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CONTEXTUALIZED EDUCATION IN THE SEMI-ARID REGION AND NATURAL COMPONENTS IN GEOGRAPHY TEACHING

EDUCAÇÃO CONTEXTUALIZADA COM O SEMIÁRIDO E OS COMPONENTES NATURAIS NO ENSINO DA GEOGRAFIA

EDUCACIÓN CONTEXTUALIZADA CON LA REGIÓN SEMIÁRIDA Y COMPONENTES NATURALES EN LA ENSEÑANZA DE LA GEOGRAFÍA

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ABSTRACT
This article discusses the importance of contextualized education in the Brazilian semi-arid region, focusing on Geography teaching that integrates theoretical content with sustainable coexistence practices tailored to local realities. It highlights natural components in Geography teaching, such as climate, soil, vegetation, relief, and water resources, analyzed in their relationship with the challenges and opportunities of contextualized education in the semi-arid region. Through a theoretical approach, the study emphasizes how understanding these natural components contributes to comprehending the semi-arid sociocultural reality. The approached pedagogical practices include studies on local vegetation adaptations and water harvesting actions. The results show that integrating natural components with pedagogical practices enriches Geography teaching, promoting meaningful learning and sensitizing students to the contextualized education of the semi-arid.
Keywords: Contextualized education in the semi-arid. Coexistence with the semi-arid. Natural components. Geography teaching. Social technologies and education.

RESUMO
O artigo discute a importância da educação contextualizada no semiárido brasileiro, com enfoque no ensino de Geografia, integrando conteúdos teóricos e práticas de convivência sustentável com a realidade local. Destacam-se os componentes naturais no ensino de Geografia, como clima, solo, vegetação, relevo e recursos hídricos, analisados em sua relação com os desafios e potencialidades da educação contextualizada no semiárido. A partir de uma abordagem teórica, o estudo ressalta

como a compreensão desses componentes naturais contribui para o entendimento da realidade sociocultural da região. Além disso, são apresentadas algumas práticas pedagógicas, como estudos sobre as adaptações da vegetação local e ações de captação de água. Os resultados evidenciam que a integração entre os componentes naturais e as práticas pedagógicas enriquece o ensino de Geografia, promovendo um aprendizado significativo e sensibilizando os estudantes para a importância da educação contextualizada no semiárido.
Palavra-chaves: educação contextualizada no semiárido; convivência com o semiárido; componentes naturais; ensino da geografia; tecnologias sociais e ensino.

RESUMEN
El artículo discute la importancia de la educación contextualizada en el semiárido brasileño, con foco en la enseñanza de la Geografía, integrando contenidos teóricos y prácticas de convivencia sustentable con la realidad local. Se destacan los componentes naturales en la enseñanza de la Geografía, como el clima, el suelo, la vegetación, el relieve y los recursos hídricos, analizados en su relación con los desafíos y potencialidades en el contexto de la educación contextualizada en la región semiárida. Desde un enfoque teórico, el estudio destaca cómo la comprensión de estos componentes naturales contribuye a la comprensión de la realidad sociocultural de la región semiárida. Se presentan algunas prácticas pedagógicas, estudios sobre las adaptaciones de la vegetación local y acciones de captación de agua. Los resultados muestran que la integración entre los componentes naturales y las prácticas pedagógicas enriquece la enseñanza de la Geografía, promoviendo aprendizajes significativos y sensibilizando a los estudiantes sobre la educación contextualizada de la región semiárida.
Palabras clave: educación contextualizada en la región semiárida; coexistencia con la región semiárida; componentes naturales; enseñanza de geografía; Tecnologías sociales y enseñanza.

WHAT IS CONTEXTUALIZED EDUCATION?

The term "Contextualized Education" refers to a pedagogical approach that seeks to connect educational content and practices to the sociocultural, economic, historical, and environmental contexts of the learners, emphasizing local perspectives and valuing the territory.

This approach aims to recognize students' knowledge and experiences and the specificities of their communities, making the teaching-learning process more meaningful and aligned with reality. It integrates students' knowledge with local experiences, respecting traditions, histories, languages, and cultural practices as part of the educational process. These practices are often associated with rural settings.

As Costa (2001) states, in the context of contextualized education, schools are considered plural spaces that prepare students to face challenging, complex, and demanding situations as a condition for the full development of their skills and potentials as individuals, citizens, and professionals. This philosophical and technical strand of education underpins the proposal for contextualized education.

Contextualized Education also integrates knowledge with the environment, considering the natural, socio-environmental, and cultural characteristics of the territory—such as soil, water, and climate—natural components in their entirety, and resources derived from these components. It addresses local challenges to contextualize school content.

This perspective is grounded in interdisciplinarity, as a single science cannot encompass all aspects. It seeks to relate knowledge from professionals in diverse fields to understand and act on the vulnerabilities and potentials of the territory, creating a symbiosis between academic and popular knowledge.

Thus, its core lies in emphasizing the learner's active role as a protagonist in the learning process, connecting school learning with their experiences and vice versa in a reciprocal, synergistic, and collaborative relationship with teachers.

WHAT DOES THE TERM "SEMI-ARID" MEAN?

Etymologically, the term "semi-arid" is derived from two elements:

1. **Semi-:** A Latin prefix meaning "half," "almost," or "partially," indicating something that is incomplete or partial in its description.
2. **Arid:** From the Latin *aridus*, meaning "dry," "devoid of moisture," or "sterile."

Thus, "semi-arid" literally means "half dry" or "partially arid." It refers to regions where the climate is intermediate between arid (extremely dry) and subhumid (with more regular humidity), characterized by considerable dry periods but still possessing some water availability for vegetation and human activities.

The term aligns with the Brazilian semi-arid region, though a detailed discussion on its precise delimitation is beyond the scope of this text.

THE BRAZILIAN SEMI-ARID REGION

The Brazilian semi-arid region, though challenging, exhibits a rich and complex environmental and sociocultural dynamic, as Ab'Saber (1999) previously noted. Located in Northeast Brazil and a small portion of Minas Gerais, this area is characterized by a predominantly hot and dry climate, with irregular rainfall concentrated in a few months. The rainy season, typically from February to May, is followed by prolonged dry periods, creating a unique hydrological regime.

This climate, which is not exclusive to the Brazilian semi-arid region (INSA, 2013), is defined by irregular rainfall combined with high evaporation rates, resulting in highly variable water availability. This directly affects agriculture and livestock farming, the region's primary economic activities. Rainfed agriculture, which relies on rainfall, is particularly vulnerable to droughts, severely impacting food security and the local economy. Although livestock farming is adapted to the arid climate, it also struggles with pasture scarcity during extended dry periods.

The soils in the semi-arid region are diverse (Santos, 2017) but predominantly shallow and rocky, with low water and nutrient retention capacity. These conditions limit agricultural productivity, necessitating specific soil management and conservation techniques to minimize erosion and degradation. Sustainable agricultural practices, such as agroecology and permaculture, are encouraged to enhance community resilience.

The predominant vegetation in the region is the *caatinga*, a biome exclusive to Brazil, with flora highly adapted to drought conditions. Xerophytic plants, such as cacti and thorny shrubs, have developed survival strategies, including water storage and leaf shedding during dry periods. This vegetation is not only crucial for maintaining ecological balance but also holds cultural significance for the traditional populations inhabiting the region, particularly for its dietary uses (Drumond et al., 2016).

The *caatinga* biome, though often underestimated, boasts remarkable biodiversity. It harbors a variety of endemic plant and animal species adapted to the extreme conditions of the semi-arid region. Conserving these natural resources is essential for preserving biodiversity and maintaining the ecosystem services that sustain life in the region.

Water scarcity is a central concern in the Brazilian semi-arid region, driving the construction of reservoirs and cisterns to store water during the rainy season. Government programs and non-governmental initiatives (ASA, 2002) have been instrumental in implementing technologies to support sustainable living in the semi-arid, such as plate cisterns for rainwater storage for human consumption and agricultural production.

Socially, the semi-arid region faces significant challenges. Drought-induced migration (OJIMA, 2015) has long been a reality, affecting local demographics and economies. Many families have historically left rural areas in search of better living conditions in cities or other parts of Brazil, contributing to urban sprawl and worsening living conditions. However, recent studies indicate that migration trends are reversing.

However, the region also serves as an example of resilience and innovation. The local culture (VELOSO, 2021), rich in traditions, music, dance, and cuisine, reflects the adaptability and creativity of semi-arid communities. Popular festivities, such as São João, and artisanal production are living expressions of this vibrant culture. Moreover, contextualized education, which integrates local knowledge with the school curriculum, has been a powerful tool for strengthening cultural identity and promoting sustainable development.

In summary, the semi-arid region is one of contrasts, where climatic adversity meets human resilience and biological richness. Sustainable development and harmonious coexistence with the environment are constant challenges, but they also present opportunities for innovation and the appreciation of local cultures. The integration of sustainable practices, biodiversity conservation, and the strengthening of communities are essential pathways to addressing difficulties and harnessing the potential of this unique region. This is precisely what Contextualized Education in the Semi-Arid Region seeks to achieve.

CONTEXTUALIZED EDUCATION IN THE SEMI-ARID REGION

Contextualized Education in the Semi-Arid Region (CESAR) is an educational proposal based on the principle of coexisting with the environmental and sociocultural characteristics of the semi-arid territory, valuing natural diversities and local knowledge. This is well established in the publications of RESAB (2023).

CESAR seeks to provide meaning to the local reality and the lives of individuals within their territory, based on their everyday practices. It is, therefore, a proposal that contrasts with traditional teaching, particularly in terms of content, when it is disconnected from students' realities—whether through examples presented in textbooks or even in the daily routines of schools.

It is important to highlight that this proposal has been shaped by social movements and non-governmental organizations, mainly associated with rural territories, within a perspective aligned with the implementation of social technologies in the semi-arid region. This approach challenges educational policies often imposed from distant realities, with their standardized educational plans and goals that fail to reflect local knowledge. CESAR proposes that, by relating to the lived territory, the key actors (teachers, students, and the community) can ensure sustainable coexistence with the semi-arid environment and overcome the difficulties imposed by socio-environmental conditions.

Addressing Contextualized Education in the Semi-Arid Region means adapting school curricula to the geographical space, local culture, identity, and the specificities of the semi-arid environment. It is rooted in the social reality of students and teachers and enables the contextualization of the teaching-learning process with the cultural diversity present in the region.

In this sense, Contextualized Education for the Semi-Arid Region entails educational practices developed primarily in schools, fostering a connection between individuals and their reality. The local community plays a crucial role in this process. Furthermore, it enables an educational approach in which individuals are capable of constructing and reconstructing their histories, valuing the actors who shape the territory through dialogues between educators, students, and the community.

The scope of CESAR dismantles the notion that the semi-arid region is unsuitable for habitation, associated with food scarcity and, primarily, water shortages. It challenges public policies that, for decades, have tied social conditions to welfare dependency and labor exploitation.

The educational project linked to CESAR is based on living with reality, subsistence practices, sustainable and healthy ecology, and cultural appreciation.

The perspective of CESAR also encompasses ethnoknowledge, prioritizing popular and local knowledge, without neglecting academic and normative knowledge. It thus considers the relationships between students, their community, and their enduring traditional habits in connection with the natural environment of their territory. It adopts an ecological approach to understanding vegetation, soil, and climate within a social and cultural framework, emphasizing a sustainable coexistence with the natural environment.

This perspective aligns with the reflections of Costa Falcão and Falcão Sobrinho (2024) when discussing ethnopedological studies:

> "In the ethnopedological framework: Ethnopedology embraces an integrative perspective on environmental knowledge, in which soil plays a crucial role, incorporating the perspective of those who use it—in this case, farmers. The knowledge of the physical environment, the cultural framework in which the farmer is embedded, and the socio-economic conditions of the local community are intrinsic elements of this approach to soil knowledge. It is not an autonomous science but a multidisciplinary knowledge perspective that differs from traditional soil profile studies. In this context, the farmer is central to soil knowledge, drawing on experience accumulated over time, practical knowledge, and lived experiences, as well as their own conceptual understanding of soil based on their knowledge."

Thus, discussions on Contextualized Education for Coexistence with the Semi-Arid Region are indispensable. Understanding local knowledge in terms of the region's vulnerabilities, potentials, and limitations leads to the development of alternative practices that promote sustainability. This approach integrates theoretical and practical knowledge, grounded in coexisting with the territory and respecting the living conditions of local communities.

The CECSAR (Contextualized Education for Coexistence with the Semi-Arid Region) framework positions the local environment as central to reflections—whether as a starting point, an element of interaction, or a means of inclusion in the construction of diverse knowledge. These considerations must be incorporated into the curriculum (FIGUEIREDO, 2012).

All these perspectives suggest analytical categories within the geographical context: territory, place, landscape, ethnoknowledge in relation to nature, and culture.

Certainly, much of what CECSAR encompasses is not found in textbooks, as they present a cultural reality shaped by an educational model that has been governed for decades by a normative, conceptual framework. These textbooks often exemplify cultural contexts that diverge significantly from the diverse realities of Brazil, including the Semi-Arid Region. However, existing educational policies do allow for the consideration of students' realities, ensuring that teaching contributes to an education that values the specificities and potentials of the local socio-environmental context. This consideration aligns with the inclusion of Contextualized Education for the Semi-Arid Region.

NATURAL COMPONENTS IN GEOGRAPHY EDUCATION

It is reasonable to assert that Geography, as a discipline, contributes to and interacts with other sciences in advancing Contextualized Education in the Semi-Arid Region and, consequently, Coexistence with the Semi-Arid Environment. Here, we focus on studies of nature within the realm of Physical Geography—a branch of geographical science that examines the natural aspects of terrestrial space. Specifically, we consider its components: relief, rock formations, climate, soil, vegetation, and water resources. These components are often presented in a conceptual and didactic manner (FALCÃO SOBRINHO *et al.*, 2023).

However, it is necessary to understand these components within their dynamics and through an integrated analysis, recognizing the importance of their elements. Components are the structural and functional parts of a whole, operating in an integrated manner, while elements refer to the particular and specific features within those components.

Understanding the integrated foundation of Physical Geography allows for reflections on the materialization of forms based on the attributes of their elements. Recognizing these elements involves acknowledging that they are not merely physical but also encompass chemical and biological dynamics. Consequently, Physical Geography is also inherently biological and chemical.

All these components and their elements can, at times, become resources—what we refer to as natural resources. When they are utilized as resources, they are inevitably altered in their natural dynamics. As a result, components and their elements may undergo changes, generating new dynamics influenced by human activity—an agent commonly referred to as the social being. For a deeper understanding of natural resources, see Venturi (2006).

Therefore, discussing Physical Geography naturally leads to considering biological and chemical elements that interact with its components. The dynamics of these interactions manifest materially as landscapes, which may, in turn, become resources under societal influence.

NATURE	
Components	**Elements**
Rock	Minerals: quartz, feldspar, mica, calcite, olivine
Relief	Sinuosity, slopes, shapes
Climate	Temperature, humidity, solar radiation, atmospheric pressure, wind and solar radiation
Soils	Minerals, sand, silt, clay, organic matter and water
Vegetation	Plant species, plant stratum, biomass
Water	Water Molecules (H_2O), mineral salts, dissolved gases, organisms

The components act in an integrated and dynamic manner within the context of Nature, being expressed through what we can call Landscape. It is important to highlight that all these components are dynamic and interdependent, playing a decisive role in the constitution of the terrestrial landscape.

Thus, we can conceptualize nature as being historicized in its own rhythms, while also being the result of human actions. This perspective situates the position of Physical Geography, that is, in the study of nature through its physical, chemical, and biological components and the interaction of society. It is, therefore, necessary to conceive a theoretical and methodological foundation that allows for an understanding of this complex organizational system that constitutes Nature.

The particularities of interpreting the natural characteristics of environments will also be guided by the General Systems Theory, proposed by Bertalanffy in 1936. In this approach, each element is associated with another, and through the flow of matter and energy, the attributes of the elements provide the necessary dynamics for their equilibrium.

This understanding further leads us to Buckley's (1967) proposal, which, when addressing Systems Theory in Sociology, warns that the sociocultural system is an organic complex, and the relationships between its parts become more flexible in terms of structure, thus reinforcing the symbiosis between nature and society.

Having established these foundational understandings for conceptualizing Nature, we must now consider the emphasis given to the components that constitute it through the

fields of study within Physical Geography. However, it is prudent to relate these components and their attributes to societal needs. In this way, Nature merges with and complements the social arrangement within its territorial base. Therefore, its contribution to Contextualized Education in the Semiarid region is highly relevant.

Geological Studies

Geology is the science that studies rocks and minerals, constituting a specific discipline within Geography. This field, characterized by its interdisciplinarity, seeks to understand the dynamics of the Earth's surface as well as the processes involved in the formation of structures such as rocks. Geological mapping and the interrelation between rocks and the natural environment are two widely recognized study objects within Physical Geography. The nature of the bedrock, whether superficial or deep, directly influences the planting practices of farmers. Geological studies facilitate the exploration of minerals extracted from rocks (such as quartz, calcite, and clay minerals), which are used in products like glass, ceramics, paints, and plastics. Minerals such as phosphate and potassium, found in rocks, are used in the production of fertilizers. Environmental education practices play a significant role in advancing knowledge in geosciences (SILVA et al., 2022).

Geomorphological Studies

Geomorphology studies landforms and seeks to understand the processes involved in their formation and dynamics on the Earth's surface. As a subfield of Physical Geography, it focuses on characterizing landscape elements such as mountains, plateaus, and plains, as well as other classifications of landforms. It also investigates processes such as erosion and weathering. Within its various branches, ethnogeomorphology and anthropogeomorphology stand out, emphasizing human actions.

It is crucial to highlight that landforms serve as the foundation for the construction of houses, roads, agricultural activities, and water reservoirs, making them central to human activities. The terrain influences the selection of areas for cultivation, livestock farming, and soil management. Flat regions, for example, are more suitable for agricultural mechanization, while hillside areas require specific techniques, such as terrace farming.

Currently, geomorphology considers anthropogeomorphology (RODRIGUES et al., 2019), which examines the marks left by human activities and attributes certain formations to geotechnogenesis (PELOGGIA, 1998). Additionally, geomorphological investigations include ethnogeomorphology (SOUZA et al., 2023), which explores the perception of landforms from the perspective of local communities. This approach is particularly relevant to studies in Contextualized Education in the Semiarid region.

Pedological Studies

Soil science encompasses the study of soil formation, composition, and dynamics. This interdisciplinary branch of Physical Geography characterizes soils based on aspects such

as color, texture, and permeability. Soil mapping and the use of soil resources for human activities are key focal points in Physical Geography.

Soils are fundamental for agriculture, which depends on their quality and fertility for food production. The selection of agricultural crops, sustainable management practices, and the use of inputs are directly linked to pedological knowledge.

The planning of safe housing and urban development depends on pedological studies to mitigate risks such as landslides. Urban flooding is often exacerbated by soil impermeabilization and vegetation loss. Therefore, community knowledge of soil characteristics is essential (JORGE; GUERRA, 2023). Within this interdisciplinary context, Soil Education emerges as a crucial field (COSTA FALCÃO; FALCÃO SOBRINHO, 2024).

Climatological Studies

Climatology is the science that studies atmospheric dynamics and climate types. In the context of Physical Geography, it addresses the spatial distribution of atmospheric elements, such as precipitation, and their interactions with other landscape components, including the formation of cold fronts. The study of global climate distribution is one of the main objectives of Physical Geography.

Climate directly influences growing seasons, crop productivity, and food security. Tropical, temperate, and arid climates exhibit characteristics that determine the types of crops that can be cultivated in each region, affecting food availability and pricing.

Climate also impacts urban planning (MUNIZ; CARACRISTI, 2020), influencing the construction of buildings, drainage systems, and transportation infrastructure. In regions prone to heavy rainfall, efficient drainage systems are necessary, while in areas with extreme heat, sustainable urban planning strategies such as green roofs and shading structures are crucial.

Biogeographical Studies

The study of vegetation elements within geographic space is widely explored in Physical Geography. The spatial distribution and characterization of vegetation types constitute the main focus of this field. Furthermore, knowledge of vegetation is directly linked to issues such as environmental impacts, natural resource management, and sustainable development.

Biogeography is a science that connects nature to human daily life, providing insights for biodiversity conservation, sustainable resource use, and addressing global challenges such as climate change and habitat loss. Its study is fundamental to ensuring a balance between human development and environmental preservation (SILVA et al., 2024).

Hydrological Studies

The study of the spatial distribution of rivers and other watercourses is the primary objective of hydrological studies. This field within Physical Geography classifies river types and examines the physical and environmental dynamics involved in the water cycle and its impact on the natural environment. Hydrological studies are closely linked to human activity and its influence on spatial organization.

Hydrogeography helps identify water sources, such as rivers, aquifers, and reservoirs, and understand their dynamics to ensure sustainable water supply. In this regard, the study of water springs is essential in the semiarid context, as emphasized by Lima (2004).

DIDATIC TRANSPOSITION IN GEOGRAPHY EDUCATION

Initially, it is essential to recognize that geographical pedagogy is grounded in teacher training. Therefore, university education plays a crucial role in shaping the contents, procedures, and methodological approaches that teachers employ in the classroom. It is important to note that, within geographical science, the classroom extends beyond the school walls, as field activities are integral to the discipline, as observed in Costa Falcão and Falcão Sobrinho (2016).

Thus, we turn to the words of Chaval (1974), which may seem distant from the present time but remain relevant:

"[…] the identity of method and interest is possible thanks to the direct transmission of knowledge, thanks to the formation of disciples who gather around a teacher to whom they owe much more than they generally believe: he has given them instruction to see and feel; he has given them the essence of his philosophy" (CLAVAL, 1974, p.).

Therefore, the teacher is the professional who defines their cognitive mediation (see COPATTI, 2023), acting as a rational subject who makes decisions throughout the execution of their task, greatly relying on what they learned in the classroom as an academic. At the same time, the teacher delineates their subjective dimension, shaped throughout life as a foundation for interacting with new knowledge encountered during academic training. Mediation, therefore, occurs in a space between reality and the intended educational outcomes.

In this context, the teacher relies on technical support, particularly the textbook, institutionalized by higher authorities, while also considering the perspective of studying the local reality, as proposed by Contextualized Education in the Semi-Arid Region.

In this regard, the National Education Guidelines and Framework Law (Law No. 9394/96) (BRAZIL, 2006) granted schools pedagogical autonomy to develop their political-pedagogical project (PPP) to fulfill the objectives of school education.

Within this framework, it is necessary that the didactic transposition of content to be transmitted and discussed with students ensures that schools recognize the dimension and importance of local knowledge as a fundamental premise in student education. This

should be incorporated into the curriculum. The curriculum's structure is based on an education focused on results and centered on specific content and skills. According to the 1988 Federal Constitution, Article 210 states that it is the duty of the State to establish "minimum content for primary education, ensuring a common basic education and respect for national and regional cultural and artistic values." Based on this article, the Ministry of Education has since 1995 developed and distributed the National Curriculum Guidelines for Early Childhood Education (Referenciais Curriculares Nacionais para a Educação Infantil, RCNEI), the National Curriculum Parameters (Parâmetros Curriculares Nacionais, PCN) for Primary Education, and the Curriculum Guidelines for Secondary Education.

However, it is important to note that the study of the local reality should not lose sight of the broader context. Content must be understood in its plural dimension, extending beyond local limits to encompass national and international perspectives.

Examples of Content Application

a) Climate Studies in Basic Education

The study of climate in Basic Education provides numerous opportunities to relate academic content to students' realities. Climate directly influences daily life, from simple choices like clothing to complex issues such as health, work, and leisure. It is essential to raise students' awareness of climate's role in agriculture at global, regional, and local levels, as it affects food production. Emphasizing the importance of rainfall and temperature for local crops also fosters an understanding of food appreciation, discouraging waste in school meals—especially in the semi-arid environment, where climatic realities reinforce the value of food.

b) Soil Studies in Basic Education

Soil studies can be closely linked to students' realities, as soil plays a fundamental role in daily life, influencing food production, health, the environment, and urban and rural spaces. Associating soil studies with food production allows students to engage in discussions and practical experiences about its significance for cultivating fruits, vegetables, and other staple foods.

From an interdisciplinary perspective, soil studies can be connected to economics, mathematics, and market value analysis. This leads to critical questions such as: *What would happen if the soil were not fertile? How would this impact food price and availability?* These discussions are directly relevant to students' lives.

As part of extension activities, implementing school gardens and promoting home gardens would be beneficial. Such initiatives would enable discussions about the importance of soil quality for plant growth.

c) Nature in Urban Spaces

Studying nature in urban areas helps students recognize the presence and significance of natural elements in cities, even in medium or small urban centers. This approach fosters an understanding of the relationship between nature, quality of life, and urban sustainability.

Green spaces help mitigate temperature extremes, and areas with diverse plant species attract more birds, fostering a richer ecosystem. Parks and squares positively impact residents' physical and mental well-being by providing shade, air purification, and noise reduction.

Urban soil compaction exacerbates flooding and landslides, often beginning with deforestation for construction. Paved roads, sidewalks, and cement-covered walls contribute to these environmental challenges.

TECHNIQUES FOR LIVING IN THE SEMI-ARID REGION ASSOCIATED WITH NATURAL COMPONENTS AND SOCIAL TECHNOLOGIES

Living in the semi-arid region is facilitated through social technologies—replicable products, techniques, or methodologies developed and applied in collaboration with communities, providing solutions for social transformation through the sustainable use of local resources.

Social technologies in the semi-arid region have a strong connection with Geography education, as they align with the natural components that geography examines in its research. They provide a contextualized, integrated, and critical approach to understanding local realities. Technologies such as rainwater harvesting cisterns, biodigesters, mandala gardens, and productive backyards are deeply linked to environmental, social, cultural, and economic dynamics. These technologies offer a rich basis for exploring geographical concepts.

In Geography education, these technologies help contextualize content and integrate local knowledge (FALCÃO SOBRINHO, 2025), enabling students to understand elements such as climate, soil, sustainable resource management, and the relationship between landscape and territory. The semi-arid region, with its challenges and potential, serves as a living laboratory for geographical studies, bringing school content closer to students' lived experiences. This reality should also be addressed in teacher training programs at universities, ensuring that educators are well-prepared to incorporate local knowledge into their teaching.

Moreover, social technologies promote an education focused on sustainability, illustrating practices that reconcile human development with environmental conservation. These technologies serve as concrete examples for discussing the Sustainable Development Goals (SDG), such as access to clean water and the preservation of terrestrial life. By linking local issues to global themes, education becomes more meaningful and relevant.

The integration of these topics into Geography education also strengthens interdisciplinarity, connecting knowledge from Natural Sciences, Geosciences, History, Sociology, Philosophy, and Mathematics. Pedagogical projects involving social technologies—such as building mini-cisterns, reusing water, or establishing community gardens—offer hands-on learning experiences that foster socio-environmental and civic competencies among students.

Examples of practical applications include case studies on local social technologies, interdisciplinary projects that merge multiple fields of knowledge, and fieldwork in areas where these solutions are implemented. These activities strengthen the link between Geography education and the local reality, transforming the discipline into a tool for critical analysis and social and environmental change in the semi-arid region.

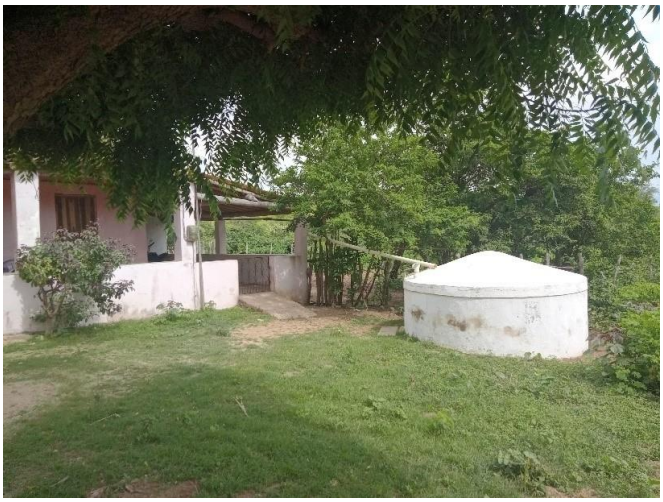
These technologies can be incorporated into university courses as well as Basic Education curricula, providing an educational foundation that aligns with local sustainability practices.

PLATE CISTERNS

Plate cisterns aim to improve the quality of life for the rural population. Within the perspective of living in the semi-arid region, the Training and Social Mobilization Program for Living with the Semi-Arid: One Million Rural Cisterns (Programa de Formação e Mobilização Social para a Convivência com o Semiárido: Um milhão de Cisternas Rurais, P1MC) stands out. This program was created by the Articulation of the Brazilian Semi-Arid (Articulação do Semiárido Brasileiro, ASA) in the early 2000s, initiating the implementation of plate cisterns (CARVALHO; FALCÃO SOBRINHO, 2021).

Plate cisterns are simple technologies for rainwater collection and storage, designed to provide access to water for rural communities in the Brazilian semi-arid region. This technology is structured around the interests, potentialities, and needs of local populations, particularly small-scale farmers. Its principles are based on: a) The conservation, sustainable use, and environmental restoration of natural resources in the semi-arid region; b) The breakdown of monopolized access to land, water, and other means of production, ensuring that these elements together promote sustainable development in the semi-arid region.

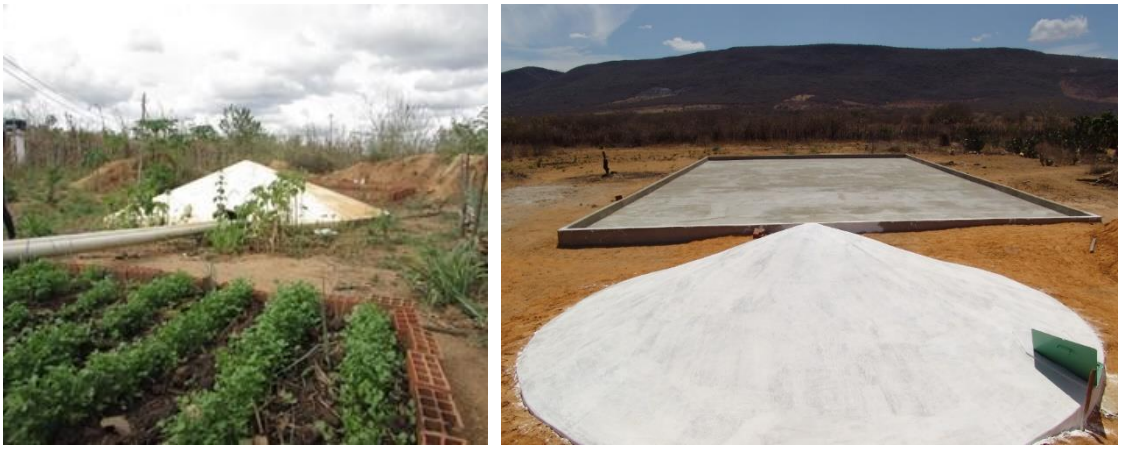
Figure 1: Plate Cisterns



Source: *Author*

In 2007, according to the ASA report (2014), a milestone was set with the creation of the One Land and Two Waters Program (Programa Uma Terra e Duas Águas, P1+2). This initiative aimed to increase the water supply for families, rural communities, and traditional populations. The number "1" represents land, while "2" refers to a second source of water intended for family farming and the raising of small livestock. This program includes technologies such as runoff cisterns, underground dams, and sidewalk cisterns, among others.

Figure 2: Runoff Cisterns



Source: *Author*

One of the many benefits provided by these social water collection technologies is the ability to produce food such as papaya, tomatoes, maxixe (a type of gourd), leafy greens, and medicinal plants, as well as support small livestock farming. The productive backyard is irrigated using water from the P1+2 technology. These practices highlight that, despite environmental limitations, it is possible to coexist with the semi-arid climate and biome in a sustainable way that does not harm the environment while also contributing to household income.

From a geographical perspective, cisterns can be related to the irregular distribution of rainfall, addressing drought periods and the rainy season. This association can be made considering the local reality or drawing parallels with other environments, such as the climatic conditions of the semi-arid hinterlands, coastal zones, and humid and dry residual massifs.

It is also important to highlight that studies on annual rainfall averages over a 30-year period can inform the appropriate sizing of cisterns, both for domestic use and for sidewalk cisterns.

Specific topics such as evapotranspiration can also be incorporated, discussing the importance of reducing water loss in regions with high evaporation rates.

Regarding public health, a field of study within Health Geography, an important aspect is the use of cisterns and water quality, including treatment and storage processes, filtration, and contaminant control.

Another perspective involves social mapping, identifying areas where these technologies are more common and analyzing how climate influences their distribution. This can be applied at both a local scale and in broader data collection efforts that guide mapping processes.

From an interdisciplinary perspective, cistern studies can incorporate mathematical concepts related to cistern size, structure dimensions, the roof area used for water collection, and flow capacity—all of which provide valuable opportunities for applying mathematical science.

Finally, it is essential to recognize that the implementation of cisterns intersects with traditional knowledge and values community practices in the construction and maintenance of these structures (see NEGEV; GIBSON, 2001).

UNDERGROUND DAMS

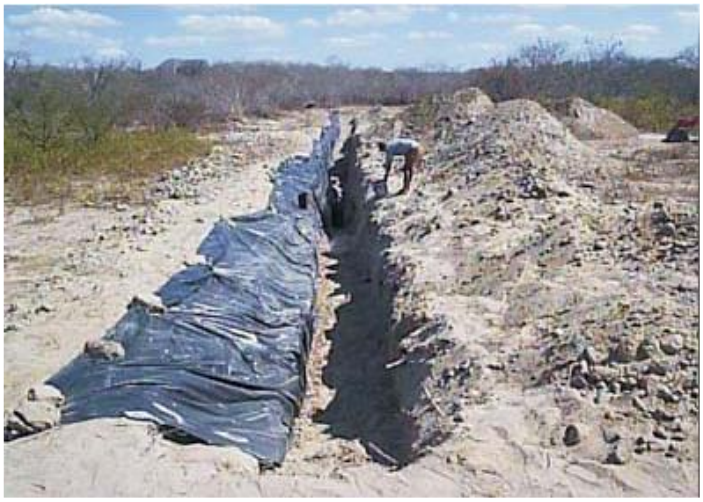
Underground dams enable rainwater storage within the soil profile, making it available for irrigating agricultural and forage crops. This technology is considered an effective tool for supplementing water needs in semi-arid regions and is commonly used for small-scale crop cultivation (see SRH, 2010).

Exploring the concept of underground dams in Geography education offers an excellent opportunity to integrate environmental, social, and economic themes into the curriculum.

This topic can be approached in multiple ways, relating it to subjects such as water resources, land use, environmental management, and sustainable development.

It is particularly relevant to examine how underground dams function, how they store water beneath the soil, and how they contribute to aquifer recharge. Additionally, discussing the hydrological cycle, with a focus on water infiltration and storage within the soil, provides further opportunities for student engagement.

Figure 3: Underground Dam



Source: *Author*

Another key aspect is sustainable agricultural practices. These dams help prevent water waste and promote efficient soil management, ensuring water is available for crops even in drought-prone areas.

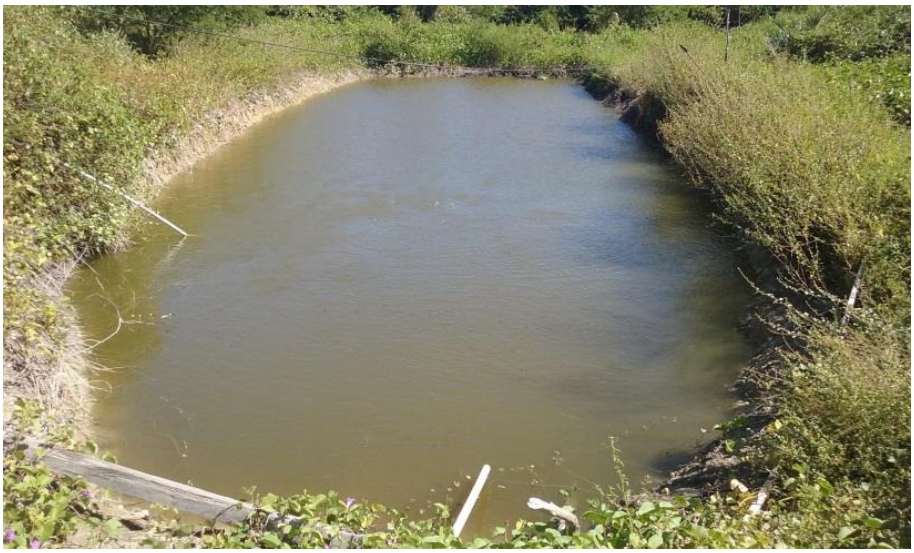
Teaching about underground dams in Geography allows for the integration of environmental, social, and economic considerations. In semi-arid regions, where water scarcity poses challenges to both human and agricultural development, these technologies become highly relevant.

TRENCH DAMS

The trench dam, also known as a trench barrier, is a simple yet highly efficient structure for water collection and underground storage, particularly in semi-arid regions. This technique involves excavating a trench or ditch, usually positioned transversely to the natural rainwater runoff path in small watersheds. It has specific structural features that maximize water infiltration into the soil, supporting the replenishment of groundwater tables and aquifers (see IRPA, 2012).

When constructing or studying a trench dam, it is valuable to integrate Geomorphology education, as it presents an opportunity for contextualized and interdisciplinary learning. This approach connects theoretical and practical knowledge about landforms with sustainable water management solutions in the semi-arid region.

Figure 4: Trench Dam (Massapê)



Source: *Author*

Key Geomorphological Aspects Related to Trench Dams:

- Identifying suitable locations for trench dams based on slope, soil types, and terrain stability. This analysis fosters discussions on landforms, land use, and water conservation.
- Understanding erosion, sedimentation, and infiltration processes, which directly impact the efficiency and longevity of trench dams.
- Exploring groundwater recharge zones, which are critical for the effective functioning of trench dams and broader water resource management strategies.
- Discussing how trench dams alter the landscape, including drainage patterns and vegetation dynamics, to promote critical reflections on the sustainability of environmental interventions.

By integrating Geomorphology with practical applications, students gain a comprehensive understanding of how landforms influence water availability and how sustainable technologies can help communities adapt to semi-arid conditions.

STONE BARRIERS

Stone barriers are traditional agricultural techniques used for soil and water conservation, especially in areas prone to erosion and degradation, such as semi-arid regions. They consist of rows or barriers made of stones arranged along the terrain, generally following contour lines.

Stone barriers can be integrated into Geography education in an interdisciplinary and creative manner, connecting physical, cultural, and environmental aspects. These elements, related to geomorphological and geological processes, offer significant pedagogical potential in both theoretical and practical fields. Initially, they align with the disciplines of geomorphology and geology.

Figure 5: Stone barriers in the São Domingos community

Source: *Author*

Within Physical Geography, stone barriers facilitate the exploration of formation processes and associated phenomena such as weathering, erosion, and sedimentation, incorporating pedology knowledge. From a geological perspective, instructors can address rock types, discuss geological time, and analyze landscape evolution.

Geographically, cartography also plays a role, as maps and satellite images can be used to identify and locate stone barriers, fostering students' cartographic reading and interpretation skills.

From a cultural and geodiversity perspective, stone barriers can be studied as elements of geoheritage, highlighting their relationship with cultural traditions, local mythologies, and agricultural practices. Their placement may reflect students' ethnoknowledge regarding relief, rocks, and soil (SOUZA et al., 2023).

Stone barriers can also be linked to urban environments, as they serve as property delimiters and resources for construction, demonstrating how communities have functionally used them over time.

From an environmental standpoint, they provide a lens for examining anthropogenic impacts, such as those caused by mining and urbanization. These formations can be utilized in environmental education activities to underscore the importance of conserving geodiversity and natural landscapes.

In practice, these topics can be explored through various methodologies. Organizing fieldwork enables students to observe stone barriers in situ and better understand their characteristics within natural and cultural contexts.

Through these approaches, stone barriers become valuable educational resources, connecting students to their local reality and encouraging critical reflection on the relationship between society and sustainable semi-arid living.

BIODIGESTER

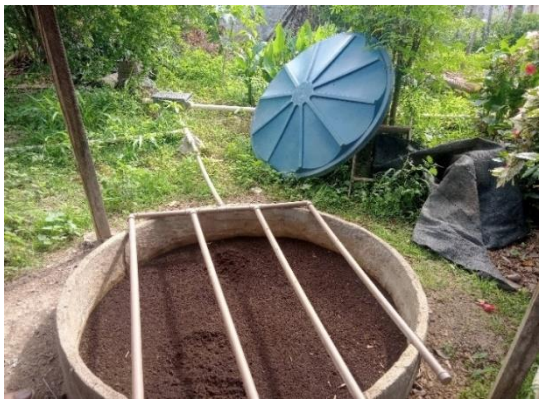
The biodigester represents an alternative for managing renewable energy sources. This technology utilizes organic matter derived from livestock waste (FERNANDES et al., 2023). In this system, organic matter undergoes anaerobic digestion, producing biogas, which is then channeled for use in household cooking.

The relationship between Geography education and biodigesters is linked to studying natural processes and technological solutions for environmental sustainability, waste management, and efficient resource use.

The biodigester is a technology that transforms organic waste (such as animal manure and food scraps) into biogas and biofertilizers, with several implications for Geography, particularly in ecosystem studies.

Geography education can address how biodigesters contribute to reducing organic waste, preventing its improper disposal in soil or water. The study of waste flows and the impact of improper disposal can be deepened within the context of sustainable solutions like biodigesters.

Figure 6: Biodigester in a rural area, municipality of Massapê



Source: *Author*

Given contemporary discussions on energy crises, efficiency, and resource conservation, biodigesters provide a renewable energy alternative that replaces fossil fuels. Geography can explore the distribution of energy sources locally and globally, the necessity of adopting clean and renewable alternatives, and the feasibility of implementing such technologies in different regional and local contexts.

Regarding soil and agricultural practices, biodigesters enable discussions on sustainable agriculture and biofertilizers. The biofertilizers produced improve soil quality, supporting the study of sustainable agricultural techniques and demonstrating how biodigesters enhance agricultural productivity while reducing environmental impacts, such as excessive use of chemical fertilizers and soil nutrient imbalances.

In rural areas, biodigesters can be incorporated into sustainable land management plans, particularly in agricultural communities. Concepts related to land use, crop types, and farming practices can be explored alongside the impact of biodigesters.

From an ecosystem perspective, biodigesters influence local ecological balance by processing organic waste, preventing soil and water contamination, and promoting environmental sustainability.

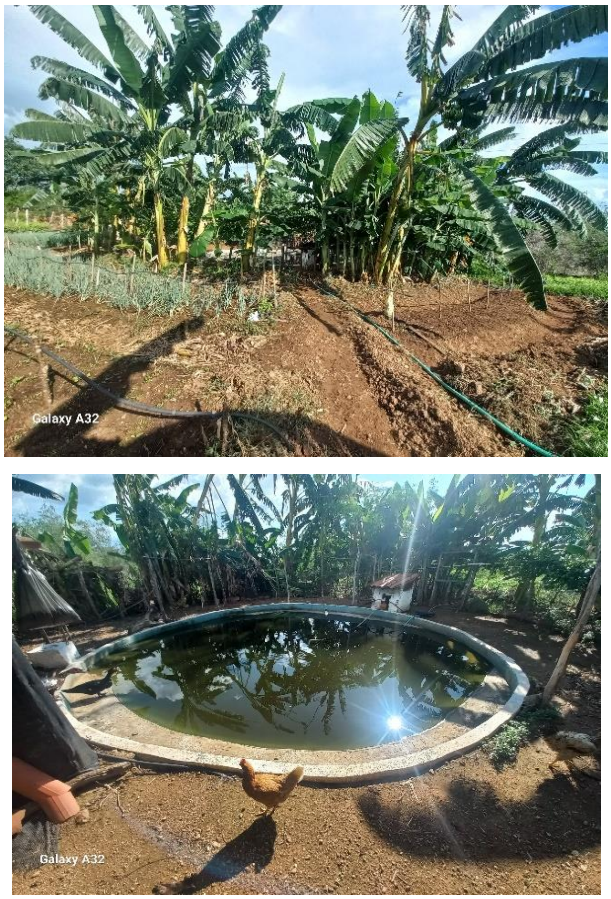
Geography education can integrate practical projects where students research and implement biodigesters in their communities (FALCÃO SOBRINHO et al., 2020), both in urban and rural settings. Environmental education becomes a tool for fostering awareness about responsible consumption, waste management, and adopting sustainable technologies.

The teaching of biodigesters also promotes interdisciplinarity, encompassing aspects of Geography, Science, Technology, and Economics, as the produced gas becomes a household resource for cooking.

MANDALAS

The Mandala system is essentially a new irrigation method focused on sustainability and active farmer participation. This system enables the cultivation of crops such as bananas, vegetables, and poultry farming, providing farmers with an additional source of income (MAGALHÃES et al., 2012).

Figure 7: Mandala in the São Domingos community, Sobral



Source: *Author*

Studying the circular arrangement of Mandala plots is crucial, as it offers wind protection and maximizes sunlight exposure—factors essential in semi-arid environments.

The Mandala system also facilitates soil conservation discussions, incorporating techniques such as contour planting and crop rotation, which address both physical and chemical soil characteristics.

Geographically, Mandalas provide opportunities for mapping their layout, introducing concepts such as scale, orientation, and location.

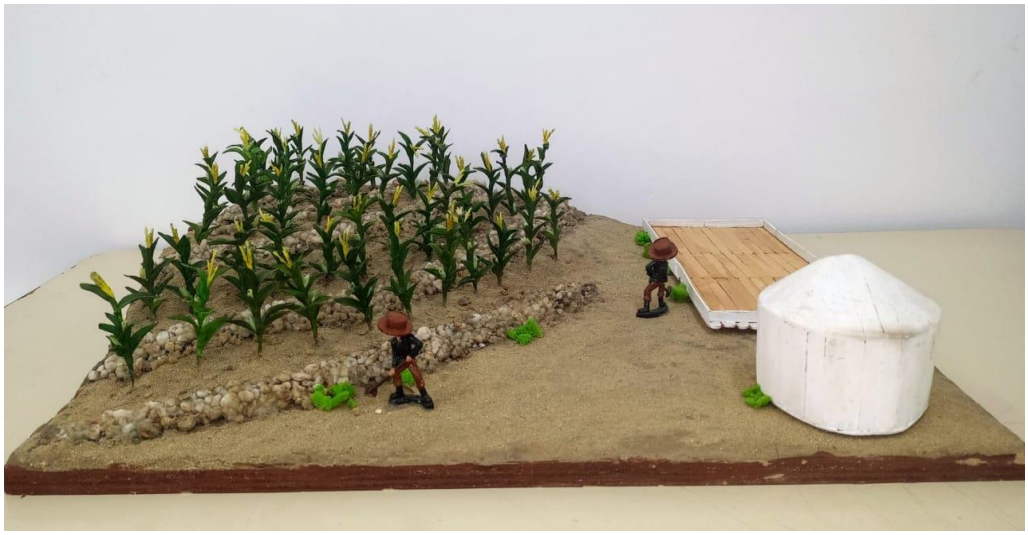
Interdisciplinary approaches can compare the financial costs of Mandala-produced crops with similar products available in local markets, fostering discussions on reducing dependency on external inputs and enhancing food autonomy.

LABORATORY ACTIVITIES

Semi-Arid Model

A model representing sustainable living in the semi-arid region highlights technologies such as plate cisterns and biodigesters. This representation integrates semi-arid adaptations using local resources, such as livestock waste, to produce biogas. It also emphasizes social technologies for meeting basic needs, including cooking and drinking, by capturing and storing rainwater for up to eight months of drought.

Figure 8: Models exhibited at the Semi-Arid Research and Extension Laboratory/UVA



Source: *Author*

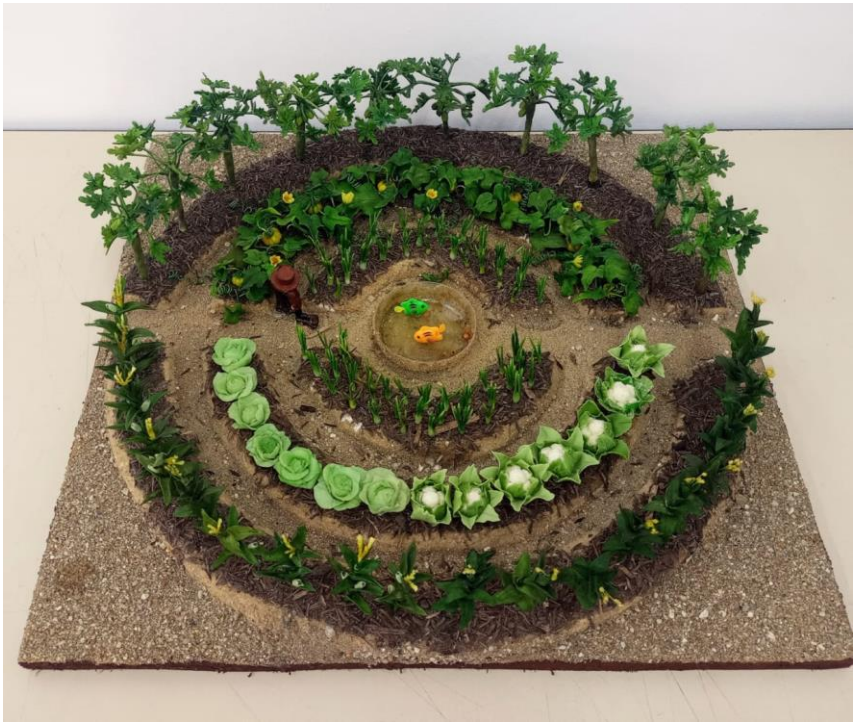
This educational model demonstrates the effectiveness of contour planting in preventing soil loss in semi-arid agricultural areas. Research has shown that conservation practices, such as contour planting combined with stone barriers, significantly reduce soil erosion, particularly in naturally erosion-prone soils like Litholic Neosols.

The construction of level stone barriers has proven to be an effective alternative for sediment retention and the management of the soil's natural stoniness. The viability of this technique is so significant that it has been expanded to non-experimental production areas, demonstrating the project's impact in extension activities as well.

In association with soil conservation practices, second-water technologies, such as the slab cistern, enable agricultural production during drought periods, contributing to water and food security. These technologies are designed exclusively for agricultural production and small-scale livestock farming, ensuring that small farmers can sustain their production and generate additional income.

In the classroom, the exploration of models representing the mandala system effectively illustrates its sustainable approach to family farming. This model is organized in concentric circles, emphasizing sustainability and the active role of the farmer in this system, allowing for the cultivation of crops such as banana trees, vegetables, and poultry farming. These agricultural activities provide farmers with an additional source of income.

Figure 9: Models exhibited at the Semi-Arid Research and Extension Laboratory/UVA



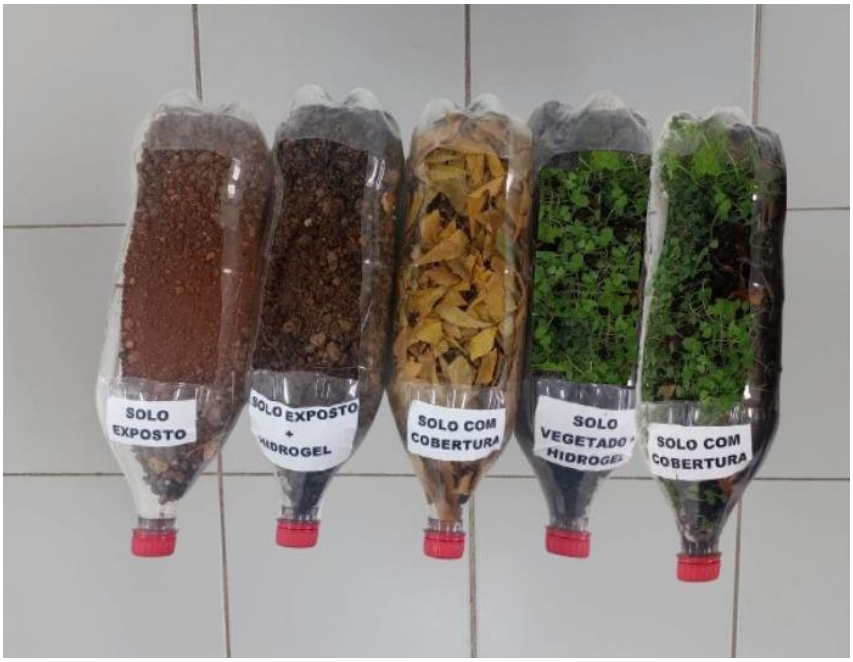
Source: *Author*

EROSION SIMULATORS

Soil degradation often stems from a lack of awareness regarding its characteristics and functions. Educational technologies for soil conservation aim to instill conservationist consciousness among students and communities, encouraging actions to protect soil and fostering a critical perspective on socio-environmental impacts.

Erosion simulators serve as practical educational tools, illustrating how unprotected soil is more susceptible to erosion due to direct rainfall impact, which dislodges soil particles.

Figure 9: Experiment exhibited at the Semi-Arid Research and Extension Laboratory/UVA



Source: *Author*

GRAY WATER REUSE

The Social Technology of Gray Water Reuse consists of a system designed to reutilize household water from showers, kitchen sinks, and laundry, which would otherwise be wasted. The system captures water through gravity flow, directing it into a preliminary filtration stage to remove solid residues and chemical contaminants. The second purification stage consists of a vermicomposting system, where earthworms play a crucial role in water treatment. After completing this process, the water becomes suitable for agricultural production.

Gray water reuse is closely linked to the teaching of Geography, particularly in the areas of water resource management, sustainability, and urban and rural planning. Gray water, which originates from domestic activities such as bathing, laundry, and dishwashing, can be treated and reused for non-potable purposes, including irrigation, cleaning, and sanitary systems (COSTA FALCÃO et al., 2019).

From a geographical perspective, the study of natural resource distribution and management highlights gray water reuse as a conservation strategy that addresses water

scarcity issues. This approach encourages the development of sustainable solutions applicable in various environmental and social contexts**.**

FINAL CONSIDERATIONS

Contextualized education in the semi-arid region, focusing on Geography and its natural components, is a crucial strategy for fostering territorial appreciation and developing students' environmental awareness.

Social technologies, such as cisterns and subterranean dams, emerge as innovative and effective educational tools, bridging theoretical knowledge with real-world applications. These approaches empower students to understand semi-arid processes practically while equipping them with the skills necessary to promote local sustainability and development.

By valuing traditional knowledge alongside scientific approaches, this proposal enhances Geography education, fostering a more meaningful and contextualized learning experience. This integration ultimately contributes to shaping critically engaged citizens committed to sustainability and regional development.

REFERENCES

AB'SABER, A. N. Sertões e sertanejos: uma geografia humana sofrida. **Estudos Avançados.** V. 13 n.36. São Paulo, 1999.

ALMEIDA, C.L.; FALCAO SOBRINHO, J. Convivência com o semiárido a partir do uso de cisternas de placas no município de Frecheirinhas, estado do Ceará, Brasil. **Revista Agua y Territorio**, Jaén 15 (2), 89-100, 2020.

ASA, 2002: **Programa da Formação e Mobilização Social para a Convivência com o Semiárido: um milhão de cisternas rurais (P1MC).** Recife (Brasil), mimeo.

BERTALANFFY, L. V. **General Theory of Systems**. New York, George Braziller. 1968.

BRASIL. [Constituição (1988)]. Constituição da República Federativa do Brasil de 1988. Brasília, DF: Presidência da República, [ano]. Disponível em: http://www.planalto.gov.br/ccivil_03/Constituicao/Constituiçao.htm

BRASIL. A Lei de Diretrizes e Bases da Educação Nacional (LDBEN) é a Lei nº 9.394, de 20 de dezembro de 1996. Brasília, 2006.

BUCKLEY, W. ***Sociology and the Modern Systems Theory****. Englewood Cliffs. 1967, New Jersey, p. 227.*

CARNEIRO, C. D. R.; TOLEDO, M. C. M.; ALMEIDA, F. F. M. Dez motivos para inclusão de temas de Geologia na Educação Básica. **Revista Brasileira de Geociências**,

São Paulo, v. 34, n. 4, p. 553-560, 2004. Disponível em: https://www.ppegeo.igc.usp.br/index.php/rbg/article/view/9787. Acesso em: 6 maio 2023.

CARVALHO, B. L.; FALCÃO SOBRINHO, J. Social Consumption and Production Technologies in the Context of the Landscape of the Hillside Surface in the Municipality of Mucambo-Ce. Journal of Geography, **Environment and Earth Science International**. 25(1): 33-45, 2021.

CAVALCANTE, L.V. Convivência com o semiárido e ducação contextualizada: interseções no ensino-aprendizagem de Geografia. In: FALCÃO SOBRINHO, J.; OLIVEIRA, C.J.; ROSS, J.L.S. **A Natureza e a Geografia no Ensino das Temáticas Físico-Naturais no Território Brasileiro**. LetraCapital, Rio de Janeiro, 2023.

COSTA FALCAO, C.L.; FALCÃO SOBRINHO, J.; SILVA, F.E.R., BRANCO, M.L.X.C.; OLIVEIRA, J.M.S. Education and Sustainability: A Pedagogical Experience for the Interaction with the Brazilian Semiariad Region. **Creative Education**. Vol.10, n.3, 2019

CLAVAL, P. **Evolución de la Geografia Humana**. Barcelona, OikosTau S. A. Ediciones. 1974.

COPATTI, C. O pensamento pedagógico-geográfico no ensio escolar de geografia: possibilidades para o estudo das temáticas fiscio-naturais. In: FALCÃO SOBRINHO, J.; SOUZA, C.J.O; ROSS, J.L.S. **A Natureza e a Geografia no ensino das Temáticas Físico-Naturais no Território Brasileiro**. LetraCapital, Rio de Janeiro, 2023.

COSTA FALCAO, C. L.; FALCÃO SOBRINHO, J. A obra de Goethe e o viajante naturalista Humboldt: à prática científica do trabalho de campo. **Ciência e Natura.** 38 (3), 1238-1245, 2016

COSTA FALCAO, C. L.; FALCÃO SOBRINHO, J. Educação em solos: abordagens teóricas e metodológicas. **Acta Geográfica**, 2024.

COSTA, A.C.G.. **O professor como educador.** Salvador: Luís Eduardo Magalhães, 2001.

DRUMOND, M.A.; KILL, L.H.P.; RIBASKI, J.; AIDAR, S.T. **Caracterização e Usos das espécies da Caatinga**. EMBRAPA Semiárido, 2016.,

FALCÃO SOBRINHO, J.; ALVES, V.C.; MAGALHÃES, M.M. NASCIMENTO, G.R.; PINTO, E.L.L. The Use of Digester and the Spread of Sustainable Actions in Semiarid Region of Ceará. **Journal of Management and Sustainability**. Vol. 10, n. 2. 2020.

FALCÃO SOBRINHO, J.; SOUZA, C.J.O; ROSS, J.L.S. **A Natureza e a Geografia no ensino das Temáticas Físico-Naturais no Território Brasileiro**. LetraCapital, Rio de Janeiro, 2023.

FALCÃO SOBRINHO, J. Ethnoknowledge and Field Class Activities in Landscape Understanding. **Journal of Education and Learning**. Vol. 14, No. 1; 2025

FERNANDES, L.E.S.; SANTOS, M.N.F.; SARAIVA, M.C. **Biodigestor compacto**. CETRA, 2023.

FIGUEIREDO, J.B.A. Saberes Curriculares Ecorrelacionados para uma Educação Contextualizada no Semiárido. In: FALCÃO SOBRINHO, J.; CAMPANI, A.; FONSECA, A.N.D.; SILVA, R.M.G. **A Educação no Ambiente Semiárido**. Edições Universitárias. 2012.

IRPA. **O barreiro trincheira**. 8º Simpósio de Captação e Manejo de Água da Chuva em Campina Grande, 2012. https://irpaa.org/publicacoes/18/artigos/o-barreiro-trincheira.

INSA. **O semiárido brasileiro: riqueza, diversidades e saberes**. MCT, 2013.

LIMA, E. C. Análise e Manejo Geoambiental das Nascentes do Alto Rio Acarau: Serra das Matas – Ce. **Dissertação de Mestrado**, UECE, 2004.

MAGALHÃES, L. C. M.; COSTA FALCÃO, C. L.; FALCÃO SOBRINHO, J. O sistema mandala como alternativa para uma melhor convivência com o semiárido,implantado no assentamento São João no Município de Sobral-CE. **Revista Homem, Espaço e Tempo**, v.6, n.1. 2012.

NEGEV, A.;GIBSON, S.**Archaeological encyclopedia of the Holy Land**. Continuum International Publishing Group, 2001. Editorial Reviews.

JORGE, M.C.O.; GUERRA, A.T. O papel das comunidades locais e a educação ambiental com enfoque na valorização dos solos. In: FALCÃO SOBRINHO, J.; SOUZA, C.J.O; ROSS, J.L.S. **A Natureza e a Geografia no ensino das Temáticas Físico-Naturais no Território Brasileiro**. LetraCapital, Rio de Janeiro, 2023.

MUNIZ, F.G.L.; CARACRISTI, I. Urbanização, conforto térmico e análise sazonal microclimática da cidade de Sobral (CE). **Revista da Casa da Geografia de Sobral (RCGS),** 2020.

OJIMA, RICARDO; FUSCO, WILSON. "Migrações e nordestinos pelo Brasil: uma breve contextualização", p.11-26. In Ricardo Ojima, Wilson Fusco. **Migrações Nordestinas no Século 21 - Um Panorama Recente**, São Paulo: Editora Edgard Blücher, 2015.

PELOGGIA A.U.G. 1998. **O Homem e o Ambiente Geológico: Geologia, Sociedade e Ocupação Urbana no Município de São Paulo**. São Paulo: Xamã, 271 p.

RODRIGUES, C.; LUZ, R.A.; SIMAS, I.T.H. Antropoceno e mudanças geomorfológicas: sistemas fluviais no processo centenário de urbanização de São Paulo. Revista do Instituto Geológico, São Paulo, 40 (1), 105-123, 2019.

RESAB. **Rede de Educação do Semiárido Brasileiro.** https://irpaa.org/noticias/2262/rede-de-educaa-sect-a-pound-o-do-semia-iexcl-rido-brasileiro-celebra-20-anos-em-defesa-de-pola-shy-ticas-educacionais-contextualizadas. 2023.

SANTOS, M.C. **Solos do Semiárido do Brasil**. Carderno do Semiárido. Conselho Regional de Engenharia e Agronomia de Pernambuco. - v. 10. EDUFRPE, 2017.

SILVA. A. F. B., M.F. FIGUEIREDO, E. B. SOUZA, J. B. S.; NASCIMENTO, J. M. R. Etnobotânica e educação não formal: construindo uma coleção didáticadas espécies nativas utilizadas pela comunidade do sítio São Gonçalo, Meruoca, Ceará. **International Journal Semiarid**, 2024.

SILVA, I. G.; ASSIS, T. M. F.; SILVA, L. A.; LOPES, D.V.; REIS, J. S. Geociências e educação ambiental no semiárido: estudo de caso na reserva ecológica Olho D'água das Onças. **International Journal Semiarid.** Ano 5. Vol. 5, pp. 465 – 476, 2022.

SILVA. F. E. R.; FALCÃO SOBRINHO, J.; COSTA FALCÃO, C. L.; BRANCO, M. L. X. C. A água e sua importância para o sertanejo no ambiente semiárido cearense. **Revista Equador (UFPI)**, Vol. 8, Nº 2, p. 186 – 208. 2019.

SOUSA, R. M. L. ; ARAUJO, R. L. ; NUNES, S. C. L.; FALCÃO SOBRINHO, J . Ethnoknowledge Through Ethnogeomorphology and Geography Teaching: First Approaches. **Journal of Education and Learning**. V. 12, p. 28, 2023.

SRH - Secretaria dos Recursos Hídricos.. **Barragem Subterrânea.** PRODHAM – Projeto de Desenvolvimento Hidroambiental do Estado do Ceará, v. 10. 2010.

VELOSO, K. **Cultura Viva do Nordeste**. Fundação Joaquim Nabuco, 2021.

VENTURI, L. A. B. Recurso natural: a construção de um conceito. **GEOUSP - Espaço e Tempo**, São Paulo, Nº 20, pp. 09 - 17, 2006.