



## Geodiversity and geoconservation in territorial dynamics: The example of the Chapada Diamantina

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### ABSTRACT

Chapada Diamantina is located in the central part of the state of Bahia. Its occupation process is closely associated with the Geodiversity, which is the natural variety that exists in the earth's surface, comprising geological and geomorphological aspects that enable and support sustainable development. This development of the region was associated with two cycles, the first of mineral exploration, and later, years later, in 1980, a second,

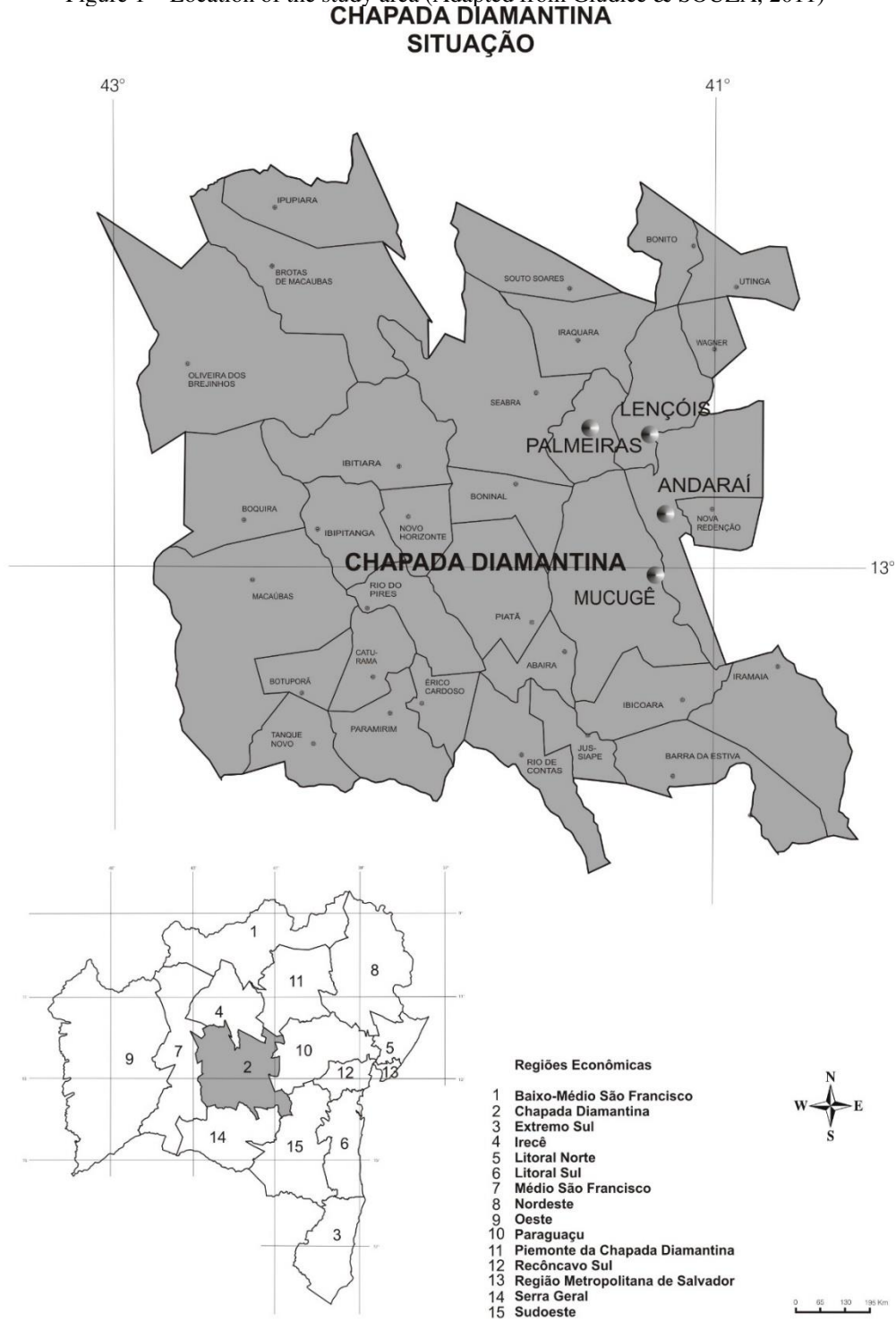
enjoying the sightseeing possibilities, based on the roughness left by the first cycle, but also in scenic beauty as a result of morphological modeling, through the action of weathering (wind and rain). The first cycle promoted the rise of cities and towns, as the abandoned Prospectors' Village in Igatu. The second cycle uses the caves, ponds, wells and waterfalls. All these attractions are geosites that must be preserved. Thus arises the need for geoconservation, effected through the establishment of conservation units (UC). Thus, the territorial dynamics in the Chapada Diamantina had geodiversity as a driver, but geoconservation is essential to maintain this momentum, because if the attractions are destroyed, this dynamic will collapse.

**Keywords:** Geodiversity, Geoconservation, Territorial Dynamics, Chapada Diamantina, Bahia.

### 1 INTRODUCTION

The Chapada Diamantina is located in the central part of the State of Bahia (Figure 1), a region that was first occupied due to the mining cycle, and more recently a new cycle has been established with tourism.

Figure 1 – Location of the study area (Adapted from Giudice & SOUZA, 2011)



Since geodiversity is the basis for sustaining biodiversity, its conservation is fundamental, not only for the preservation of life, but also of the physical structure, represented by the natural heritage.

Geodiversity and territorial conservation, or geoconservation, are closely intertwined, being the fundamental one in the conservation strategy of this.

The world woke up to geodiversity at the end of the last century, taking the premise that it is a quality we try to conserve, while geoconservation is the effort of trying to conserve it.

However, geoconservation does not have the dimension of bioconservation, although, by worrying about its conservation, we are indirectly preserving both. However, there are isolated sites (the geosites) that are not covered by 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 existing caves in Bahia, among others, where visitation is free, and there is no infrastructure to enable its use as an economic resource.

## 2 DISCUSSING GEODIVERSITY

For the discussion on geodiversity, 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, **geoconservation** is the effort of trying to conserve it **and geological heritage** comprises 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 rather complementary. (**translation and emphasis added**)

Geodiversity began to attract attention recently, in the 1990s, when it began to be used by geologists and geomorphologists to describe the variety of the abiotic medium (Gray, 2004). However, this author states that it is difficult to specify when it was first used, most likely in Australia (Tasmania), because, according to Nascimento, Ruchkys and Mantesso-Neto (2008), "in this country the term geodiversity was used by Sharples (1995), Kiernan (1994, 1996, 1997) and Dixon (1995 and 1996), in geological and geomorphological conservation studies".

Sharples (1995) defined geodiversity as the variety (or diversity) of geological (rock), geomorphological (modeled), and pedological (soil) features, assemblies, systems, and processes. This brief definition implicitly includes hydrological and climatic (atmospheric) processes, insofar as these are involved in geological, morphological and pedological formations.

Also according to Nascimento, Ruchkys and Mantesso-Neto (2008), in 2001, *the Royal Society for Nature Conservation*, of the United Kingdom, defined geodiversity as "the variety of geological environments, phenomena and active processes that give rise to landscapes, rocks, minerals, fossils, soils and other surface deposits that are the support for life on Earth".

In Brazil, this concept has been delineated concomitantly with other countries, but with a strong focus on territorial planning, although geoconservation, although incipiently has also been addressed. Silva and collaborators, in a publication of CPRM - Geological Survey of Brazil, in 2008, present a

very geographical proposal to make a contribution to the proper use of the territory, aiming at the planning of sustainable territorial planning. Thus, geodiversity is defined as:

The study of abiotic nature (physical environment) consists of a variety of environments, composition, phenomena and geological processes that give rise to landscapes, rocks, minerals, waters, fossils, soils, climate and other surface deposits that propitiate the development of life on Earth, having as intrinsic values the culture, the aesthetic, the economic, the scientific, the educational and the tourist (Silva, 2008).

On the other hand, Silva & Carvalho Filho (2001) defines geodiversity from the "variability of the environmental characteristics of a given geographical area".

There are divergences in the conception of geodiversity, because there is the current that opts for the most restrictive line, and interconnects it exclusively to minerals, rocks and fossils, and another trend that considers the term more comprehensive. In our conception, the term is quite comprehensive, encompassing even the biodiversity that depends on the space to exist, even though this is much more studied, as it is verified when entering *research sites* when the disproportion of that term in relation to this one is verified.

The perspective of the term being more comprehensive is evident in Lazzerini (2005), when he states that:

The term geodiversity can be briefly considered as the diversity of the terrestrial Mineral Kingdom. It addresses aspects of the geological, climatic, geographical and biological sciences of Planet Earth. Its principles and foundations can correlate with the concepts of biodiversity, also assuming similar international ecological, economic, ethical and scientific roles. It differs from biodiversity by involving all the natural processes of 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 locality; to be able to conclude about possible 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 still untouched. In this way, research with this focus can bring a more uniform and consistent vision along with discussions and strategic economic, political and legal planning that aim to broadly meet current parameters of sustainable development and common concerns of humanity, such as Agenda 21 and the Kyoto Protocol.

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 to know, study and interpret the geological history of the Earth, the processes that shaped it, the climates and landscapes of the past and present, and the origin and evolution of life on this planet.

According to Ibañez (2004), citing the 1997 Girona Declaration,

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 contemplate 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, actively move in a campaign of awareness among the population as a whole, in order to create a conception that Heritage is a good of all (Declaration of Girona, 1997).

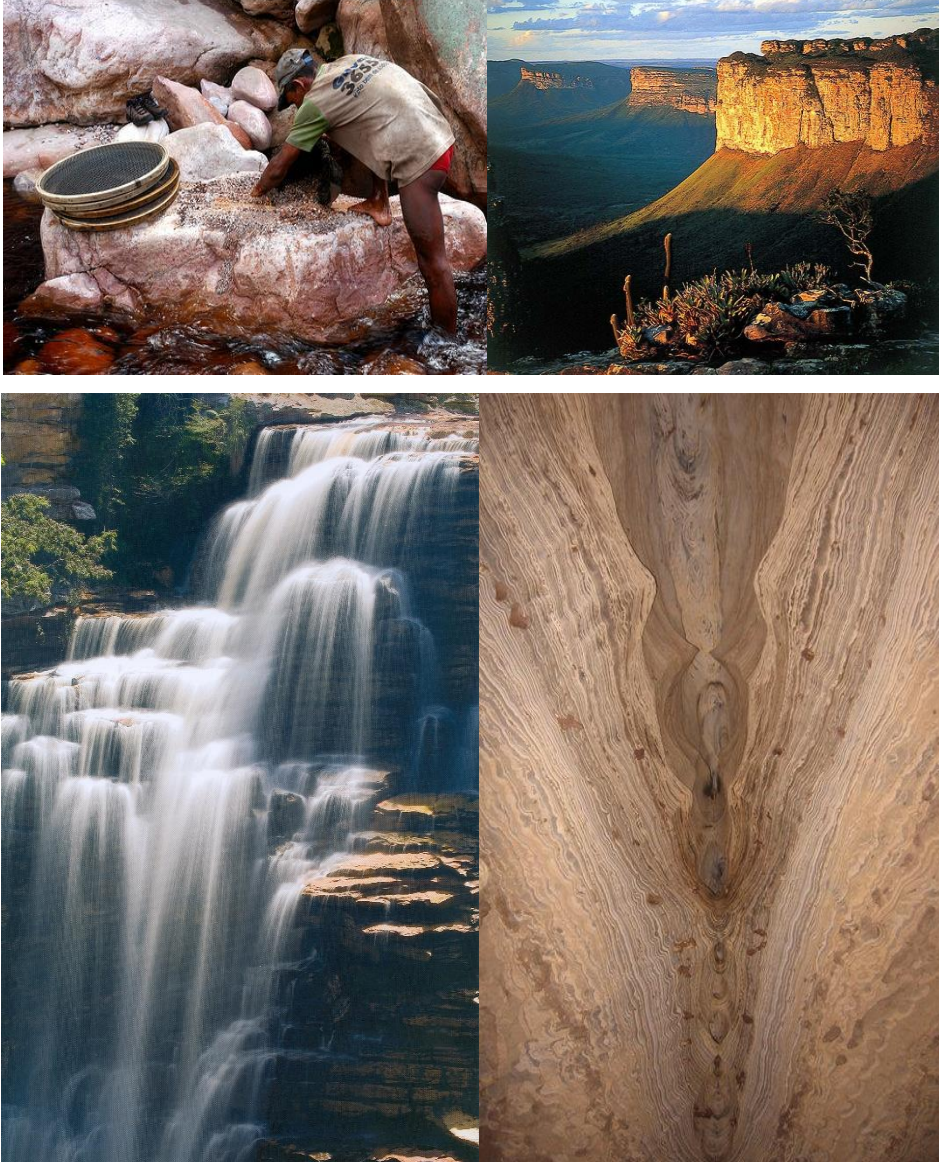
It can be said that the natural heritage is also an expression of geodiversity, according to Kozłowski (2004), who defines it:

Geodiversity is the natural variety on the surface of the earth, referring to 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 various actions of society to ensure its development that transform the natural space into geographical space, and so it is necessary to understand the complexity and diversity of ecosystems to understand how the process evolves. As Kozłowski (2004) states, 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 significance in the creation and development of life. Therefore, it is necessary to protect geodiversity as an indispensable feature for the proliferation of life.

The following are representative images of Geodiversity in the Chapada Diamantina (Figure 2).

Figure 2 – Examples of Geodiversity in the Chapada Diamantina (Author's Collection)



### **3 GEODIVERSITY AS A TERRITORIAL CONSERVATION STRATEGY**

Geodiversity includes the variety of geological environments, phenomena, and processes that give rise to the landscapes, rocks, minerals, fossils, soils, and other surface deposits that are the support for life on earth; in short, abiotic nature.

It is shaped by the action of water and climate (particularly winds), in a weathering process that gives the regions characteristic morphological features, which can serve as an attraction for tourism of various shades, be it ecological, adventure, or even contemplative.

The understanding of the formative mechanisms of these models allows a conscious evaluation of the geological heritage, because:

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

Here it is appropriate to introduce the term geological heritage that is taken as a set of geological sites (geosites), a definition that we disagree with, because we consider that an isolated geosite also constitutes a heritage. The term is strictly related to geodiversity, but one should be careful not to consider it as a synonym, since in fact it is a small part of it.

Thus, geological heritage presents rare specifications that give it peculiarity and, therefore, need to be preserved. Thus, Brilha (2005) speaks of conservation of "fossil outcrops in the world", and Nascimento, Ruchkys and Mantesso-Neto (2008) refer to "what can be considered top of the range of geodiversity". These authors consider that heritage should be defined by geologists, because they consider that only these professionals have the competence to identify its superlative value, to be defined as such.

In this way, all landscapes around the world, such as African savannas, coral barriers, etc. constitute geodiversity, while only geosites, such as the Pai Inácio hill in the Chapada Diamantina National Park (Brazil) or the geysers in the Yellowstone National Park (USA), constitute geological heritage.

However, heritage has more emphasis on tourist utility since it is one of the attractions that drives the conservation trend, in addition to having value for the scientific and cultural/educational aspects, as stated by Valcarce & 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 latter being more commonly used by the German school, and the former by the AngloScandinavian school. The term geomorphosite is also used to treat landscape forms with geomorphological attributes, as well as geomonuments, but in this work we will use only geosite, in order to standardize the language.

According to Wimbledon (1999), "a geosite can be any locality, area, or territory, where it is possible to define a geological interest for conservation". It is actually considered an abbreviated form of geological site or site of geological interest.

On the other hand, Gray (2004) defines the term in question as "elements of geodiversity, well delimited geographically and that, 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 a very important bias for the conservation of the territory, but for this it is necessary that it be included in the policy developed by

the state, the same emphasis that is given to biodiversity, even because the changes inflicted on geodiversity can imply significant changes in biodiversity.

#### **4 THE IMPORTANCE OF PROTECTED AREAS IN TERRITORIAL DYNAMICS**

Conservation units are of fundamental importance in "territorial conservation" or "geoconservation". These units represented by Park, Environmental Protection Areas, Permanent Protection Areas, and Extractive Reserves, emerged to protect regions of great scenic beauty or rarities.

This concern to conserve and preserve geodiversity reveals a territorial dynamic of occupation, in which the public power interferes, legally protecting areas over which it cannot fully supervise, leaving them vulnerable to various types of aggression.

According to Villarroel (2012), regardless of the perspectives adopted, the conservation/protection practices adopted in the different points 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 embark on the endeavor 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 only in terms of isolated national experiences:

There is, for example, the assertion that conservation was one of America's greatest contributions to the world's [environmental] reform movements and that its ideas were eventually exported to other nations. In fact, American conservationism was greatly 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).

The creation of protected areas aimed at the management and protection of spaces of ecological and social importance became a global phenomenon in the mid-twentieth century. However already at the end of the nineteenth century, the creation of the Yellowstone National Park (USA) was a milestone, because it was created with the objective of socializing the enjoyment of a scenery endowed with great wild natural beauty.

The mode of preservation varies between countries, and in Brazil it is governed by the Law of the National System of Conservation Units – SNUC – of 2000, which divides them into Integral Protection Units where only the indirect use of natural resources (the Parks) and the Sustainable Use Units (such as the APAs – Environmental Protection Areas) is admitted. This law and all its consequences 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 group of integral protection, in the category "natural monument" that provides for the preservation of rare natural sites, singular or of great scenic beauty, with the exception that it must be compatible with the objectives of the Conservation Unit.

According to Villarroel (2012), the policy of expansion of UCs in the country, in recent decades, has been a relevant strategy to contain the impacts of a pattern of unbridled occupation of the territory and unpredictable use of natural resources.

From the above it can be observed that the concern with the preservation of geodiversity is placed on a scale of minor 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, as is the tonic worldwide, and the Chapada Diamantina is no different. There are three conservation units in the region, namely: Chapada Diamantina National Park (PARNA CD), the Marimbus-Iraquara Environmental Protection Area (APA) and the Mucugê Municipal Park (Parmu).

According to Giudice (2011):

This concern to conserve and preserve geodiversity is a factor of attraction for tourism, but it also reveals a territorial dynamic of occupation, in which the public power interferes, legally protecting areas over which it does not have the capacity to fully supervise, leaving them vulnerable to various types of aggression, including real estate speculation, since not even public agencies can develop work in them, But clandestinely many speculators, sometimes foreigners, shielded as tourists or looking for alternative ways of life can do so.

Finally, the conservation units, here considered as protection, are strategic mechanisms of geoconservation of the territory with influence on the territorial dynamics, which according to Pellegrini (2000), consists of "giving natural assets a convenient function, with appropriate solutions that imply the proper use of nature's attractions, however, avoiding or minimizing them the damage to them or their loss". However, the geosites that are not included in the UCs must be protected by means of 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-sustainable, as happens in Furnas (Ponta Grossa, Paraná and Zipaquirá, Colombia), on the outskirts of Bogotá, where an old mine was transformed into the Salt Cathedral.

## **5 FINAL CONSIDERATIONS**

Territorial conservation or geoconservation is closely linked to geodiversity. In today's world, where consumption is the watchword, conserving and preserving have become fundamental. In this context of consumption at any cost, it is forgotten that the resilience of the planet is limited, and if there is no imposition of strong laws, the conscience of man is not "awakened" who unfortunately only understands the law of capital. Even so, we are always working in the perspective of circumventing these laws, and this is not only the reality of the developing world, but also of many developed countries. Thus, the geodiversity that sustains us, also because the biota develops in it, needs to be

preserved/conserved as a territorial conservation strategy, otherwise we will reach the extreme of "scorched earth", a situation that would make it practically impossible to reverse the picture of destruction.

In this context the idea of geoconservation was developed, through the creation of UCs and protected areas, such as indigenous reserves, governments began to pay greater attention to the fact, acting in two lines. The first aimed at conservation and the second at preservation that enabled scientific studies, protection of species and indirectly preservation of natural heritage.

Thus, allied to the fact that it was the geodiversity in the Chapada Diamantina that provided the economic subsidies that enabled its occupation and determined the territorial dynamics, it was necessary to ensure its sustainability (geoconservation) through the creation, by the public power, of protection units that despite having their existence based on legal mechanisms, coexist with external and internal conflicts that continue to interfere in the territorial dynamics.

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