidae), and *Tropidurus mucujensis* (Tropiduridae).

Besides the biological targets, some alternative habitats were included as conservation targets. An important target is the remnants of tall, arboreal Caatinga that have been recently mapped (Hansen et al. 2013). In order to partially contemplate alternative habitats that could be useful to small-sized organisms, such as arthropods, which were not considered explicitly as conservation targets, 26 topographic classes were included as conservation targets (e.g., inselbergs, dunes, coastal plains). Also, some ecosystems (e.g., mangroves) were selected as conservation targets. Furthermore, four classes of caves were defined according the basic lithology (i.e., granitoids, siliciclastics, carbonatics, and ferruginous) since this can determine a different endemic composition of troglophyles and troglobites (Silva et al. 2011).

17.4   The Caatinga Priority Areas

In the Caatinga biome, 282 Priority Areas for conservation were identified (Fig. 17.2). The Priority Areas varied considerably in relation to the number of conservation targets they possess; while some had five, a single Priority Area is home of 309 conservation targets (Fig. 17.2a). There is a noticeable latitudinal gradient from the northern areas that contains fewer conservation targets than southern areas which have hundreds of conservation targets.

An important landscape element defining such a pattern is the Diamantina Highlands. In fact, the Diamantina Highlands possess hundreds of endemic, red-listed plant species (Martinelli and Moraes 2013). Furthermore, several amphibian
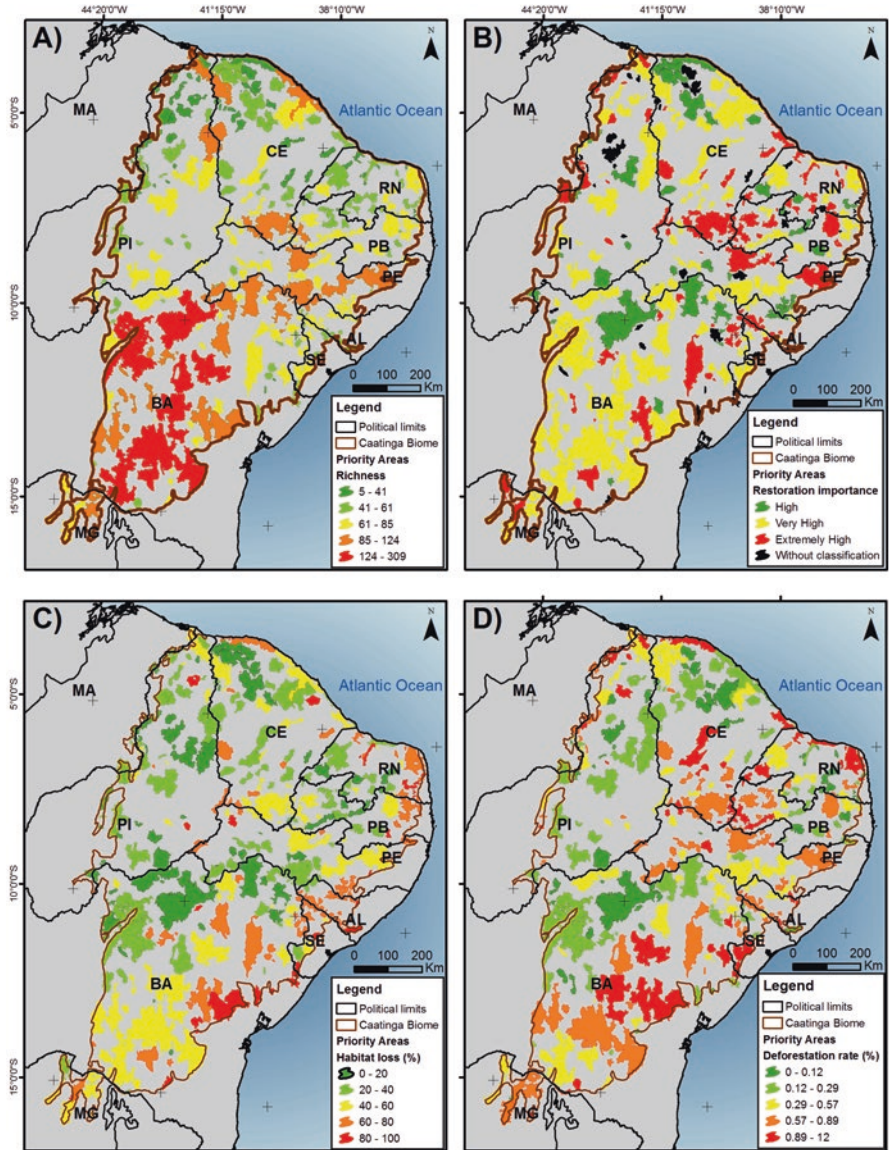
Fig. 17.2 Distribution of the 282 Priority Areas for conservation, sustainable use, and shared benefits of the Caatinga biodiversity according to Law MMA 223 of 21 June 2016. The Priority Areas are classified according to classes of (**a**) richness of conservation targets; (**b**) restoration importance based on landscape connectivity analysis; (**c**) habitat loss (%) until 2009; and (**d**) deforestation rate (%/year) between 2002 and 2009

Table 17.2 Distribution of the Caatinga Priority Areas among the Brazilian states

State	Priority Area (ha)	%	N	Caatinga area (ha)
Alagoas	381,599	29.4	16	1,299,387
Bahia	13,169,797	43.8	73	30,093,957
Ceará	5,378,831	36.1	55	14,890,874
Maranhão	334,621	89.2	13	374,960
Minas Gerais	801,580	72.3	10	1,109,334
Paraíba	1,446,198	28.2	32	5,137,097
Pernambuco	2,737,678	33.8	31	8,101,162
Piauí	4,172,145	26.4	52	15,810,964
Rio Grande do Norte	1,565,975	31.5	45	4,970,347
Sergipe	416,715	41.6	14	1,002,719
Total	30,405,138	36.7	282	82,790,802

species are restricted to this location, such as *Proceratophrys minuta* and *P. redacta* (Cycloramphidae), *Bokermannohyla diamantine*, *B. juiju*, *B. flavopictus*, *B. itapoty*, *B. oxente*, *Corythomantis galeata* (Hylidae), *Leptodactylus oreomantis* and *Rupirana cardosoi* (Leptodactylidae), and *Haddadus aramunha* (Craugastoridae).

The 282 Caatinga Priority Areas together covered 36.7% (30,405,138 ha) of the Caatinga territory (Table 17.2). The number of Priority Areas varied considerably among the Brazilian states, partially reflecting differences in the Caatinga coverage. For instance, the Bahia state had 73 Priority Areas distributed over 13,169,797 ha, corresponding to 43% of the total. However, 36% of the biome occurs in this state alone. In absolute terms, larger portions of Priority Areas are located in Bahia, Ceará, Piauí, and Pernambuco but this also is a direct function of the size of the biome within each state.

17.5 Habitat Loss and Deforestation Rates

The Caatinga biome officially had 54.5% of its original cover relatively intact in 2009 (but see Chap. 13). The situation, however, is clearly more worrying than this figure suggests since the whole biome has been explored for centuries and is affected by chronic anthropogenic disturbance (Ribeiro et al. 2015, 2016; Chap. 14).

Considering the 282 Priority Areas, mean habitat loss in 2009 was estimated to be 44.2% (Fig. 17.2c). Habitat loss, however, varied considerably among Priority Areas. Whereas some had already lost 99.6% of its cover, the loss in others was only 0.03%. The deforestation rate from 2002 to 2009 indicated that, on average, Priority Areas were losing 0.7% of their cover annually (Fig. 17.2d). Again, while some areas had undetected annual losses, others suffered a loss of 12% per year between 2002 and 2009.

17.6 Restoration for Caatinga Connectivity

Theoretical and empirical studies indicate that landscape connectivity is essential for the long-term maintenance of genetic diversity, animal and plant populations, community structure, and ecosystem processes and services (e.g., Taylor et al. 1993). A connectivity analysis based on graph theory (Antongiovanni 2017) that has been incorporated by the MMA for the definitions of the actions to be performed in the Priority Areas indicated that the connectivity of the Caatinga can be improved by restoration actions inside the Priority Areas. The analysis, which was based on watersheds of 8200 ha, determined the relative importance of restoration actions for all Priority Areas (Fig. 17.2b). Overall, 93 Priority Areas were considered to have an extremely high importance for the biome connectivity and deserve restoration effort. Also, 96 and 33 Priority Areas received a classification of very high and high, respectively, and 60 do not require any restoration effort.

17.7 A Scarce Conservation Unit Network

The National System of Conservation Units (SNUC) is a Brazilian law, created in 2000 to establish the criteria and norms for the creation, implementation, and management of Conservation Units (MMA Law 9985, 18 July 2000). Under this law, two basic types of Conservation Units are recognized: Conservation Units of Integral Protection and Conservation Units of Sustainable Use.

The main aim of Conservation Units of Integral Protection is biodiversity conservation, being more restricted in relation to human use. Among the different types of Conservation Units of Integral Protection, Biological Reserves are more restricted, while others are designed for scientific research (Ecological Station), to stimulate ecotourism (National Parks), to protect sites of singular beauty (Natural Monument), and to safeguard particular species or ecosystems (Wildlife Refuges). Only in the last two categories are private properties allowed to overlap with the Conservation Unit limits as long as there is no conflict of interest.

The main purpose of Conservation Units of Sustainable Use is to make biodiversity conservation and sustainable use of natural resources compatible. Among the Conservation Units of Sustainable Use, Areas of Environmental Protection (APA) are intended to be extensive and regulate private land use. In practice, this has been the most permissive Conservation Unit category of the whole SNUC system. Small private lands can also constitute Areas of Relevant Ecological Interest when they contribute to the protection of conservation targets of regional importance. Several Conservation Units of Sustainable Use, established in public lands, are designed to study and produce forestry products based on native species (National Forest), allow natural resource extraction activities by traditional populations (Reserve of Extractive Activities), facilitate studies on the management of animal populations of commercial use (Fauna Reserves), and embrace traditional populations that use
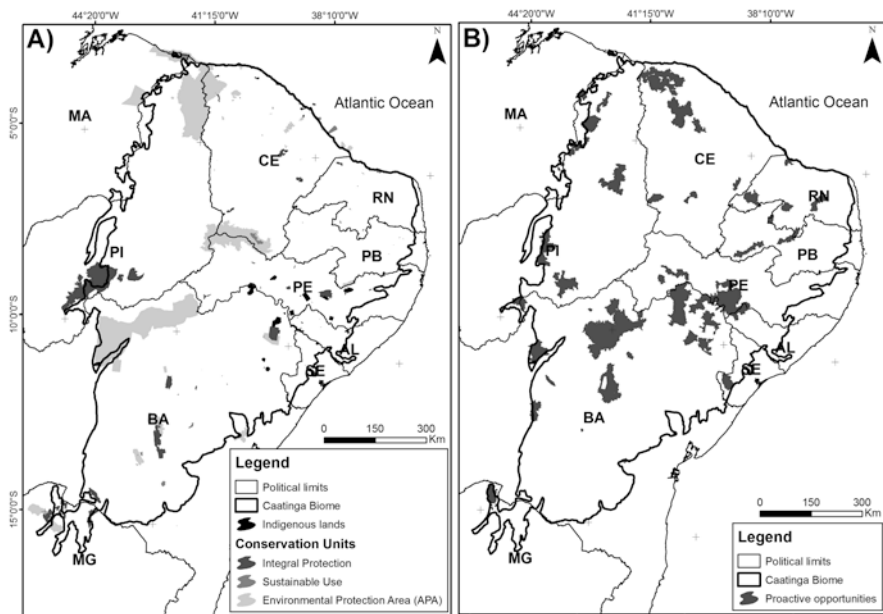
Fig. 17.3   Distribution of (**a**) the established Conservation Unit network in the Caatinga biome with the Conservation Units classified according the type of management category (see text) and (**b**) the 53 Priority Areas that are considered the best proactive conservation opportunities for the creation of new Conservation Units

local natural resources in a sustainable way (Reserve of Sustainable Development). Finally, there are private lands that receive a perpetuity title to be used exclusively for scientific studies and ecotourism (Private Reserve of Natural Heritage).

In the Caatinga, only 1.13% is currently protected by Conservation Units of Integral Protection (Fig. 17.3a). Additionally, 6.32% of the biome is protected in Conservation Units of Sustainable Use. However, 98.4% of the Conservation Units of Sustainable Use are APA, the most permissive of the SNUC categories (Fig. 17.3a).

17.8   Resource Limitations in the Established Conservation Units

The expansion of the areas under protection in the Caatinga is urgent and much needed (Fig. 17.3). However, like anywhere in the world, financial resources are essential for the effective management of Conservation Units (Bruner et al. 2001; Leverington et al. 2010; Geluda and Serrão 2014; Watson et al. 2014). Expanding the current Conservation Unit network in the Caatinga will certainly require further investments from the Brazilian Federal Government. A closer look at the available

resources for the current federal Conservation Units in the region points to an already worrisome financial scenario. A recent analysis (Oliveira 2015; Oliveira and Bernard 2017) of the budget allocated by the Brazilian Government to 20 federal Conservation Units in the Caatinga between 2008 and 2014 indicated that, in spite of an apparent significant budget, the money available is unevenly and disproportionally spent in terms of both the size of the total area considered and the distribution of values among units. Resources varied from US$231,575 in 2008 to US$13,517,129 in 2011, totaling US$33,257,478 for the 7 years analyzed. However, land regularization in Serra das Confusões National Park in 2010 and 2011 alone consumed ~75% (US$24,873,718) of the whole budget for the entire period. Besides land regularization, the second largest expense in the Conservation Units in the Caatinga was ostensible property security (US$5,182,479), a third-party service, the focus of which is the protection of properties and goods (e.g., buildings, equipment, and cars—when existing), and not the biodiversity per se in the Conservation Units (Oliveira 2015; Oliveira and Bernard 2017). Ostensible property security consumed ~15.6% of the total budget, or ~61.8% of the remaining budget when land regularization is excluded.

The Conservation Units in the Caatinga are effectively receiving very few resources considering the area they cover (around 2.3 million hectares) and the environmental services they provide (Manhães et al. 2016). A comparison between the average amount spent in Conservation Units elsewhere and the budget allocated by the Brazilian Government for the federal Conservation Units in the Caatinga clearly points out how underfunded those sites are. Division of the whole budget spent in the 20 Conservation Units by the 7 years analyzed and by their total area results in an average cost of US$2.01/ha/year (Oliveira and Bernard 2017). Excluding land regularization costs spent in Serra das Confusões National Park, the total expenses averaged US$0.50/ha/year. This is approximately 12 times lower than the values specified by the own Brazilian MMA as necessary for the basic operation of a Conservation Unit in Brazil (MMA 2009), nearly 1.8 times lower than the average spent globally (James et al. 2001), up to six times lower than the average values spent in Latin American and African parks (Bruner et al. 2004; Green et al. 2012), and up to 86 times lower than values spent in protected areas in the European Union (López and Jiménez 2006).

Not coincidentally, some of the federal protected areas in the Caatinga are acting as *paper parks*. According to the Cadastro Nacional de Unidades de Conservação (National Database of Conservation Units), of the 20 Conservation Units analyzed, 12 do not have a management council, 11 do not have a management plan, ten do not have basic infrastructure, and only seven are open to visitors (Oliveira and Bernard 2017). This situation violates the current legislation in several ways: since 1979 all Brazilian protected areas must have a management plan (Decreto 84,017/1979, Brasil 2000); a management council has been mandatory since 2000 (Brasil 2000); and the public visiting was one of the key objectives for the creation of several of the areas currently closed to tourists. Therefore, in order to maintain and expand the protected areas system in the Caatinga, an official commitment to secure funds from federal and state governments is mandatory.

17.9   Proactive Conservation Opportunities

Conservation strategies can be classified as proactive and reactive (Brooks et al. 2006). Proactive conservation strategies are those for which the moderate investment costs of open opportunities are covered sooner but with a stream of return benefit that will accumulate in the long run. Reactive strategies delay the investments in conservation actions for the future, but the total cost to be paid in the future rises steadily. As demonstrated by the spatial analysis here, there are still a number of great proactive conservation opportunities in the Caatinga (Fig. 17.2). Such areas are highly irreplaceable with many threatened species but are not substantially affected by habitat loss while recent measures of deforestation rates are still low. Many such areas are located in the north and northeast region of the Bahia state, but also in Ceará, Piauí, Rio Grande do Norte, and Paraíba. Therefore, the first step towards an effective proactive conservation strategy in the Caatinga is complete and updated—the localization of the main proactive opportunities based on their degree of habitat integrity, habitat connectivity, biological representativeness, geopolitics, and anthropogenic pressure.

The main mechanism for the proactive conservation strategy is, of course, the creation of new conservation areas. The 2016 MMA law indicated 150 Priority Areas for the creation of Conservation Units; however, a single Priority Area can be indicated for the creation of different Conservation Unit categories. In total, 79 Priority Areas were indicated for the creation of Conservation Units of Integral Protection, 54 for the creation of Conservation Units of Sustainable Use, and 45 with potential for the creation of Conservation Units of both types. Among the 150 Priority Areas indicated for the creation of Conservation Units, 53 were considered the best proactive opportunities due to their low level of habitat loss (mean = 17.3%) (Fig. 17.3b). From an economic viewpoint, the immediate creation of new Conservation Units in these Caatinga Priority Areas can be considered the best cost-effective action to be implemented.

The next step is to transform the recommendations that came out of this information-based planning phase into concrete actions, considering the growing pressure of several economic activities such as agriculture, cattle ranching, forestry, mining, and wind farms. Due to the recent economic crisis, the federal and state governments have now serious limitations to execute such conservation planning in the short run. We foresee, therefore, that new alliances with the productive sector can move such enterprises forwards. For instance, the wind power industry is growing substantially in the Caatinga. We envisage that the continuous expansion of the wind power industry in the biome should occur in parallel to the expansion of the Caatinga Conservation Unit network, via compensatory mechanisms to be openly discussed. Also, Caatinga conservation can profit immensely from the collaboration of international partners concerned with the world biodiversity. The Amazon, for instance, has profited substantially with collaborations from international NGOs (e.g., the World Wildlife Fund [WWF]) and financial institutions (e.g., World Bank, the German bank KfW). Independent of how the actions will take place, it is clear that Brazil now has an updated systematic conservation plan for the Caatinga biome and a historically unique window of opportunity to protect its biodiversity for the centuries to come.

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