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GEODIVERSITY AND GEOCONSERVATION IN TERRITORIAL DYNAMICS: THE EXAMPLE OF THE CHAPADA DIAMANTINA - BAHIA – BRAZIL

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ABSTRACT

The occupation process of The Chapada Diamantina - located in the central part of the state of Bahia, Brazil - is directly associated with its peculiar Geodiversity, where geological and geomorphological aspects stands out. The region's growth was associated with two economic cycles: firstly, mineral exploration, which promoted the emergence of important cities and towns; and then what tries to explore the tourist possibilities of the Plate. It is worth noting that this second cycle is based on the roughness left by the first cycle, as well as on the scenic beauty, wells and waterfalls. All of these attractions are geosites that must be conserved. Thus, there is a need for geo-conservation, carried out through the institution of Conservation Units (UC). This way, the territorial dynamics in Diamantine Plate had geodiversity as the driving force, but geo-conservation is essential to maintain this dynamic, because if the attractions are destroyed, this dynamics will collapse.

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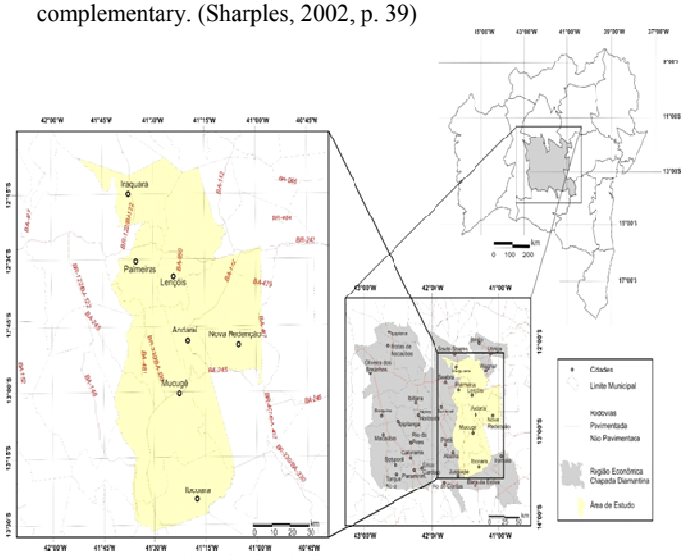
INTRODUCTION

The Geodiversity and territorial conservation, or geo-conservation, are closely interconnected, the former being fundamental in its conservation strategy. The world being awoke to geodiversity at the end of the 20th century, departing the premise that it is a quality that we should try to preserve. The term geo-conservation is a steal from the effort to try to conserve it. However, geo-conservation does not have the dimension of bio-conservation. When we are concerned with the conservation of this, we are indirectly trying to conserve both. Conservation Unit (UC) is the name given by the National System for the Conservation of Nature (SUC - law nº 9.985, of 07/18/2000), for natural protection areas due to their special characteristics, both biotic and abiotic. Among the abiotic are geosites that are sites of particular interest for the study of geology and geography, from a scientific, didactic or tourism point of view. However, there are isolated sites (the geosites) that are not included in the Conservation Units (UC), and are vulnerable, especially in countries, such as Brazil, where environmental laws are not yet strict. We can cite the example of the caves in Bahia, among others, where visiting is free, and there is no infrastructure to enable its use as an economic resource. In this article, some of these issues will be analyzed in the context of the Diamantine Plate, located in the center of the State of Bahia, Brazil, between the parallels of 12 ° 00 'to 13 ° 30'S, and the meridians of 41 ° 00' and 42 ° 00'W (Figure 1.1). Although the Diamantine Plate's economic region covers 33 towns, in this article, only seven are detailed, due to their importance in the mining cycle and later in tourism. They are: Andaraí, Ibicoara, Iraquara, Lençóis, Mucugê, Nova Redenção and Palmeiras, which have in their limits almost all the natural attractions, and concentrate the infrastructure to support tourism, becoming a bright space, as Santos calls it (2001).

Discussing the Geo-diversity: When talking about Geo-diversity, it is necessary to work on the terms related to this context, in order to elucidate them. Thus, Sharples (2002) draws attention to the distinction between three frequently used terms:

> Geodiversity is a quality that we try to conserve, geo-conservation is the effort to try to conserve it and geological heritage comprises of the concrete examples representative of the resources and processes by which we direct our management efforts in order to conserve them. These three terms are not synonymous, but complementary. (Sharples, 2002, p. 39)



Fonte: Adaptado de Giudice (2011).

Figura 1. Mapa de localização da Chapada Diamantina, Bahia, Brasil

The study of the abiotic Geodiversity nature started to attract attention recently, in the 90's decade, when it began to be used by geologists and geomorphologists, to describe the variety of the abiotic environment (GRAY, 2004). However, this author states that it is difficult to specify when it was first used, most likely in Australia (Tasmania), since, according to Nascimento, Ruchkys and Mantesso-Neto (2008, p.10), "in this country the term geodiversity was used by Sharples (1995), Kiernan (1994, 1996, 1997) and Dixon (1995 and 1996), in studies of geological and geomorphological conservation".
Sharples (1995) defined geodiversity as being the variety (or diversity) of features, assemblies, systems and geological (rocks), geomorphological (modeled) and pedological (soils) processes. This brief definition implicitly includes hydrological and climatic (atmospheric) processes, insofar as they are involved in geological, morphological and pedological formations. Also, according to Nascimento, Ruchkys and Mantesso-Neto (2008, p. 10), in 2001, the Royal Society for Nature Conservation, from the United Kingdom, defined geodiversity as "the variety of geological environments, phenomena and active processes that gives rise to landscapes, rocks, minerals, fossils, soils and other surface deposits that are the support for life on Earth ". In Brazil, the concept of geodiversity has had a strong focus on territorial planning and geoconservation, albeit incipiently, have also been addressed. Silva and his co-workers, in a publication by the Research and Mineral Resources Company (CPRM), today corresponding to the Geological Survey of Brazil (2008), presented a very good geographical proposal in order to make a contribution to the proper use of the territory, aiming at planning the spatial planning with environmental concern. Thus, geodiversity is defined as:

> (physical environment) constituted by a variety of environments, composition, phenomena and geological processes that gives rise to landscapes, rocks, minerals, waters, fossils, soils, climate and other superficial deposits that favor the development of life on Earth, having as values intrinsic to culture, aesthetics, economics, science, education and tourism (SILVA, 2008, p. 12).

On the other hand, Silva and Carvalho Filho (2001, p. 59) defined geodiversity from the "variability of the environmental characteristics of a given geographical area". There are divergences in the conception of geodiversity, as there is a current that opts for the more restrictive line, and interconnects it exclusively to minerals, rocks and fossils, and another trend that considers the term more comprehensive. In our view, the term is quite comprehensive, encompassing even the biodiversity that depends on space to exist, even though it is much more studied, as it appears when entering research sites when there is a disproportion of that term in relation to this one. The perspective of the term being more comprehensive is evident in Lazzerini (2005, p. 2), when he states that:

> The term geodiversity can briefly be considered as the diversity of the terrestrial Mineral Kingdom. It covers aspects of the geological, climatic, geographic and biological sciences of Planet Earth. Its principles and foundations can be correlated with the concepts of biodiversity, also assuming similar international ecological, economic, ethical and scientific roles. It differs from biodiversity that involves the natural processes on the planet Earth, in detail or together, as a whole. Its inventory involves the global complexity of natural agents and processes, the singularities, coincidences and groupings of each location; in order to conclude on any rarities, search for origins and localized social, economic and environmental importance. Its knowledge aims to add value to natural properties and products, discover characteristics that benefit human beings, in questioning national sovereignty, minimize risks due to excesses of anthropic action and conserve points considered to be still untouched. In this way, researches with this approach can bring a more uniform and consistent vision together with discussions and economic strategic, political and legal plans that aim to broadly meet current parameters of sustainable development and common concerns of humanity, such as the 21st Agenda and the Protocol of Kyoto.

Natural heritage (which makes up geodiversity) is considered the set of natural resources of scientific/cultural, educational and/or recreational value, and consists of geological formations and structures, morphology, sedimentary deposits, minerals, rocks, fossils, soils and other geological manifestations that allow knowing, studying and interpreting history Earth's geological structure, the processes that shaped it, the climates and landscapes of the past and present, and the origin and evolution of life on this planet. The conservation of places of geological interest is absolutely necessary and inseparable from that of Natural and Cultural Heritage in general, a characteristic of culturally advanced societies. Any environmental and nature conservation policy that does not adequately address the management of the Geological Heritage will never be a correct environmental policy. It is necessary that those responsible for the different institutions, whether public or otherwise, are actively involved in a campaign to raise awareness among the population as a whole, in order to create a concept on how the Heritage is good for all. It can also be said that the natural heritage is an expression of geodiversity, according to Kozlowski (2004, p. 834), who defines it as:

> Geodiversity is the natural variety on the earth's surface, referring to the geological and geomorphological aspects, soils and water resources, as important as other systems created as a result of endogenous and exogenous processes and human activity. Together with biodiversity, it forms the determining elements that enable the support and sustainability of development.

In fact, it is the society's various actions to ensure its developments that transform the geographic space, and that is why it is necessary to understand the complexity and diversity of ecosystems to understand how the process evolves. As stated by Kozlowski (2004), the development of societies is closely linked to abiotic conditions, and geodiversity was fundamental for the increase of biological diversity during geological evolution, with the lithosphere having an important meaning in the creation and development of life. Therefore, it is necessary to protect geodiversity, as an indispensable feature for the proliferation of life.

Geodiversity as a territorial conservation strategy: Geodiversity includes the varieties of geological environments that are phenomena and processes that give rise to rocks, minerals, fossils, soils and other surface deposits that are in support of life on earth, in short, the abiotic nature. It is shaped by the actions of water and climate (the winds particularly), in a process of weathering that gives the regions characteristic morphological features, which can serve as tourist attraction of various shades, whether ecological, adventure, or even contemplative. Understanding the mechanisms that form these models allows a conscious assessment of geological heritage, as:

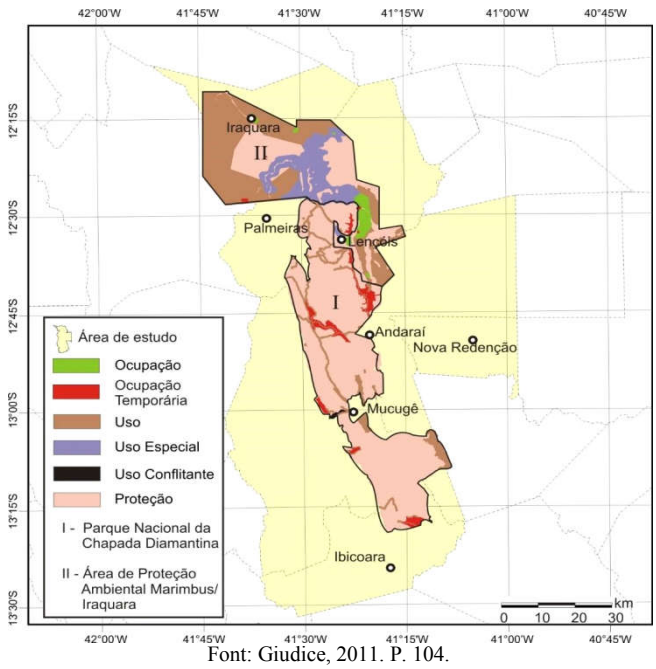
> The study of natural landscapes through geomorphology is therefore of relevant interest for the assessment of the geodiversity of a given region, since the morphology of the terrains represents an interface between all other variables in the physical environment and consists of one of the elements under analysis (SILVA, 2008, p. 34).

Here, it is appropriate to introduce the concept of geological heritage, which is seen as a set of geological sites (geosites), a definition that we disagree with, as we consider that an isolated geosite is also an heritage. The term is strictly related to geodiversity, but one must be careful not to consider it synonymous, since it is actually a small part of it. Thus, geological heritage presents rare specifications that they confer peculiarity and therefore need to be conserved. Thus, Shines (2005, p. 38) talks about the conservation of "fossil outcrops in the world", and Nascimento, Ruchkys and Mantesso-Neto (2008, p. 11) referred to "what can be considered top-of-the-range geodiversity". These authors consider that heritage should be defined by geologists, as they believe that only these professionals are competent to identify its superlative value, to be defined as such. So, for example, all landscapes around the world, like the African savannas, coral reefs, etc. constitutes geodiversity, while only geosites, such as Pai Inácio Hill, in Chapada Diamantina National Park (Brazil) or geysers, in Yellowstone National Park (USA), constitute geological heritage. However, the heritage has more emphasis on the tourist utility as it is one of the attractions that drives the conservation trend, in addition to having value for its scientific and cultural/educational aspects, as stated by Valcarce and Cortés (1996). Considering that by definition, geological heritage is a set of geosites, it is important to define them. The terms geosite and geotope are synonymous, the second one is more employed by the German school, and the former by the Anglo-Scandinavian school. The term geomorphosite is also used to treat landscape forms with geomorphological attributes, as well as geomonuments, but in this work, we will only use geosite, in order to standardize the language. According to Wimbledon (1999, p. 53), "a geosite can be any location, area, or territory, where it is possible to define a geological interest for conservation". In fact, it is considered an abbreviated form of geological site or site of geological interest. On the other hand, Gray (2004, p. 81) defined the term in question as "geodiversity elements, well delimited geographically and which, due to their peculiarity or rarity, present scientific, pedagogical, cultural, aesthetic, economic, or other value". Due to the value and importance of geodiversity, it becomes very detachable for the conservation of the territory, but for this, it needs to be included in the policy developed by the state, with the same emphasis that is given to biodiversity, even because the changes inflicted on geodiversity can imply significant changes in biodiversity.

The importance of conservation units in territorial dynamics: Conservation units are of fundamental importance in "territorial conservation" or "geoconservation". These units are represented by Park, Environmental Protection Areas, Permanent Protection Areas, and Extractive Reserves, emerged to protect regions of great scenic beauty or rarities. This concern about geodiversity is to reveal a dynamic territory of occupation, in which the government interferes, legally protecting areas over which it cannot fully inspect, leaving them vulnerable to various types of aggression. According to Villarroel (2012), regardless of the perspectives adopted, the conservation/protection practices adopted in different parts of the planet acquired their own contours, influenced by the different contexts in which they were developed. However, McCormick (1992) states that, for those who undertake the task of understanding the development of the environmental issue in the world, it is necessary to understand the contributions of this debate in a broader way and not just in terms of isolated national experiences:

> For example, the certainty that conservation was one of the greatest contributions of America [USA] to the [environmental] reform movements worldwide and that its ideas ended up being exported to other nations. In fact, American conservationism was heavily influenced by German forest management techniques and conservation was practiced in some parts of Europe – and even in South Africa and India – before it emerged in the United States (MCCORMICK, 1992, p. 40).

The making of protected areas are aimed at the management and protection of spaces of ecological and social importance, became a global phenomenon in the mid 20th century. However, at the end of the 19th century, the creation of Yellowstone National Park (USA) was a milestone, as it was created with the objective of socializing the enjoyment of a scenery endowed with great wild natural beauty. The mode of conservation varies between countries, and in Brazil it is governed by the National System of Conservation Units (SNUC) Act of 2000, which divides them into: Full Protection Units where only the indirect use of natural resources is allowed (the Parks); and Sustainable Use Units (such as Environmental Protection Areas (APAs)). This law and all its consequences are always provided for the conservation of biodiversity, as if it did not depend on the geodiversity that sustains it. However, geodiversity is only included in the strict protection group, in the "natural monument" category, which provides for the conservation of rare, unique or of great scenic beauty natural sites, with the caution that it must be compatible with the objectives of the Unit of Conservation. According to Villarroel (2012), the expansion policy of PAs in the country, in recent decades, it has been a relevant strategy to contain the impacts of a pattern of unrestrained occupation of the territory and the inadvertent use of natural resources. It can be observed from above, that the preservation of geodiversity is placed on a scale of lesser importance, and when it is protected, it is part of the Conservation Units that mainly target the biota. Thus, the protection of geodiversity takes place in the wake of the protection of biodiversity, which is the keynote around the world, and Chapada Diamantina is no different. Thus, there are three conservation units in the region, namely: Chapada Diamantina National Park (PARNA CD); the Marimbus-Iraquara Environmental Protection Area (APA); and the Municipal Park (Parmu) of Mucugê (Figure 2).



Font: Giudice, 2011. P. 104.

Figure 2. The map showing the location of the Chapada Diamantina PAs, Bahia, Brazil

According to Giudice (2011, p. 146):

> The thought of preserving geodiversity is an attraction factor for tourism, but it also reveals a territorial dynamic of occupation, in which the government interferes, legally safeguarding areas over which it is unable to fully inspect, leaving them vulnerable to various types of aggression, including real estate speculation, since not even public agencies can carry out work in them, but clandestinely many speculators, sometimes foreigners, shielded as tourists or looking for alternative ways of life can do so.

Finally, conservation units, considered here as protections, are strategic mechanisms for geo-conservation of the territory that influence territorial dynamics, which, according to Pellegrini (2000, p. 22), consists of "giving natural assets a convenient function, with adequate solutions that imply the proper use of natural attractions, however, avoiding or minimizing the damage to them or their loss". However, geosites that are not included in the UCs must be protected through laws at the municipal and state scale, mainly structuring the area of their occurrence so that there is control of visitation, providing them with infrastructure that makes them self-sufficient in terms of maintenance, as seing in the case of Furnas (Ponta Grossa, PR, and in Zipaquirá (Colombia), on the outskirts of Bogotá, where an old mine was transformed into the Salt Cathedral.

Characterization of the main UCs study area and their respective tourist potentials: Chapada Diamantina is located in the Central part of the state of Bahia (Figure 1 and according to Giudice (2012, p. 1)

> Geologically, the region is part of the Espinhaço mountain range: a chain of mountains that extends from the central part of the state of Minas Gerais to the north of the state of Bahia, along approximately 1200km of length NS. The rocks that support this chain belong to the Espinhaço supergroup, a lithostratigraphic unit belonging to the Proterozoic Eon and which is divided into four domains called, from north to south, Chapada Diamantina (BA), Espinhaço Northern (BA), River Plateau Brown (MG) and Espinhaço Meridional (MG).

There are three UCs involved in the study, as shown in Figure 2 above, and the Mucugê Municipal Park is not represented there, due to scale reasons. Let's take a look at each one of them and their main characteristics and respective uses.

Chapada Diamantina National Park (PARNA): The above mentioned Park was created by Federal Decree No. 91,655, of September 17, 1985, with the objective of protecting, in environmental terms, the Serra do Sincorá area and its natural beauty. It has an area of 152,000 hectares (110 km long, in an approximate north-south direction, and 27 km in maximum width, with an external perimeter of approximately 370 km). It expands predominantly on the eastern slope of Chapada Diamantina, between coordinates 12°24'23"S and 13°11'57"S and 41°35'38"W and 41°05'45"W, occupying more than half of the Serra do Sincorá, in the municipalities of Lençóis, Andaraí, Mucugê, Palmeiras, Itaetê and Ibicoara. The unit has been linked to the Chico Mendes Institute for Biodiversity Conservation (ICMbio) since its creation in 2007. The PARNA also has the mission of protecting the region that is known as the water tank in Bahia, because it is the grace of the water that flows from the interior of the unit that the Paraguaçu river, which originates in Chapada and flows into the Recôncavo Baiano, and has sufficient strength and volume to supply about 60% of the metropolitan region of Bahia. third most populous city in the country: Salvador. Considered as one of the main natural tourism centers in Brazil, the park has impressive natural scenery. There are countless waterfalls, such as Cachoeira da Fumaça (Figure 3), the second highest in the country with its 340m free fall; deep valleys and canyons with humid forests in their interior; peaks with more than 1,500m in altitude, the highest being 1700m. In addition to these natural attractions, the historical and cultural heritage of diamond mining – an economic activity that gave birth to the cities and named the region – also draws attention with buildings, such as the village of prospectors, which are also tourist attraction. Despite having being in existence for over 35 years.

Source: Authors' collection (2019)

Figure 3. Cachoeira da Fumaça – Chapada National Park

The Park does not have a Management Plan, which is the technical document that establishes the limits and rules for their use, with rules for the controlled exploitation of its natural resources and implementation of the physical structures necessary for the management of the unit. Even by SNUC, the Park is considered as an integral protection area, we can say that it has multiple uses today, for example: residential, tourist, commercial, agricultural, mining. Due to all these, we assume that when/if the Management Plans are approved, a regularization process should be launched that will stop most of these uses.

A APA Marimbus-Iraquara: Created by the State Decree No. 2,216, of June 14, 1993, RC No. 1440,20th of June 20, 1997, in accordance with the Tourism Development Program of Bahia (PRODETUR), with the purpose of ensuring environmental protection in line with the development of tourism in the region. It has a land mass of 125,400 hectares, covering four of the seven municipalities in our area of study: Iraquara, Seabra, Palmeira and Lençóis. The Management Plan, prepared by the State Government in 1998, regulated by the Resolution of the State Council for the Environment (CEPRAM) No. 1440, June 20, 1997, established the APA's ecological economic zoning and defined 15 zones, grouped into three different categories: conservation, preservation, and sustainable use. The Preservation category covers areas of high ecological value in its ecosystems, being closely associated with the preservation of wild fauna and flora remnants in an advanced stage of regeneration. This category encompasses the Wildlife Protection (ZPVS), Strict Protection (ZPR), Permanent Preservation (ZPP) and Cave Protection (ZPC) zones, encompassing the Marimbus, the rupestrian fields, the biodiversity corridors. The Conservation category are areas where human activities must be developed with great control, due to their high ecological fragility, great scenic value or the presence of ecosystems protected by environmental legislation, all of which are under private domain. This category includes the zones, Agroforestry, Landscape Control, and Visual Protection, covering part of the mountains of Santo

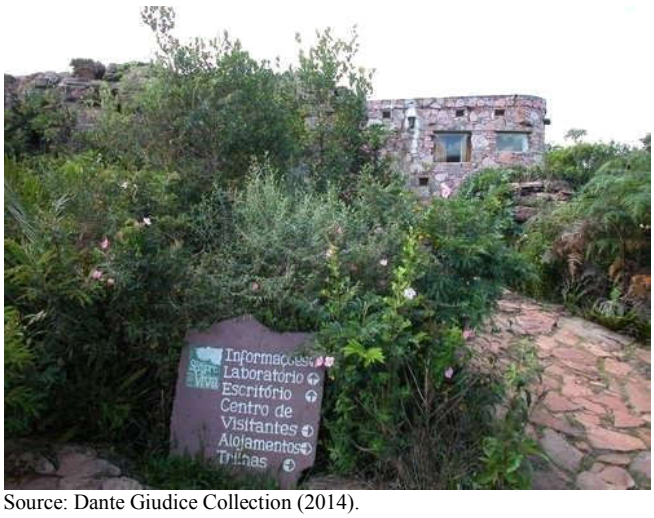
Antonio and Gameleira (Iraquara/Seabra), area between Estiva and Iraporanga (Lençóis/Iraquara), areas around the Marimbus (Figure 4), part of the Santo Antonio river basin in the Iraquara limestone plain, rock fields south of Estiva, slopes of the São José river, areas around the BR-242 – stretch between the bridge of the Santo Antonio river and the BA-850, and mountain ranges around the São João river. Finally, the Sustainable Use category refers to areas with the presence of environments that are still preserved and in different stages of anthropization.

Source: Authors' collection, (2018).

Figure 4. Pantanal da Chapada – Marimbus

The use is based on studies of the natural environment and on the vocations and economic trends identified in the environmental diagnosis. This includes the areas of Agriculture, Restricted Agriculture, Controlled Occupation, Priority Expansion, Special Tourism, Tourist Village, and the Urban Support and Consolidated Urban Nucleus, which occupy the trays with soils of high natural fertility, valleys along the banks of rivers, streams and around the Marimbus, areas located in the growth vector of the city of Lençóis (along the BA-850 and BR242), main road junctions, around the main cities, urban centers within the APA , and areas of the Santo Antonio and Mucugezinho rivers.

Mucugê Municipal Park: Created by Municipal Decree No. 235, March 15, 1999, and the Semper Viva Project (Figure 5) is developed within it. It was also created in 1999. Today, it is one of the main tourist attractions in Bahia and the largest center for biological research in Bahia. Diamond Plate. It has an area of 270 hectares, but its polygonal has not yet been made available. Because it has a reduced area, it was not possible to be represented in Figure 2. It is considered a Conservation Unit (UC) in accordance with Conama Resolution nº 11, of November 3, 1987. Its management plan is detailed, proposing an integrated, participatory and sustainable form of management. It is the most structured UC of the three, as, in addition to its reduced dimensions, it has a present and active administration.



Source: Dante Giudice Collection (2014).

Figure 5. Headquarters of the Semper Viva Project – Mucugê

In Mucugê Municipal Park, several activities take place, such as research in partnership with the State University of Feira de Santana (UEFS) for the reproduction of an endemic evergreen species (Syngonanthus mucugensis A.Giulietti) that is very threatened with extinction. Also occur the; geoprocessing and the making of thematic maps of the municipality of Mucugê, of the entire National Park and of several other locations in Chapada Diamantina. There are several projects in the environmental education that involves public and private schools in Mucugê, some from surrounding municipalities, as well as several private schools in Recife and Salvador. These projects identify plants in the reserve area, with a view to expanding the Park's herbarium, which already has more than 1,000 cataloged and identified plants.

Final considerations

Territorial conservation or geo-conservation is closely linked to geodiversity. In today's world, where consumption is the watchword, conservation only arouses interest when it can generate profit. In this context of consumption at any cost, it is forgotten that the planet's capacity for resilience is limited, and if there is no imposition of strong laws with heavy fines, man's conscience is not "awakened" Thus, the geodiversity that sustains us, including the bita develops in it, needs to be conserved as a strategy to maintain life itself, otherwise we will reach the extreme of "scorched earth", a situation that would make it practically impossible to reverse the destruction scenario. In the specific case of the study area, as we have seen, each of the UCS has its peculiarities and respective needs that are very important in territorial dynamics. In this context, the idea of geo-conservation was developed, through the creation of UCs and protected areas, such as indigenous reserves. Governments began to pay greater attention to this fact, acting along two lines: the first aimed at conservation, where resources are used sparingly; and the second, which is preservation, where scientific studies are made possible, for the protection of species and indirectly generating preservation of the natural heritage. Thus, attesting to the fact that it was the geodiversity in Chapada Diamantina that provided the economic subsidies for its occupation and territorial dynamics, it was necessary to ensure its environmental protection (geo-conservation) through the creation, by the government, of protection units . It is worth noting that these protection units, despite having their existence based on legal mechanisms, coexist with external and internal conflicts that continue to interfere in territorial dynamics.

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