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TERRITORIAL APPROACH TO DEVELOPMENT: NATURAL DIMENSION AND CONTRIBUTIONS TO THE DIAGNOSIS AND SURVEYING OF NEW SCENARIOS

ABORDAGEM TERRITORIAL DO DESENVOLVIMENTO: DIMENSÃO NATURAL E CONTRIBUIÇÕES PARA O DIAGNÓSTICO E PROSPECÇÃO DE CENÁRIOS

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Abstract

The emerging notion of territorial development is, by definition, multidimensional and it is opportune to think of alternatives and strategies for development in rural and urban spaces. A development that does not allow the degradation of ecosystems, nor the expansion of social inequalities. The paper aims to discuss the natural dimension in the territorial approach to development and provide elements to carry out diagnoses and support the prospecting of scenarios for territorial development. To achieve this objective, a bibliographical review was used and four conceptual categories were mobilized: geosites and geological heritage that can be used as guidelines for the promotion of territorial development; agroecosystems as the main locus of expression of sustainable development; urban environmental vulnerability as a way to guarantee the right to the city, the quality of life and the well-being of urban populations; the basket of territorial goods and services as a theoretical-methodological approach to guide the processes of valuing territorial resources and assets that contribute to development. In conclusion, isolating a single dimension, the natural one, brings complexity and the categories presented can enlighten, providing indicators/variables, to support the realization of diagnoses and prospecting of scenarios that consider the natural dimension of territorial development.

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Keywords: Territorial Development. Geosites. Agroecosystems. Vulnerabilities. Basket of Goods.

Resumo

A noção emergente de desenvolvimento territorial é, por definição, multidimensional e se apresenta útil para pensar alternativas e estratégias para o desenvolvimento em espaços rurais e urbanos. Um desenvolvimento que não permita a degradação dos ecossistemas e amplie as desigualdades sociais. O artigo tem por objetivos problematizar a dimensão natural na abordagem territorial do desenvolvimento e aportar elementos que auxiliem na realização de diagnósticos e apoio à prospecção de cenários de desenvolvimento territorial. Para atingir tal objetivo se valeu de revisão bibliográfica e mobilizou-se quatro categorias conceituais: os geossítios e o patrimônio geológico que podem ser usados como diretrizes para a promoção do desenvolvimento territorial; os agroecossistemas como lócus principal de expressão do desenvolvimento sustentável; a vulnerabilidade ambiental urbana como forma de garantir o direito à cidade, a qualidade de vida e o bem-estar das populações urbanas; a cesta de bens e serviços territoriais como enfoque teórico-metodológico de orientação dos processos de valorização de recursos e ativos territoriais que aportam desenvolvimento. Em conclusão, isolar uma única dimensão, a natural, aporta complexidade e as categorias apresentadas podem lançar luzes, aportar indicadores/variáveis, para subsidiar a realização de diagnósticos e prospecção de cenários que considerem a dimensão natural do desenvolvimento territorial.

Palavras-chave: Desenvolvimento Territorial. Geossítios. Agroecossistemas. Vulnerabilidades. Cesta de Bens.

Introduction

In the process of the historical development of the capital reproduction process, productive activities are increasingly subordinated to the accumulative logic, fueled by the exploitation of labor force and natural resources. However, in the 1970s, a set of structural bottlenecks were exposed that compromised the growth patterns of the world economy, which were hegemonic in the post-war period.

In the economic field, there is the economic disruption of central countries, which accumulate budget deficits and stagflation; loss of profitability, productivity and competitiveness in the face of new world markets, such as Asia, which adopt models of flexible accumulation in contrast to the rigidity of Taylor-Fordist regimes, which are running out in their countries of origin. The fragility of the economic system is exposed amidst the first oil shock, occurred in 1973, expressed in the vulnerability of the balance of payments, forcing the adoption of macroeconomic adjustment policies that deepen the magnitude of the recessive crisis. In the field of regulation, in view of the crisis in the Welfare State, the dissemination of neoliberal prescriptions is strengthened, especially in the new world crisis scenario, in the late 1970s, during the second oil shock.

Crises in economic and social systems are permeated by the environmental crisis, as the development model is indistinctly consolidated, in central and peripheral countries, with the growing extraction of natural resources and the significant increase in environmental imbalances. In this way, the structural and systemic nature that assumes the crisis in society at the end of the 20th century, refers to the environmental crisis as an expression of a multidimensional civilizational crisis, which contributes to the re-reading and interpretation of dominant paradigms and demands new alternatives to think about the development (sustainable, local endogenous, regional, territorial).

The report by the so-called "Club of Rome", "Limits to Growth" (1972), is considered a milestone for discussions that start to include the environmental variable in the evaluation of economic growth processes, based on the impacts of human action on the environment (MEADOWS *et al*., 1972). However, such debates take on a global dimension at the first World Conference on the Human Environment, held in Stockholm by the United Nations (UN) in 1972.

It stands out for the successive contributions towards the concept of sustainable development, with the theoretical suggestions of scientific environmentalism and the notion of "ecodevelopment" suggested by Maurice Strong, in 1973, systematized and defined by Ignacy Sachs, in 1974. It is in the late 1980s that the concept of Sustainable Development (SD) is presented through the Brundtland Report (Our Common Future) by the World Commission on Environment and Development (1987), as being capable of meeting the needs of the present without compromising the ability of future generations to satisfy their own (CMMDA, 1991, p. 34).

In the academic field, the environmental variable plays a leading role in conflicts and antagonistic interests, on the one hand, in the area where economic interest practically ignores the imminent environmental collapse, and on the other, where "zero growth" is advocated as the only possibility for the planet to exist. The SD is, therefore, the path that tries to balance the interests between environmental protection and economic growth.

In this scenario, where analyzes of the structural crisis of the dominant system and the environmental crisis multiply, the elements pointed out by ecological economics are highlighted, through the epistemological approach suggested by Georgescu-Roegen, which addresses a "more holistic view of the relations between the man (economic system) and nature (ecosystems). Furthermore, the economy is seen as an open subsystem inserted in a broad ecosystem, which is finite, non-growing and materially closed." (DENARDIN; SULZBACH, 2012, p. 2) (DENARDIN; SULZBACH, 2012, p. 2).

This more systemic interpretation brings to the scene the contributions of the theory of complexity, by Edgar Morin (2001), for which traditional knowledge has privileged only the scientific rationality, which imposes a process of simplification, one-dimensional and does not recognize and/or apprehends the complexity of the real. Thus, the social use of science presupposes a more modest attitude about what is possible to do, recognizing the impossibility of exhausting the real. In complex thinking, the recognition of the unfinished, the incomplete is absorbed, based on the resignification of the inexistence of absolute knowledge and the recognition of the limits of reason (reason is a social construct).
In complexity theory, every living system generates complex, complementary, recurrent and antagonistic relationships.

From this perspective, the recognition of environmental knowledge and, consequently, the environmental crisis is part of the construction of a new paradigm, which considers human intervention in society, nature and subjectivity, where mechanistic thinking gives way to systemic thinking. It is noteworthy that in the systemic approach, the properties of the parts can only be understood from the organization of the whole. "Systemic thinking is 'contextual', which is opposite to analytical thinking. Analysis means isolating something to understand it; systemic thinking means placing it in the context of a broader whole" (CAPRA, 2006, p. 41).

In economic terms, therefore, the forms of social organization and anthropic intervention on nature must be internalized, from new vectors, where it is perceived "the ecological balance, the preservation of biodiversity and the quality of life of human beings -, not just as intrinsic or extra-economic values, but as fundamental conditions for the sustainability of the economy itself." (LEFF, 2010, p. 20).That said,

> [...] the great socio-environmental challenge today is, therefore, to break with the idea of a single, one-dimensional thought, oriented towards "unlimited progress", which has been reducing, suffocating and overexploiting nature. And for this, it is not enough to sign agreements and conventions, which after being put into practice will be governed by the same instrumental and economic rationality that we question today, but rather to legitimize other ways of understanding life and the complexity of the world and a new ethics of praxis in the world (LEFF, 2007, p. 9).

It is worth mentioning the criticism pointed out about the "destructive structural antagonism of the capital system", and according to Mészáros (2011), it results from a model whose production is not aimed at meeting human needs, which become secondary to exchange values and yes, for the needs of the self-reproduction of capital (and profit making), and in which the main sources of capital accumulation are the exploitation of the labor force and the exploitation of natural resources.

According to this context, this paper aims to discuss the natural dimension in the territorial approach to development and provide elements to carry out diagnoses and support the prospecting of scenarios for territorial development.

This proposition dialogues with the natural dimension of territorial heritage presented by Dallabrida *et al*. (2021), understanding territorial heritage as the set of resources and assets, tangible and intangible, present in the territory. In addition, it is a contribution to research projects: "Territorial heritage as a reference in the development process of territories or regions" (National Council for Scientific and Technological Development - CNPq) and "Territorial heritage as a reference in the development process of territories or regions: epistemic assumptions - theoretical and proposal of methodological instruments" (Post- Graduation Program in Sustainable Territorial Development - PPGDTS-UFPR).

The natural dimension in territorial development processes

The analysis of economic and social systems has been increasingly rethought based on their environmental connections, as part of a new systemic and multidimensional understanding of development, in which different sciences have contributed to the interpretation of issues that capture aspects of the improvement of quality of life and well-being of populations, in favor of sustainability and territorial development.

It is widely recognized, therefore, that environmental issues are fundamental to compose the different dimensions that characterize the development of a region, and aspects of conservation and environmental management figure as an important pact for any experience of territorial development, which must engage those involved in public administration, third sector organizations, organized civil society and business entities.

The emerging notion of territorial development is useful for thinking about alternatives and strategies for development in rural and urban spaces. However, greater clarity is needed about which development is being talked about. In territories with socioeconomic weaknesses, it is not acceptable to treat development as synonymous with economic growth, a perspective that aggravates and accelerates the processes of social and environmental inequalities (DENARDIN, 2016).

Development, thought of based on actors and resources, rediscovers the path of the territory, which had been abandoned with the emergence of "globalization", which led to a simplification, homogenization, of the development model in territories (CAMPAGNE; PECQUEUR, 2014).

Territorial development presents itself as a new focus in construction (VIEIRA *et al*., 2010), and must be thought of in a way that articulates the rural and the urban (JEAN, 2015). Theoretical clarity regarding which development, territory and sustainability we are referring to is necessary and useful to think of alternatives aimed at reducing and combating social and environmental inequalities present in the economies of the South. A territorial development that does not allow the degradation of ecosystems and expansion of social inequalities (VIEIRA, 2009; VIEIRA *et al*., 2010).

The dynamization of territories, according to Campagne and Pecqueur (2014, p. 216), depends on the "(...) emergence of new resources to be valued, which need to be put into activity based on particular governance in the territories where they (resources) emerge". For these authors, territorial development results from the search for undisclosed local resources, this may originate one or more specific, non-generic products or services to this territory.

The importance of undisclosed territorial resources for development processes is not a recent theoretical construct; for Hirschman (1986), "it matters less, to promote economic development, to find optimal combinations of resources and given factors of production, than to identify and mobilize hidden, dispersed or misused resources and capacities at their service". Sachs (1986, p. 18), in turn, corroborates by stating that "in each ecoregion, the effort is focused on valuing its specific resources, to meet the fundamental needs of population in terms of food, housing (...)".

Identifying and activating tangible and intangible territorial resources existing in the territory is a development strategy. However, for this to occur, it is necessary for the actors to articulate themselves to solve problems inherent to production. With the activation of territorial resources, by the actors, the territorial development process can be carried out.

The valuation of specific resources in the territory reveals a new way of generating wealth, which does not involve the notion of productivity, competition via production costs (PECQUEUR, 2014). In this model, resources are factors to be explored, organized or revealed, which can be generic or specific, and become assets (generic or specific) if the conditions of production and technological innovation allow (PECQUEUR, 2006).

The "asset specification" is the process of transforming specific resources into specific assets, through their insertion in the production system, providing the differentiation of one territory from the others. The specification process consists of the qualification and differentiation of resources that local actors reveal when solving their problems. The valorization and activation of specific resources by the actors allows the territory to obtain a "territorial quality income" derived from the commercialization of goods and services specific to the territory, a monopoly income.

The income of territorial quality derives from the specificity of the goods and services transacted in the market (PECQUEUR, 2006b, p. 136) and indicates "[...] the capacity of local actors to, through certain institutional devices, capture the disposition of consumers of paying for aspects related to the productive environment". In this perspective, Fonte *et al.* (2006, p. 13) point out that the possibility of creating and benefiting from territorial income is associated with the framework of "local governance", that is, it is related to the capacity of local actors to create collective institutional mechanisms capable of regulating the use of resources and the respective distribution of benefits obtained among the actors involved, as in the basket of goods strategy presented below.
The challenge of territorial development strategies, therefore, is to identify and activate the specific resources of the territory. Each ecoregion can identify its potential latent, tangible and intangible resources, and insert them into the production system. The territory, in this perspective, is an active unit of development, which has unique resources, not transferable from one region to another.

Territorial resources are constituted from natural, tangible resources, such as mineral deposits, forests, soils, rivers and lakes, etc., which are by definition limited, and from intangible (immaterial) resources, such as the know-how of a farmer, or artisan, linked to its history and local culture. However, not every natural resource that constitutes a pre-existing reserve will become a territorial resource activated by the development process (GUMUCHIAN; PECQUEUR, 2007). The valuation of these specific resources, via the market, can enable the territory to generate work and income, however the income generated must overflow, not be concentrated in the hands of a few, generating, in this case, mere economic growth, to the detriment of a true development, in its multiple dimensions (environmental, social, economic, and others).

Therefore, territorial development must be thought of as a model that reduces social inequalities and the environmental impacts of production and consumption activities. Practices that aim at solidarity, cooperation and encourage trust between actors must be prioritized. On the other hand, the use of natural resources, for the production of raw materials and agro-industrialization, must observe the physical limits of ecosystems (DENARDIN; SULZBACH, 2019).

Nature (renewable and non-renewable resources) enters the production and consumption system as raw material, nature as a supplying source, and also acts as a cesspool for waste, matter and energy. However, nature provides important, irreplaceable ecosystem services that allow the continuity of human and non-human life on the planet. The natural dimension, inherent to the territorial development process, can be operationalized through sustainable production and consumption practices in the man-nature relationship.

Sustainability, required for territorial development processes, should not be based on the approach of eco-efficiency, ecological modernization, weak sustainability perspective, which is primarily guided by two questionable attributes (HAUWERMEIREN, 1998, p. 112): "Possibility of almost perfect substitution between natural capital (nature) and manufactured capital (man-made); technical progress must be continuous, overcoming the limitations that impede economic growth due to scarcity of resources". Contrary to the idea above, strong sustainability does not accept the almost perfect replacement of natural capital by manufactured capital; it understands them as strongly complementary. Turner *et al.* (1994) and Harte (1995) point out, for example, that some ecosystem services are essential for human survival and they are not replaceable.

With this north, it is possible to show that there are biophysical restrictions that limit the growth of the economy, which can support territorial development processes committed to the use of natural resources in a long-term perspective, which is recommended (HAUWERMEIREN, 1998, p. 76):

- Use renewable resources (fishing, timber, etc.) at a rate that does not exceed their rate of regeneration.
- Use non-renewable resources (oil, coal) at a rate no higher than their replacement by renewable resources.
- Generate an amount of waste that the ecosystem is able to assimilate or recycle.

- Conserving biological diversity.

From this perspective, it is proposed to think of geosites and geological heritage as strategic, can and should be used as guidelines for the promotion of territorial development; to think of agroecosystems as the main locus of expression of sustainable development, where the concern with ecological sustainability and social equity is internalized; to think of urban environmental vulnerability as a way to guarantee the right to the city, the quality of life and the well-being of urban populations; to think of the basket of territorial goods and services as a theoretical-methodological approach to guide the processes of valuing territorial resources and assets undertaken by multi-players in the territory that contribute to development.

Geodiversity and Territorial Heritage

Geoconservation seeks to preserve the natural diversity – or geodiversity – of important geological (rocky substrate), geomorphological (relief) and pedological (soil) features and processes (SHARPLES, 2002). Thus, geodiversity encompasses the variety of rocks, sediments, minerals, fossils, landforms and soils, as well as their formation processes, in scales that vary from microscopic to continental.

According to Sharples (2002), geodiversity has three values: **1)** *intrinsic* (or "existential") – something can have its own value, regardless of human or other species purposes; **2)** *ecological* (or "natural process") – importance in the maintenance of natural systems and ecological processes; and **3)** *human* (anthropocentric or geoinheritance) – it has significant value to the human being for non-depletion purposes (e.g., research, education, aesthetics, recreation, tourism, etc.), contrary to the notion of resource (extraction, processing, etc.). In addition to *educational, aesthetic and cultural* values, Brilha (2016) also highlights the scientific value of geodiversity, which is directly related to its importance for current and future knowledge about the functioning of the geosphere and its interactions with other Earth systems - biosphere, hydrosphere and atmosphere. This author defines *geosites* as places where one or more elements of geodiversity with the aforementioned values are found – above all, the scientific one. Finally, the set of geosites in a given area constitutes the *geological heritage*.

The inventory and quantitative assessment of sites are the first steps for defining geodiversity areas or geosites (BRILHA, 2016) (Table 1; Annexes 1 and 2). The inventory aims to gather information about potential geosites and their uses, based on bibliography and specialists in the field of study. Such information is checked through work in field, which seek additional data to characterize these places. Then, a quantitative assessment is carried out, focusing on values and the risk of degradation, which will support the proper management of the listed geosites. The criteria must be limited in terms of quantity and can be adapted to the local reality – such as population density, which has little representation in the analysis of very small areas (BRILHA, 2016). Thus, in the present article, Annexes 1 and 2 were partially modified from the original proposal of the aforementioned author for application in the diagnosis of the natural dimension of the territorial heritage (e.g.: exclusion of some criteria, alteration of weights, etc.).

In summary, geosites of high educational or tourist value must present several distinct geological features or visual beauty appreciable by the majority of the public, which can be easily understood by students of all educational levels or by non-specialists, with comfortable and quick access, in addition to of good security conditions and low risk of degradation. In analyzing these criteria, it is necessary to consider the average age of most people who will visit the site, as there are differences in physical capacity, cognition and other characteristics between different age groups (e.g., children and young university students).

Table 1: Inventory of geosites with educational and/or tourist value

Educational Value	**Tourist Value**
Review of geological literature; Consultations with experts who have worked in the field;	
Review of places used in educational activities	Review of tourist publicity materials
List of potential geosites	
Work in field to identify new geosites and qualitative assessment of each geosite on the list, based on the following criteria: * Didactic potential: ability of a geological feature to be easily understood by students from different levels of education; * Geological diversity: number of geodiversity elements present at the site; * Accessibility: conditions of access to the site (difficulty, walking time); * Security: visitation conditions with minimal risk to people.	* Scenario: visual beauty of the geological occurrence (landscape or outcrop); * Interpretive potential: ability of a geological feature to be easily understood by lay people; * Accessibility: conditions of access to the site (difficulty, walking time); * Security: visitation conditions with minimal risk to people.
Final list of geosites with full characterization	
Quantitative Assessment of Educational Value	Quantitative Assessment of Tourist Value
Quantitative assessment of the risk of degradation	
Final list of geosites in the area ranked by educational value and risk of degradation	Final list of geosites in the area classified by tourist value and risk of degradation

Source: Brilha (2016).

Monitoring, evaluation and transition to sustainable systems and societies: agroecological systemic approach

In recent decades, the effects and consequences of externalities arising from the established economic model, such as the Brazilian agribusiness, have been widely discussed and problematized. The pandemic scenario experienced from 2020, with the new corona virus; facing the worst drought in the last 90 years, in 2021; the decrease and absence of pollinating insects, especially the different species of bees that are dying and disappearing from ecosystems and agroecosystems; decreasing global food stocks; the high level of poverty and starvation, the increase in the Earth's temperature, among many other events are intrinsically related to this predatory economic model. It is known that the deforestation of our forests, the loss of fauna and flora habitats, the extinction of thousands of species, erosion and loss of the fertile soil layer, the use of pesticides, contamination of groundwater and other sources of drinking water, as well as climatic adversities (droughts, frosts and more frequent hailstorms) have a cause and effect relationship.

Currently, one the greatest challenges of humanity is to find ways, strategies and regenerative models, with new technological, political, economic, social and environmental bases, which consider our high dependence on ecosystem services and natural resources. And, therefore, be able to recover ecosystems and biomes that have been largely degraded in recent decades, as well as to conserve biomes, traditional management systems and their water, fauna, flora and edaphic resources.

In this sense, rethink the current agricultural model, based on agribusiness, which advocates wrong forms of arrangements (monoculture), insect management technologies, spontaneous herbs and microorganisms (pesticides), genetic (transgenic) and soil management technologies (plow and leveling harrow) has been the object of studies, extension and teaching, mainly in the last 50 years. Perhaps our biggest challenge is the construction and multiplication and resilient agrifood systems, on a global scale, to feed and meet the current requirements in fiber and food, in their entirety, without compromising future generations, as the modernization of agriculture, also known as revolution that would end hunger in the world, failed, given the existence of nearly 1 billion people in a situation of food insecurity and poverty.

In the 1970s, Agroecology emerged as a new science, presenting a new methodological theoretical framework capable of analyzing the sustainability of agroecosystems (EMBRAPA, 2006;

GLIESSMAN, 2005; ALTIERI, 2002), of communities and territories, in a systemic and multidimensional way (CAPORAL; COSTABEBER, 2002; MASERA *et al.*, 1999). In addition to the analysis of agroecosystems, Agroecology, as a science, presents principles, bases, technologies, models and sustainable management practices (CAPORAL; COSTABEBER, 2004; ALTIERI, 2002; GLIESSMAN, 2005; KHATOUNIAN, 2001) capable of recovering and conserving agrobiodiversity, ecosystem services, cultures and traditional knowledge, enabling the transition to sustainable systems.

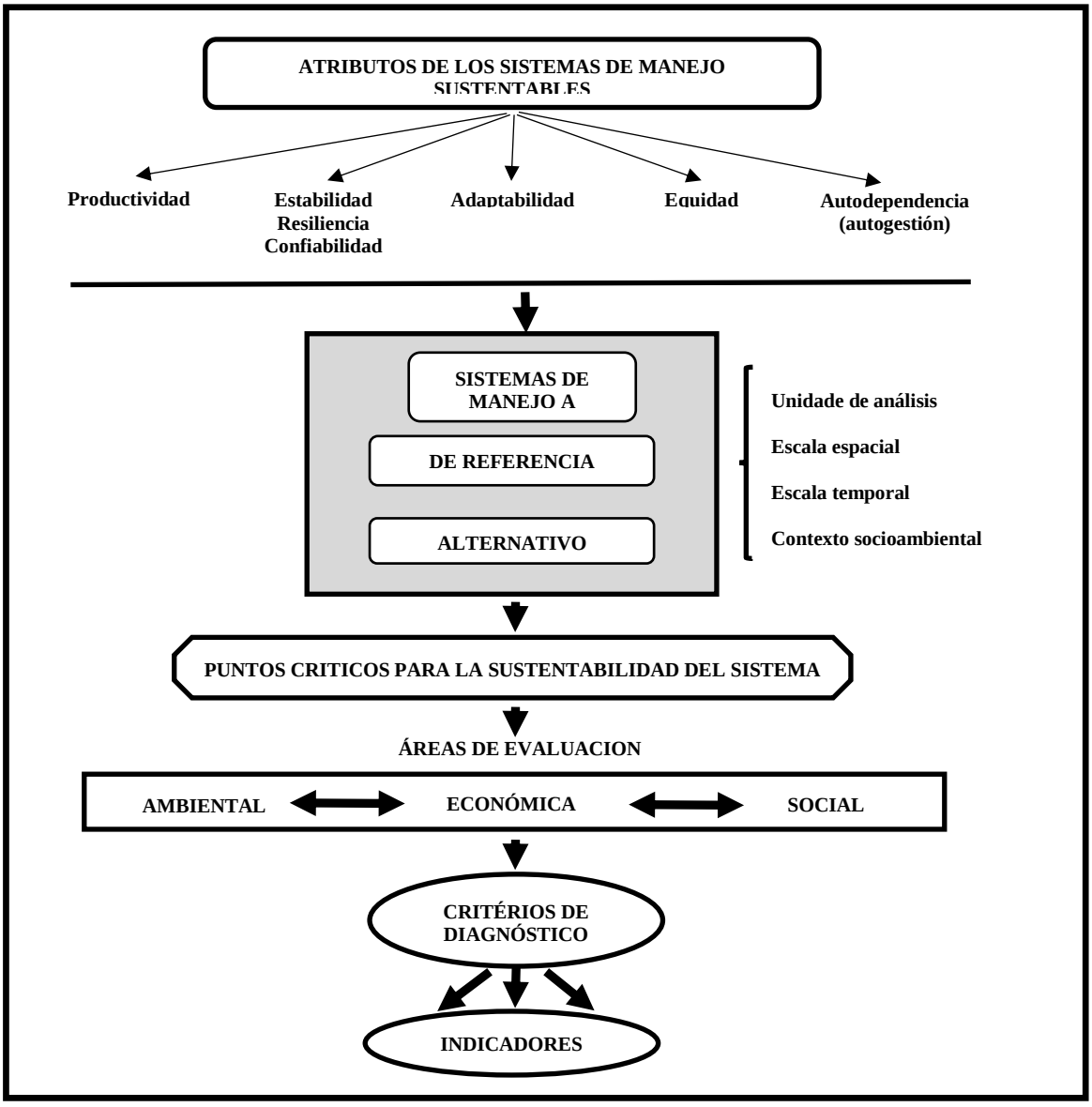
Agroecology advocates and values participatory methodologies that enable a collective assessment and interpretation of all the variables that influence agro-ecosystem sustainability. Among the main approaches we cite the works and methodological proposals of Altieri (2002), Hart (1985); Khatounian (2001); Embrapa (2006) and Masera *et al.* (1999). It is noteworthy that the methodological proposals formulated by these authors consider the attributes of sustainability and their interrelationships: productive, social, economic, environmental, energetic, ecological, political, scenic, ethical and cultural symbolic. Costa (1995) states that a Cartesian and reductionist analytical framework has shown itself to be increasingly limited and insufficient for analyzing the causes and identifying the possibilities of overcoming the recurrent problems and consequences linked to agricultural systems, in the economic, social and environmental dimensions.

Masera *et al*. (1999) proposed a methodological framework for the assessment of natural resource management systems, incorporating sustainability indicators (MESMIS), revolutionizing the methodological bases for evaluating agroecosystems. Among the main structural characteristics of the MESMIS method, the following stand out: the concept of sustainability is based on 5 general attributes of agroecosystems (productivity, stability, reliability and resilience, adaptability, equity and self-dependence or self-management); sustainability dimensions are incorporated and linked to attributes; sustainability indicators are constructed and used for diagnostic or assessment processes in a participatory and dialectical manner; it is a method that expresses an analytical, pedagogical and political care, in addition to covering the evaluative gaps of other methodological proposals; it presupposes the participation of an interdisciplinary team, effectively including the subjects of the local communities (MASERA *et al.*, 1999).

The MESMIS, according to Masera *et al.* (1999), initially points out the need to define the systems that are intended to be evaluated, their characteristics and socio-environmental context; in a second moment, the critical points that interfere in systemic sustainability are determined; as a third step, diagnostic criteria and strategic indicators are defined; fourth, the construction of analysis instruments, such as parameters, for measuring and monitoring the systems is carried out; in a fifth moment, the analysis of the results is foreseen, comparing the sustainability of the agroecosystems, directing the eyes to the obstacles, obstacles and points that favor the sustainability of the system, and, finally, a conclusive synthesis is carried out, with proposals to overcome the problems and/or highlighted points, in order to achieve the sustainability of the system (Figure 1).
Agroecological productive systems also known as ecological, alternative, socio-ecological, organic, biological, sustainable, agroforestry, biodynamic, natural and biodiverse systems are being practiced and multiplied by farmers in all Brazilian regions. The agroecological transition process, in the countryside and in cities, gained evidence and planetary proportions.

Several environmental, social, conservationist, NGOs, countries, territories and communities movements have assumed the agroecological movement as the only possible path for the maintenance and existence of planet Earth and all forms of life that inhabit it. The agroecological proposal to reconcile food production with the conservation of "agro sociobiodiversity", produce healthy food without the use of pesticides and synthetic fertilizers, at fair and affordable prices, promote equity and social justice in the countryside and cities, reducing levels of social inequality and poverty, has been widely discussed, planned and executed by rural social movements, associations and family farming cooperatives. As presented by Lopes *et al*. (2018), the agroecological transition experience, carried out in the extreme south of Bahia, for example, demonstrates the construction of dozens of agroecological rural settlements.

Figure 1: General scheme of the MESMIS method: relationship between attributes and indicators



Source: Masera *et al.* (1999).

These models and agroecological productive arrangements have in their historical process of existence, "the digital" of traditional peoples, who for thousands of years have known, planned and taken care of their territories and natural resources, managing agrobiodiversity, soil, water and landscaped. Gliessman (2005) and Altieri (2002) present in their research several scientific studies related to ethno knowledge, traditional knowledge linked to fauna, flora, soil, climate, relief, biomes and management of natural resources in a sustainable way, in time and space. Traditional peoples, such as indigenous peoples, *quilombolas*, riverside dwellers, *caiçaras*, extractivists and other types of peasants, have managed their territories for hundreds and thousands of years, with locally adapted technologies and practices.

Gliessman (2005, p. 584 and 585) presents several parameters related to the sustainability of agroecosystems that can be used to measure the sustainability and functionality of productive systems managed by human beings. The methodological paths of analysis and diagnosis of the management of agroecosystems and their surroundings (natural ecosystems), the problematization of local realities and the planning of the agroecological transition, with the adoption of sustainable social technologies, over time, and sustainable territorial development processes can be observed in the works of Miguel Altieri (2000, 2002), Ana Maria Primavesi (1997), Carlos Armênio Khatounian

(2001), Stephen R. Gliessman (2005), Masera *et al*. (1999), Sosa *et al*. (2012), Embrapa (2006), among others.

The benchmark in Agroecology elaborated by Embrapa (2006), Altieri (2002) and Gliessman (2005) point out some steps and paths to achieve the sustainability of agroecosystems:

1) Reduction in the use of chemical inputs, such as pesticides and synthetic fertilizers;

2) Replacement of chemical inputs by inputs of organic and biological origin;

3) Redesign of agroecosystems, with a significant increase in biodiversity, articulation and integration of subsystems, seeking greater levels of resilience, self-sufficiency, balance and adaptability.

Based on the paths indicated in the literature, an approximation of sustainability indicators in agroecosystems is proposed, as shown in Table 2.

Table 2: Sustainability indicators in agroecosystems

Dimensions	Indicators/variables	Source
Soils	Depth	Bibliographic research (maps) and work in field, from the opening of trenches and/or soil cultural profile.
	% Organic matter	Work in field and laboratory analysis.
	Infiltration rate and water percolation	Work in field (experimentation) and laboratory analysis.
	Work in field (experimentation) and laboratory analysis.	Soil sampling in subsystems and/or plots and subsequent laboratory analysis (chemical soil analysis).
	Carbon/Nitrogen Ratio	Soil sampling in subsystems and/or plots and, later, laboratory analysis (chemical soil analysis).
	Annual erosion rate	Work in field, with periodic monitoring.
Hydrological	Drainage capacity	Work in field
	Sedimentation of water courses	Field research and laboratory analysis.
	Pesticides levels	Field research and laboratory analysis.
	Nutrient leaching	Field research.
	Levels of laminar erosion, in furrows and gullies	Work in field, with periodic monitoring.
Biological	Soil microbial biomass	Field research and laboratory analysis.
	Biomass cycling rates	Field research and laboratory analysis.
	Diversity of soil microorganisms	Field research and laboratory analysis.
	Rhizosphere structure	Field research and laboratory analysis.
	Diversity and abundance of pest populations	Field research and laboratory analysis (Malaise and Moericke traps).
	Diversity and abundance of natural and beneficial enemies	Field research and laboratory analysis (Malaise and Moericke traps).
	Diversity and abundance of native plants and animals	Field research (botanical identification and preparation and storage of exsiccates).
	Annual production	Field research.
	Energy sources	Bibliographic and field research.
	Biological population growth rate	Field research (population surveys and statistical estimates).
	Complexity and Biological Interactions and Communities	Field research and laboratory analysis.

Source: Adapted by the authors from the components and indicators presented by Gliessman (2005).

Contributions to thinking about urban environmental vulnerability

The expansion of the urban network in the last decades of the 20th century and the new movements in the conformation of the system of cities in Brazil are accentuating asymmetries in economic spaces, strong pressures on the provision of services in regional hub cities and under acute pressure on natural systems, expanding socio-environmental vulnerabilities and demanding action

from different social actors, especially in the public sector, in favor of guaranteeing the right to the city and a better quality of life for the populations.

In this sense, it has been found that, "with the accelerated growth of large cities and the conurbation processes that frequently occur in them, certain urban problems are intensified and acquire a character of environmental vulnerability, prone to induced anthropogenic processes" (BARCELLOS; OLIVEIRA, 2008, p. 2).

Despite the multiplicity of interpretations, the theoretical matrices of environmental vulnerability point to a first block of contributions, in which vulnerability is intrinsically associated with the physical characteristics of the environment and the approaches in the literature initially recognize three vectors that characterize the phenomenon: exposure to risk; (in)ability to react; difficulty in adapting through risks. Thus, vulnerability is constantly associated with the degree of susceptibility of a system to intrinsic or extrinsic factors that exert pressure on it.

In a way, in these contributions, residents in precarious physical environments and exposed to greater risks are more vulnerable. At the same time, the ability of individuals or groups to respond to changes in the natural environment influences the vulnerability of such individuals or social groups (TOMINAGA; SANTORO; AMARAL, 2009).

In another line of contributions, the ability to respond to situations of environmental change is determined by more systemic factors, varying according to the possibilities and environmental, social, economic, cultural and political conditions of the populations (ADGER, 2006). It is intrinsically associated with the effective and institutional presence of the State in promoting adequate conditions that interfere in the quality of life and interaction of populations with the natural environment (GAMBA, 2010).

In this sense, vulnerable people would be less able to take advantage of the opportunities offered by the market, the State and society. Such ability to take advantage of opportunities referred to by Kaztman *et al.* (1999) by “possession or control of assets”, closely links vulnerability to the social dimension of populations.

In Hogan and Marandola (2006, p. 27), “vulnerability is associated with the social disadvantages that produce and, at the same time, are reflections and products of poverty”. And the social character of vulnerability is also emphasized by Deschamps (2004, p. 140), who draws attention to the close relationship "between the spatial location of groups that present social disadvantages and those areas where there is a risk of an adverse event, or that is, socially vulnerable populations are located in environmentally vulnerable areas”.

It is also worth highlighting one of the main challenges faced by urban and rural populations, which concerns Food and Nutritional Security (FNS)[6], whose determining factors are often associated with:

> hunger, obesity, diseases associated with poor diet, consumption of food of questionable quality or harmful to health, structure of food production that is predatory in relation to the natural environment or economic and social relations; food and essential goods with abusive prices and the imposition of food standards that do not respect cultural diversity (BRASIL, 2004, p. 4).

They greatly contribute to potentialize situations of food and nutritional insecurity, patterns of income inequality, poverty and extreme poverty among populations. The dimensions that make up the spectrum of assessment of the FNS are diverse, in which the proposals by the FAO (2013) and the National Council for Food and Nutritional Security - CONSEA (BRASIL, 2010) stand out, highlighted here: production and availability of food; income and food expenses; access to adequate food; biological use of nutrients; health and education and stability over time.

Despite recognizing the multidimensionality of vulnerability, the four-dimensional approach was chosen here: housing, urban infrastructure, pressure on the natural environment and food and

[6]For Consea (BRASIL, 2004, p. 4), Food and Nutritional Security (FNS) is the realization of the right of everyone to regular and permanent access to quality food, in sufficient quantity, without compromising access to other essential needs, based on health-promoting dietary practices that respect cultural diversity and that are socially, economically and environmentally sustainable.

nutritional security. A set of indicators and variables, components of the respective dimensions, are also presented (Table 3).

The inclusion of the housing dimension aims to infer about adequate housing conditions, in the indicators: occupation condition (OCI), households in inadequate sanitary conditions (ISCI), density of residents per room (DPRI) and type of housing covering (HCI), that reflect social aspects of vulnerability.

In urban infrastructure, the objective is to investigate the exclusion of the population in relation to services and public goods considered essential to urban life (urban sewage coverage indicator - SCI; water supply indicator - WSI, household indicator without garbage collection - GCI) , in addition to variables to measure vulnerability based on the surrounding conditions and infrastructure deficiencies that lead to an increase in environmental risks, such as: indicator of surrounding conditions - HSCI (afforestation, accumulated garbage, existence of sewers or sewers, sewage open air) and rainwater management indicator – WMI (risk of floods and landslides and structure to deal with these problems).

The pressure on the natural environment dimension aims to capture the risk arising from the pressure of human activities on the natural environment, on natural processes of recycling of resources and nutrients, as well as the risks inherent to pollution, fires, exposure to risk of contamination by chemical substances or biological agents, loss of well-being due to the reduction or absence of conserved environments, etc. This dimension includes the following indicators: vehicular carbon monoxide emission (VCMEI), industrial waste (IWI), fire outbreaks per thousand hectare (EDBI), number of cases of compulsory notification diseases (per thousand inhabitants) caused by a biological agent (NDBVI) and percentage of municipal area reserved for natural forests or forests destined for permanent preservation (PNFI).

In the dimension of food and nutritional insecurity, it was decided to cut the problem through the access or stability of families in access to food, where indicators of inequality and poverty (IPI) are evident; income and unemployment (IUI); prices and expenses with food (PFI).

Table 3: Dimensions, indicators and variables for urban environmental vulnerability

Dimensions	Indicators	Variables	Source
Housing Vulnerability	Property Occupancy Condition - OCI	Percentage of households that are not owned or leased; Owned or rented – 0; other condition - 1	Demographic Census/IBGE
	Households in inadequate sanitary conditions - ISCI	Percentage of households without connection to the general sewage network	Demographic Census/IBGE
	Density of people per room - DPRI	Percentage of households with more than two people per room	Demographic Census/IBGE
	Household cladding standard - HCI	Percentage of households with non-masonry coverings	Demographic Census/IBGE
Urban Infrastructure Vulnerability	Sewage - SCI	Percentage of urban population without sewage coverage	State sources
	Water Supply -WSI	Percentage of households that obtain water from a well, spring or otherwise	State sources
	Garbage Collection - GCI	Percentage of households without garbage collected	State sources
	Urban characteristics of households surroundings HSCI	Assessment of the existence of urban afforestation, mouth of the wolf or manhole, garbage accumulated in the street and open sewer	Demographic Census/IBGE
	Stormwater Management - WMI	Assessment of the existence of: a) only surface drainage; b) risk areas subject to landslides; c) risk area without drainage infrastructure; d) risk area that needs special drainage; e) river water damping devices	National Basic Sanitation Research

Pressure on the Natural Environment	Carbon monoxide emission - VCMEI	Vehicle carbon monoxide emission (kg/inhabit)	National inventory of atmospheric emissions by road motor vehicles
	Total Industrial Waste - IWI	Industrial Waste (kg/hectare) in 2001 according to state inventory	State sources
	Environmental Degradation by Burning - EDBI	Fire spots (per thousand/inhabitant)	Database - INPE
	Notifiable diseases caused by biological vector - NDBVI	Number of cases per thousand inhabitants	State sources
	Preservation of native forest - PNFI	Percentage of the are in municipality set aside for natural woods or forests intended for permanent preservation or legal reserve	Agricultural Census/IBGE
Food and Nutritional Insecurity	Inequality and Poverty – IPI	Gini index of monthly income distribution of permanent private households with income	Demographic Census/IBGE
		Poverty and extreme poverty rate	National Household Sample Survey - PNAD/IBGE Demographic Census/IBGE
	Income and unemployment – IUI	Household income per capita	National Household Sample Research - PNAD/IBGE Demographic Census/IBGE
		Vacancy rate	
	Prices and expenses with food - PFI	Percentage of household spending on food in total spending	Family Budget Survey - POF/IBGE
		Food Price Level Index	National Survey of Basic Food Basket – PNCBA/DIEESE

Source: Elaborated by the authors.

The basket of territorial goods and services: the creative interrelationship between nature, economy and rural and urban population

The theoretical-methodological approach of the Basket of Territorial Goods and Services (BTGS) was originally formulated from empirical research on territorial development carried out in French rural areas considered "disadvantaged" from a socioeconomic point of view. The definition of this type of zone is intrinsically associated with the action of public authorities which, based on this categorization of physical geography, provides subsidized public policies for these regions. Generally speaking, they correspond to mountainous areas, or areas with rugged reliefs, far from urban centers and that suffered a strong population exodus, especially after the Second World War. Topographic and climatic characteristics made it difficult, to a great extent, to promote the model of productivist agriculture advocated from the 1950s onwards.

This productive exclusion process is directly linked to the focus of this paper. Ecosystems, natural landscapes, crops and traditional knowledge and agrobiodiversity in areas considered to be disadvantaged were less impacted by the model of productive agriculture and livestock. A hindrance to the dissemination of this model in the past, currently, represents an enormous repository of

specific territorial resources, which allows for the social construction of a style of development that is better aligned with the precepts of sustainability. BTGS's approach, therefore, has a strong correlation with rural areas inappropriate to the productivist ideology that guided the so-called green revolution or the modernization of agriculture that began in the 1950s.

Another relevant aspect, highlighted by Campagne and Pecqueur (2014), resides in the family nature of rural establishments that engage in territorial development initiatives. The greater adherence of this type of enterprise to territorial development actions is explained, in large part, by the multifunctional character, in particular, of family agricultural units, which differentiates them in several aspects from productive units based on salaried work force (CAZELLA; BONNAL ; MALUF, 2009).

> It can also be advanced that territorial development processes are generally composed of forms of initiatives and modes of innovation that, in the rural world, are mainly led by family units. This is not to say that innovation is not found in large units. But the form that innovation takes in family units is, (...), very particular, as it is based on the local valorization of specific resources in the territory. In general, this does not occur in large units, which innovate to better adapt their production to the world market on which they depend (CAMPAGNE; PECQUEUR, 2014, p. 94; free translation).

The first formulations about the BTGS were the works of Pecqueur (2001) and Mollard (2001), which showed the advantages of territorial development actions capable of promoting the heterogeneous and articulated offer of quality territorial goods and services, with a marked valorization of specific territorial resources. The deepening of the theme, with new studies, highlighted three main components of the focus: the products and services of territorial quality, the scenario constituted by natural and traditional attributes and the territorial governance system engendered by multi-players (HIRCZAK et al., 2008; CAMPAGNE; PECQUEUR, 2014; ALVAREZ et al., 2014; CAZELLA et al., 2019 and 2020). The first two components have a clear correlation with environmental sustainability, as they are associated with stocks of biodiversity, landscapes and traditional know-how existing in rural territories.

The process of specifying and activating territorial resources, in turn, depends on the associative creativity of territorial multi-players and the history of adopting forms of cooperation. The inventory of territorial resources and assets with the potential to constitute a heterogeneous and articulated offer of products and services of territorial quality represents, at the same time, the starting point and the basis of the approach. It is about mobilizing environmental, scenic, historical and cultural attributes associated with localized agro-food systems and quality territorial services, with emphasis on the different forms of rural tourism, catering and typical gastronomy, as well as the existence of marketing channels based on short circuits, also called territorial markets (SCHNEIDER, 2016).

The objective is not restricted to doing what other territories cannot do, but also to do differently and better than other territories (PECQUEUR, 2005; GLON; PECQUEUR, 2016). Therefore, the social construction of a territorial governance system, which integrates public, associative and private actors, represents the possibility of creating an environment of social innovation capable of generating income of territorial quality. This type of income is appropriated by the different productive segments or service providers, not equally, but distributed sufficiently among the different actors, so as to promote improvements in the indicators of socioeconomic and environmental sustainability of rural territories. "This leads us to formulate the hypothesis that the value produced must be above all a 'use value', which must have prominence over the 'exchange value' that inscribes territories in competition processes without respect for collective well-being" (KLEIN; PECQUEUR, 2020, p. 231).

The continuity of studies on the subject, based on analysis of empirical cases, led the French authors to formulate a typology of different forms of social construction of the BTGS, which allows them to account for different situations that present elements of the approach idealized above, even that not all of them are present or are in an incipient stage of construction (HIRCZAK *et al.*, 2008). The coexistence of distinct and, at times, antagonistic models of agricultural development, in the same geographic space, does not represent an impediment to the valorization of specific territorial

resources, according to the precepts of the basket approach. Thus, this approach represents both an analysis model for conducting research and a methodological guide to guide the actions of sustainable territorial development agents.

The weakest element in most of the cases studied resides in the territorial governance system, which explains the recurrence of juxtaposed initiatives in the territories analyzed (HIRCZAK *et al.*, 2008). The heterogeneous offer of quality products and services is present, but no social actor has taken the initiative to formulate and propose the idea of a shared offer that provides collective benefits, such as the creation of new ones or the strengthening of existing sales channels. The dispersion of actions to value products and services of territorial quality weakens the capacity to generate collective benefits, especially those that are tributary to the BTGS scenario, whose base is public goods associated with the natural environment and traditional know-how.

Reflections on the relevance of this approach for studies of rural Brazilian territories have pointed to the need to carry out adaptations, given the profound socioeconomic differences between France and Brazil[7]. Some first results of ongoing research indicate the need to include, in the analysis model, the role played by the territory's consumer, therefore of territorial markets, relativizing the centrality of the tourist or of owners of secondary residences in generating income with territorial quality. It is about rethinking the strategies for obtaining this type of income through the mere increase in the prices of quality products and services, which may represent the exclusion of a significant portion of the population from the consumption of these goods and services. The "club effect", benefits a select group of consumers, producers and service providers of territorial quality, is contrary to the precepts of sustainable territorial development.

Finally, a challenge that persists in the formulation of the BTGS resides in the design of a panel of indicators that allows both the comparison between different territories and the monitoring over time, within the same territory, of the process of social construction of the components of the Basket (CAZELLA *et al*, 2020). Table 4 presents a first effort to formulate these indicators for the dimension of the scenario, which corresponds to the BTGS component with the greatest interaction with the environmental theme.

Table 4: Dimensions and indicators for monitoring the implementation of a Basket of Territorial Goods and Services related to the BTGS Scenario

Dimensions	Indicators	Source
Specific Territorial Resources linked to the environment (biodiversity and landscape)	The specific climate and typical landscapes as a differential of the territory.	Field research
	Access infrastructures, sales channels, marketing and digital interactivity	
Recognition, by "consumers" or users, of the preservation of the natural environment.	Communication and information access infrastructure	
Specific territorial resources linked to historical, architectural and cultural heritage	Architectural heritage associated with territorial identity.	
	Respect and appreciation of monuments and historic sites	
	Recognition of the history of the territory	
	Valuing territorial traditions	

Source: Turnes *et al.* (2021).

Conclusions

Territorial development is, by definition, multidimensional. Isolating a single dimension, the natural one, adds complexity and choices were made. Inventorying territorial, material and immaterial, generic and specific assets and resources require methodologies that are not yet available. Thus, this article aims to enlighten, point out indicators/variables to support the

[7]The formulation of this topic is part of the results of research foreseen in the projects "The Approach to the Basket of Territorial Goods and Services: Model for Analysis of Sustainable Territorial Development" and " Sustainable territorial development: interfaces between the basket of goods and services, markets and territorial brands" funded respectively by Universal CNPq Notice (Process 40.9597 / 2018-00) and Public Call Notice N FAPESC the 12 / Universal search 2020 Program (Term Grant No. 2021TR000531).

realization of a diagnosis of the natural dimension, mobilizing some approaches: geodiversity, agroecosystems, vulnerabilities and a basket of goods, in line with the commitment to think of a territorial development that does not expand the social and environmental inequalities.

The interaction between rural and urban spaces in the same territory represents a central dimension of the analysis elaborated in this article. It is understood that the concept of sustainable territorial development depends on synergistic articulations between resources and populations in these two types of spaces. Among them, food represents, possibly, the main element of this interaction, as all inhabitants of a given territory need food to survive. It is not about imagining, in an illusory way, a territorial autarchy on the subject, but to encourage the emergence of alternatives that reduce external dependencies, initially, in the provision of food, even if this is restricted to symbolic initiatives. The creation of successful experiences in this area serves as a reference for other associated actions, such as rural tourism related to the preservation of landscapes, geosites, traditional know-how, history and different forms of expression of territorial heritage.

In a country that, until recently, the urbanization rate was taken as an indicator of modernity and the rural area continues to be understood as the space where agricultural activities are practiced, preferably commodities, any and all initiatives that are oriented towards the valorization of different territorial resources deserves to be considered. The risk to be avoided is, however, that the processes of valuing these resources do not further deepen the historical social inequalities existing in all territories, whether rural or urban. Ultimately, it is not about creating niche markets for quality products and services aimed at a minority of the population, but about providing mechanisms so that products and services of territorial quality are accessible to the majority of the population.

This perspective opens up space for a vast program of re-education, formal and informal, to be undertaken on a territorial scale, at the initiative of public, private and associative organizations. It is about reversing the assumption, which has been widespread for a long time, that the rural is synonymous with backwardness and that the modern is only tangible in large urban centers.

In this sense, it is noteworthy that despite territorial development having as its locus of expression approaches of the bottom-up type, where individuals and organizations must exercise their social and environmental responsibility, from the bottom up and where the role of the State becomes more restricted, considering the vulnerabilities of rural and urban populations requires resuming the role of the State in the provision of public services and in the execution of macroeconomic and social policies that correct or minimize historical inequalities. In this sense, the following are included: policies for the preservation of different territorial heritages; policies to reduce regional and territorial disparities; policies to promote decent work; sectoral policies to strengthen activities and income in family farming; policies to fight poverty, extreme poverty and food and nutritional insufficiency; inclusive and reparatory policies for segregation by gender, race and age, among others. Particularly, with regard to the natural dimension, policies that have a particular look at the correction of environmental injustices.

In turn, the performance of institutions and society via mechanisms that guarantee them better conditions in defining public policies, in general, can only occur through the induction of the strategic role of a critical proposal for environmental education, aimed at understanding from the complexity of the environmental and work crises, from the intrinsic vulnerabilities to the model of production and accumulation and to the questioning and proposal of new social mechanisms, guided by a new sustainability and socio-environmental ethics.

Thus, arousing interest and empowering territorial actors in the art of identifying, preserving and specifying in a creative, collaborative and inclusive way, territorial resources represents a counterpoint, perhaps the main one, to the hegemonic thinking of unlimited economic growth.

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Annexes

Annex 1: Criteria, indicators and parameters for the quantitative assessment of educational and tourism values of geosites

Criteria/indicators	Parameters
A. Accessibility: weight = 15%	
Geosite located less than 100 m from paved road; Geosite located less than 500 m from paved road; Geosite accessible via a dirt road; Geosite without direct road access;	4 points 3 points 2 points 1 point
B. Safety: weight = 15%	
Geosite with security facilities (fences, stairs, handrails, etc.), mobile phone coverage and located less than 5 km from emergency services; Geosite with security facilities (fences, stairs, handrails, etc.), mobile phone coverage and located less than 25 km from emergency services; Geosite without security facilities but with mobile phone coverage and located less than 50 km from emergency services; Geosite without security facilities and mobile phone coverage and located more than 50 km from emergency services;	4 points 3 points 2 points 1 point
C. Population density: weight = 10%	
Geosite located in a municipality with more than 1000 inhabitants/km 2; Geosite located in a municipality with 250 – 1000 inhabitants/km2; Geosite located in a municipality with 100 – 250 inhabitants/km2; Geosite located in a municipality with less than 100 inhabitants/km2;	4 points 3 points 2 points 1 point
D. Association with other values: weight = 10%	
Occurrence of various ecological and cultural values less than 5 km away; Occurrence of various ecological and cultural values less than 10 km away; Occurrence of an ecological and cultural value less than 10 km away; Occurrence of an ecological or cultural value less than 10 km away;	4 points 3 points 2 points 1 point
E. Uniqueness: weight = 10% (educational) or 25% (tourist)	
The geosite exhibits unique and unusual features considering its country and adjacent countries; The geosite displays features that are unique and unusual in the country; The geosite exhibits features that are common in the region, but uncommon in other regions of the country; The geosite exhibits features that are quite common across the country;	4 points 3 points 2 points 1 point
F. Teaching potential (interpretative): weight = 25% (15%)	
The geosite presents geological elements that are taught at all educational levels (or very clear and expressive for all types of audience); The geosite presents geological elements that are taught in Elementary School (or require some prior geological knowledge); The geosite features geological elements that are taught in high school (or require solid prior geological knowledge); The geosite presents geological elements that are taught in Higher Education (or understandable only by specialists in Geology and related fields);	4 points 3 points 2 points 1 point
G. Geological diversity (economic level): weight = 15% (10%)	4 points

More than three types of geodiversity elements occur in the geosite - mineralogical, paleontological, geomorphological, etc. (or geosite located in a municipality with a family income of at least twice the national average); There are three types of geodiversity elements in the geosite (or geosite located in a municipality with a family income higher than the national average); There are two types of geodiversity elements in the geosite (or geosite located in a municipality with family income equivalent to the national average); There is only one type of geodiversity element in the geosite (or geosite located in a municipality with a family income lower than the national average);	3 points 2 points 1 point

Source: Adapted by the authors from Brilha (2016).

Annex 2: Criteria, indicators and parameters for the quantitative assessment of the risk of degradation of geosites, where: low risk < 200; moderate risk = 201 - 300; and high risk = 301 - 400

Criteria/indicators	Parameters
A. Deterioration of geological elements: weight = 35% Possibility of deterioration of all geological elements; Possibility of deterioration of the main geological elements; Possibility of deterioration of secondary geological elements; Small possibility of deterioration of secondary geological elements;	 4 points 3 points 2 points 1 point
B. Proximity to areas/activities with potential for degradation: weight = 20% Geosite located less than 50 m from area/activity with potential for degradation; Geosite located less than 200 m from area/activity with potential for degradation; Geosite located less than 500 m from area/activity with potential for degradation; Geosite located less than 1 km from area/activity with potential for degradation;	 4 points 3 points 2 points 1 point
C. Legal protection: weight = 20% Geosite located in an area without legal protection and without access control; Geosite located in an area without legal protection, but with access control; Geosite located in an area with legal protection, but without access control; Geosite located in an area with legal protection and access control;	 4 points 3 points 2 points 1 point
D. Accessibility: weight = 15% Geosite located less than 100 m from paved road; Geosite located less than 500 m from paved road; Geosite accessible via a dirt road; Geosite without direct road access;	 4 points 3 points 2 points 1 point
E. Population density: weight = 10% Geosite located in a municipality with more than 1000 inhabitants/km 2; Geosite located in a municipality with 250 – 1000 inhabitants/km2; Geosite located in a municipality with 100 – 250 inhabitants/km2; Geosite located in a municipality with less than 100 inhabitants/km2;	 4 points 3 points 2 points 1 point

Source: Adapted by the authors from Brilha (2016).