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ANALYSIS OF THE GEOMORPHOLOGICAL COMPARTMENTATION OF THE JAIBARAS SUB-BASIN - CE FOR THE IMPLEMENTATION OF SOCIAL TECHNOLOGIES FOR COEXISTENCE WITH THE SEMI-ARID

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ABSTRACT
The present work aimed to analyze the geomorphological compartments of the Jaibaras-CE Sub-basin, in order to understand the elements that make up the configuration of the geomorphological compartments and from that to provide subsidies for the implementation of social technologies of coexistence with the semiarid. The methodology was a bibliographic, exploratory research. The results showed that for areas of residual massifs, the most appropriate technologies are the Cistern-Calçadão, Cisterna - flash flood, due to the slope of the slopes and stone tank that work to capture rainwater and stone cord, for presenting rocky terrain and slabs, suitable for construction. In rural surface environments, the most suitable technologies are Integrated and Sustainable Agroecological Production type – PAIS and stone strings. In sedimentary environments, technologies such as Mandala, Calçadão Cistern, Underground Dams, Barreiro – Trench, Runoff Cistern and PAIS are proposed.
Keywords: Semiarid. Social technology. Jaibaras sub-basin, Ceará.

ANÁLISE DA COMPARTIMENTAÇÃO GEOMORFOLÓGICA DA SUB-BACIA JAIBARAS – CE PARA IMPLANTAÇÃO DAS TECNOLOGIAS SOCIAIS DE CONVIVÊNCIA COM O SEMIÁRIDO

Resumo: O presente trabalho teve como objetivo analisar as compartimentações geomorfológicas da Sub-bacia Jaibaras-CE, com intuito de compreender os elementos que compõe a configuração dos compartimentos geomorfológicos e a partir disso fornecer subsídios para implantação de tecnologias sociais de convivência com o semiárido. A metodologia tratou-se de uma pesquisa de cunho bibliográfico, exploratória. Os resultados apontaram que para áreas de Maciços residuais as tecnologias mais adequadas são as Cisterna-Calçadão, Cisterna – enxurrada, devido a inclinação das vertentes e tanque de pedra que funcionam para captação da água da chuva e cordão de pedra, por apresentar terreno rochoso e lajedos, adequados para construção. Em ambientes de superfície sertanejas as mais adequadas são tecnologias do tipo Produção Agroecológico Integrada e Sustentável – PAIS e cordões de pedra. Já em ambientes

sedimentares propõe-se tecnologias do tipo Mandala, Cisterna Calçadão, Barragens Subterrâneas, Barreiro – Trincheira, Cisterna de enxurrada e PAIS.
Palavras-chave: Semiárido. Tecnologia sociais. Sub-bacia Jaibaras, Ceará.

INTRODUCTION

The Brazilian Northeast, inserted in the semi-arid climatic region, has as main characteristics low rainfall, rivers, mostly intermittent, and caatinga vegetation in a large part of the territory. The physical limitations presented in the northeastern semi-arid environment have had repercussions for more than a century, plaguing the needy population with long periods of drought, which requires differentiated attention from public policies for this region (ALMEIDA; FALCÃO SOBRINHO, 2020).

The first public policies for the Northeast region were created from a perspective of "drought combat" with the implementation of hydraulic solutions and only from the beginning of the 1990s, debates arise for new practices aimed at the problem of the semi-arid environment, with the perception that it is not possible to end the problem of drought, but it is possible to live in harmony with the environment through the practices of coexistence with the semi-arid region.

In 2000, through social movements, NGOs, unions and the Articulation of the Brazilian Semi-Arid Region – ASA, the first training and social mobilization program for coexistence with the semi-arid region was created: One Million Rural Cisterns – P1MC. It is a simple technology for capturing rainwater to supply the main basic needs of families. The materials for the construction of the cistern are accessible and low-cost, made from pre-molded cement slabs built close to the homes by the residents of the communities, trained by the program.

In order to expand the water storage of families, rural communities and traditional populations to meet the needs of plantations and animal husbandry, in 2007 ASA implemented the program Uma Terra e Duas Água, the P1+2, in the semiarid region. The program is a possibility for sertaneja families to obtain interdependence through technology, promoting work and income for farmers.

In recent times, coexistence with the semiarid has become possible through governmental and non-governmental action with the insertion of social technologies and social programs, but it is still not enough for the sertanejos to have a harmonious relationship with nature and obtain environmental interdependence. , social, economic, cultural and political. Barbosa (2016) emphasizes that, so that coexistence with the semi-arid region is actually achieved, the population residing in this type of climate will acquire an environmental awareness and, from that, environmental sustainability, economic growth and social development will be obtained. without letting there be a balance with nature.

There are significant numbers of research related to social technologies of coexistence with the semiarid for the area chosen as an analysis cut, pointing out its benefits since

its implementation. Among them, Almeida and Falcao Sobrinho (2020), Carvalho and Falcão Sobrinho (2021); Falcao Sobrinho, 2020a and Gomes et. al (2021) among others.

However, the number decreases when the geomorphological compartmentalization is considered as an analysis criterion for the implementation of social technologies for coexistence with the semiarid region. In this sense, the present work sought to carry out an analysis considering as a criterion the geomorphological compartmentalization of the Jaibaras Sub-basin, in order to understand the elements that make up the configuration of the geomorphological compartments and from that to provide subsidies for the adequate implementation of social technologies for each compartmentation. of the study area.

In this way, it is justified to study the aforementioned area, because it is an extremely expressive area containing a great diversity of natural environments and also composing the most important tributary of the left bank of the Acaraú River, comprising nine municipalities in the state of Ceará in the total of 184, in which a large part is located in the semi-arid climatic region, with a poorly distributed rainfall regime in time and space.

The research also had the aid of geoprocessing, an essential tool for carrying out the research. Thus, it was possible to gather the necessary data for the elaboration of maps of geology, geomorphology and declivity, in the scale 1: 250,000, which provided subsidies in the understanding of the relationship between the compartmentalization of relief and social technologies.

METHODOLOGY

The guiding methodology for the present work was a bibliographic, exploratory research and data collected on the website of the institution Articulação no Semiárido Brasileiro (ASA). According to Praia, Cachupuz and Pérez (2002), bibliographic research is based on materials that have already been constructed, which includes scientific articles published in academic journals. In this way, literature constitutes an essential component to investigate various scientific themes and its set of procedures to support the theoretical discussion and direction that the researcher can follow.

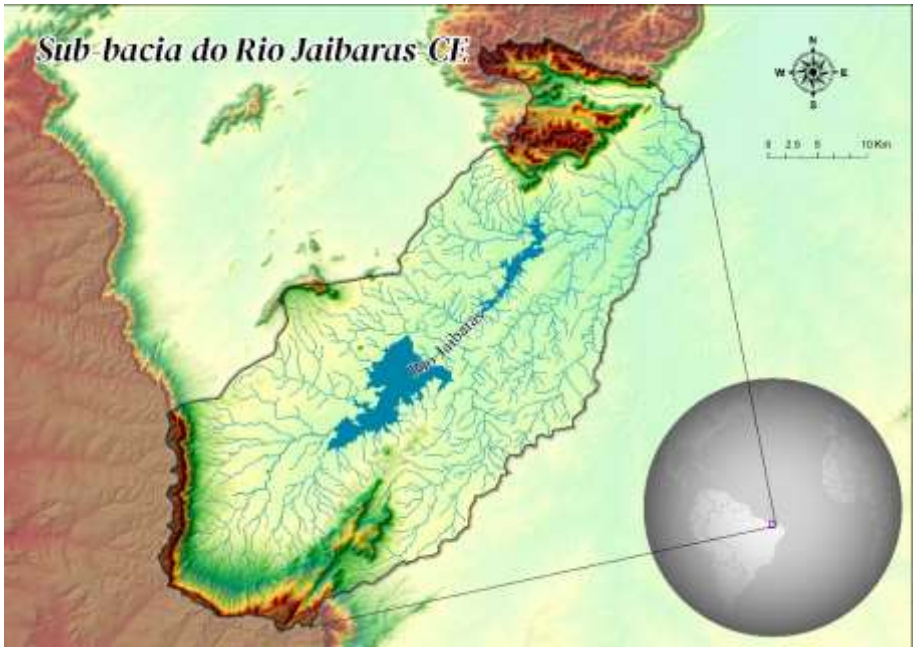
For this study, it follows the methodological principle of Libault (1971), dividing the research phases into a compilation level, which corresponds to the first stage where data related to the topic are collected, the correlative level that corresponds to the stage of comparing the data already collected and establish analyzes of the data already collected and the normative level corresponding to the results.

As a delimitable spatial unit for the application of the research, the Jaibaras River Sub-basin is adopted, located in the northwest portion of the State of Ceará, comprising an extension of approximately 1,567 km², being considered one of the most important sub-basins of the hydrographic basin. of the Rio Acaraú. The research area has, in most of its territory, shallow and stony soils, with low agricultural productivity, which,

associated with the use of inappropriate agricultural practices, accelerates the process of soil erosion, consequently, influencing the forms of the relief.

The sub-basin is located in the semi-arid morphoclimatic domain, characterized by rainfall irregularity in time and space, with rainfall concentrated between the months of January and May and the rest of the months with little and/or no rainfall (ALMEIDA, 2017; FALCÃO SOBRINHO). 2020b).

Figure 1: Location of the Jaibaras River Sub-basin



Source: SRTM. Elaboration: Gomes, 2021

Based on the theoretical and methodological support used, a survey of information was carried out regarding the identification and characterization of the sectoral components of the Sub-basin such as: geology, geomorphology, soils and slope, to subsequently assist in the understanding of the dynamics of the morphology of the basin. importance for more adequate implementation of social technologies.

In the second moment, a bibliographic review was carried out, which is fundamental for any scientific research. Thus, it was consulted in monographs, dissertations, theses, books and periodicals the readings related to social technologies of coexistence with the semiarid, geomorphology of Ceará and geotechnologies, which subsidized its development. The readings and discussions involved references related to the studies of the works of authors such as Almeida (2017), Asa (2019), Santos (2015), Silva (2004), related to theories of social technologies of coexistence with the semiarid and authors with studies of practices in this environment Magalhães et al (2012), Falcao Sobrinho et al (2015; 2017; 2019; 2021), , and Florenzano (2011), alluding to mapping and geotechnologies such as remote sensing techniques and geographic information system-GIS.

The next step that followed was the technical and operational treatment of the research, in order to explain the methodological procedures of the organization and elaboration of the cartographic products made for that research.

DATA PROCESSING FOR THE ELABORATION OF THE THEMATIC MAPPING

The cartographic material of the area in question was made using geoprocessing techniques, using the ArcGIS Pro software with an original and free student license and the SIG Quantum Gis 3.16, with a free license. For the elaboration of thematic maps in the identification of relief units of the Jaibaras Sub-Basin, a scale of 1: 250,000 was adopted. The geocartographic material used as a database for making the maps were the following:

In developing the geology map, it used information from the geological map of the state of Ceará (CPRM, 2003 and 2020), as well as the vector files made available by them to prepare the final product.

Regarding the making of the geomorphology map, we based on the principles of Souza (2000) and the Institute of Research and Economic Strategy of Ceará - IPECE (2019), in this way, six geomorphological compartments were defined for the study area: the surface sertaneja, the humid mountain range, the dry mountain range, the Ibiapaba plateau, the inselbergs and the river plain.

For the soil classification map, the technical procedures of the Brazilian Soil Classification System, developed by the Brazilian Agricultural Research Corporation - EMBRAPA, and also the IPECE database (2019) were adopted.

In the preparation of the slope map, the slope class proposed by Ross (1992) was considered with adjustment in the intervals for the study area, as can be seen in the table below:

Table 1 - Slope Classes in Percentage

CLASSES	DECLIVITY RANGE (%)	RELIEF CHARACTERISTICS	RELIEF FRAGILITY
A	0 % - 3 %	Flat and Smooth	Very Weak
B	3 % - 8 %	Soft Wavy	Weak
C	8 % - 20 %	Wavy	Average
D	20 % - 40 %	Strong Wavy	Strong
E	40 % - 80%	Mountainous/Cliff	Very Strong

Source: Adapted from Ross (1992)

THE TECHNOLOGIES OF COEXISTENCE WITH THE SEMIARID

At the beginning of the 1980s, the first conceptions of coexistence with the semiarid region emerged, the initiatives started from research center actions, such as that of the Embrapa company and non-governmental actions, which began to develop projects in the areas of water, productive and sociocultural resources. (SILVA, 2004). After these first initiatives, in the 1990s, the Articulation of the Brazilian Semiarid Region (ASA) emerged, further strengthening the other associations linked to the process of living with the semiarid region.

Almeida and Falcão Sobrinho (2020) point out that, from the moment that the perception of coexistence with the semiarid arises, new forms of policies occur, with

decentralized organization when compared to the centralization of decisions in times of "drought combat".

Social movements, NGOs, trade unions and ASA itself created the first training and social mobilization program for living with the semiarid region: One Million Rural Cisterns – P1MC. Cisterns have come to play an important role in rural families, as they were designed to be built close to homes to capture rainwater into the reservoir, which has the capacity to store up to 16,000 liters, ensuring six to eight months of water security. , food and nutrition.

The studies carried out by Almeida in the municipality of Frecheirinha, in 2017, located in the northwest of the state of Ceará, pointed to improvements in the quality of life of the beneficiaries of the P1MC program, such as optimizing the time to fetch water in distant places and reducing significant number of diseases transmitted by contaminated water.

The second technology implemented in the semiarid region was the One Land and Two Water program, the P1+2. The program was based on the possibility for sertaneja families to obtain interdependence through technology, as this, in turn, will offer work and income to farmers. Gomes et., al (2021) in their studies on the program Uma Terra e Duas Águas, the P1+2, showed the contributions in the sustainable use of the environment and in the improvement in the food and income of the families benefited with the technologies. From this program, other technologies were derived that were implemented in the Brazilian semiarid region, benefiting millions of families. Listed just below:

Cistern-Calçadão (figure 1), the model has the following structure, a cistern with a capacity of 52 thousand liters, a 200 m² sidewalk built on the ground, pipes that will drain water into the cistern, which are located in the lowest ground. The boardwalk can also be used for drying beans and corn, among other uses. The water stored in the reservoir is used for irrigation of productive backyards and for raising animals (ASA, 2019). The research carried out by Barbosa et., al (2015) on the importance of sidewalk cisterns in the semi-arid region of Paraíba, pointed out that after the insertion of this type of social technology, the quality of life of the surveyed families has improved, with the opportunity to raise animals, produce vegetables and legumes free of pesticides for own consumption and commercialization.

Underground dam (figure 1) is a technology built in areas of shallows, streams and streams that form in rainy seasons. For the construction of the dam, it is necessary to excavate to the impermeable layer, the bedrock. The open channel has to be lined with a plastic tarp and then closed. It is necessary to build a spillway to remove excess water. And for water and food security, during periods of drought, wells are made approximately 5 m away from the dam. In this way, ensuring that families produce for an entire year (ASA, 2019). Underground dams arise with the purpose, in addition to storing water during the dry months, to fix man in the field, providing him with a subsistence production on his property. In studies carried out by Sousa et. al (2014) concluded that, with the necessary care since its implementation, the technology has been successfully used, enabling agricultural and livestock farming, reducing dependence on rain.

The stone tank (figure 1), the model has accessible materials for its construction. Usually in areas where there are slabs on which masonry walls are built that work in capturing rainwater. Stored water is used for animal consumption, crops and domestic purposes (ASA, 2019). It was found in the research developed by Pereira et., al (2018) that stone tanks have contributed to promoting an increase in water supply in the dry season, meeting the main needs of families, in addition to being a sustainable technology, without causing impacts to the environment. environment.

Figure 1: a) Boardwalk cistern b) Underground dam c) Stone tank

Source: GOMES (2019), EMBRAPA (2018), Living Semiarid (2021).

Water pump (figure 2), is used to extract water from deactivated tabular wells. The technology has the following equipment, a flywheel, which when turned pulls large volumes of water (ASA, 2019). As with other social technologies, Silva and Barros (2016) states that popular pumps have promoted access to quality water for families in the Brazilian semiarid region throughout the dry season for various uses, such as: food production, consumption of animals and domestic use.

Figure 2: Water pump

Source: ASA (2021).

Barreiro – trench (figure 3) just like other social technologies of coexistence with the semi-arid region, it is simple, common and low-cost to implement, accessible to the population. For construction, it must be a flat land and close to the production

perimeter. The structure of the barrier - trench has: long and narrow tanks and depths with a capacity of 500,000 liters, this makes evaporation less and allowing stored water to last for months without precipitation (ASA, 2019). The study carried out by Silva and Barros (2016) in the semi-arid region of the state of Rio Grande do Norte, showed that the main uses of water stored in the trench barreiro have been used for watering animals and for irrigation of plantations, in addition to meeting the needs of more than one family, especially during the dry season.

Barraginha (figure 3) is a shell-shaped technology that captures water during the rainy season. The model has the following structure, two to three meters deep, with a diameter between 12 and 30 meters. It is recommended that the construction of the barraginha be carried out next to each other, so that when one bleeds, the water supplies the next (ASA, 2019). According to Silva and Barros (2016) the barraginha contributes to alleviate problems such as floods and erosion, retaining silted and polluting materials, in addition to the sustainable use of rural activities.

Cistern – runoff (figure 3) has a structure with a cistern with a capacity of 52,000 liters, built into the ground, with only the conical cover on the surface, decanting boxes and pipes being visible. The structure is mounted on a plot of land, where it will be used to capture the water and drain it into the decanter boxes that are in sequence and that will perform the filtering role and then take the water into the reservoir. Stored water has as its main objective the healthy and sustainable production of organic food and the raising of small animals (ASA, 2019). The study developed by Gomes et al (2021), in a community in the municipality of Sobral, northwest of Ceará, it was observed that the relief characteristics maintained a reciprocity relationship with the runoff cisterns providing conditions for water storage during the period of drought and production of food for consumption and commercialization of the family.

Figure 3: a) Barreiro - trench b) Barraginha c) Runoff cisterna

Source: MDS (2021), EMBRAPA (2018) and GOMES (2019)

The conservationist practices called agroecology, which has been presented as one of the solutions for soil conservation, in addition to providing farmers with large-scale production during the twelve months of the year, such as the following systems: the mandala system, PAIS and cords of stone.

RESULTS

According to the study carried out in the Jaibaras sub-basin, the main environmental components (geology, geomorphology, soils) found in the research of geomorphological

analysis of the area under study will be described below to provide subsidies for the discussion of the geomorphological analysis of the sub-basin Jaibaras for the implementation of social technologies. According to Gomes et. al (2021) the integrated study allows us to understand how the relationships of the elements that make up the natural landscape occur and for this understanding, it requires the observation and analysis of the landscape.

The analysis and knowledge of the geology of a given area is essential to provide elements for understanding the organization of the drainage pattern and the availability of groundwater. In addition, the combinations of information with other geoenvironmental elements provide subsidies for understanding the relief and its impact on other components of the landscape (COSTA, 2017). In this way, the discussions were based on the integrated analysis of the elements that make up the natural landscape of the researched area, and from the understanding of these natural aspects, it made it possible to propose which technologies are most suitable for the environmental geomorphological compartments of the Jaibaras River Sub-basin.

The territorial area under analysis permeates over three geomorphological structures with peculiar properties, corresponding to the compartments, Massif Residual Humido da Meruoca, Surface Sertaneja and Plateau Sedimentar da Ibiapaba, comprising nine municipalities in the state of Ceará, as shown in the following table.

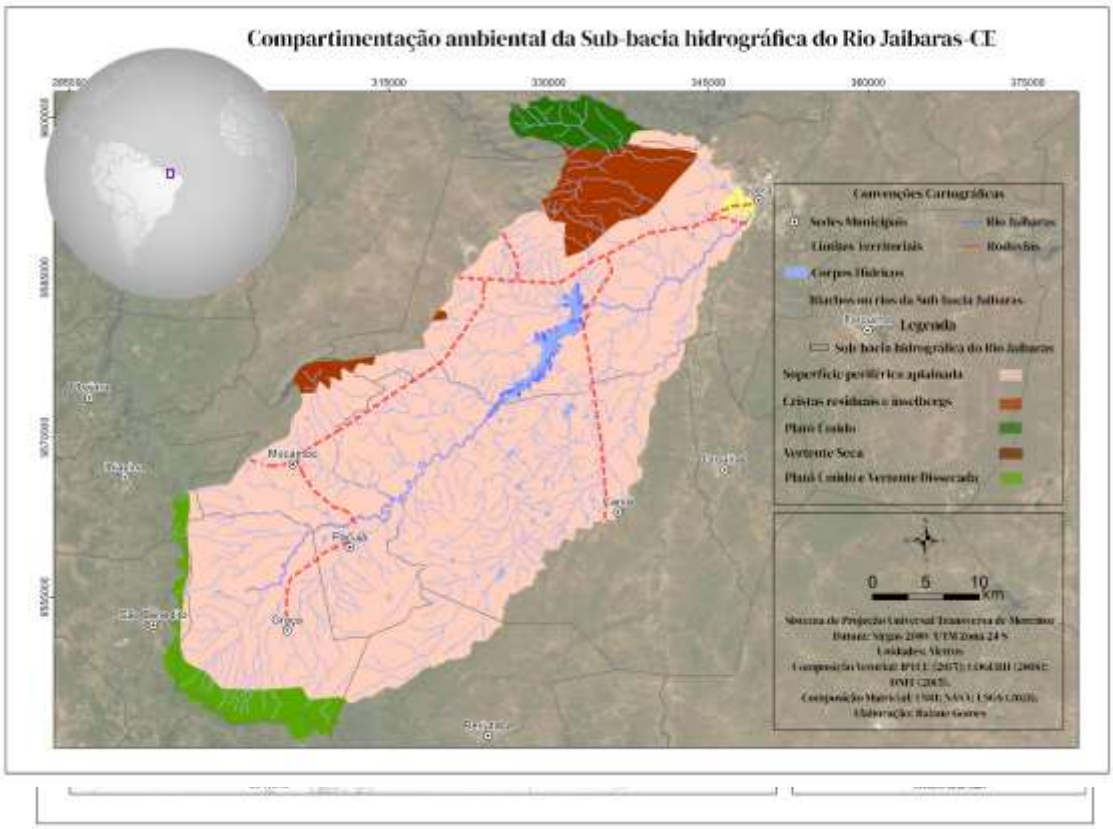
Table 2- Municipalities bordering the Jaibaras River Hydrographic Sub-basin

County	Total area of the municipality	Total area bathed by the Jaibaras River Sub-basin (%)
Alcântaras	138, 605	20
Cariré	756, 875	58
Graça	281, 872	99
Ibiapina	414, 938	2
Meruoca	149, 845	15
Mucambo	190, 602	71
Pacujá	76, 128	100
Reriutaba	383, 319	22
Sobral	2, 122, 897	23

Source: IBGE (2017) and GOMES (2011).

The geological and geomorphological aspects (figure 4) are highlighted in this analysis, as they were elementary in understanding the dynamics of the elements that make up the landscape. Knowledge of lithology is important because, according to Almeida (2017), it influences the process of soil formation, depending on the strength of the materials (rock hardness), the weathering process can act in different ways, in terms of time, in the fragmentation and decomposition of rock material.

Figure 4 - Spatialization of geomorphological compartments and Spatialization of units



geological features of the Jaibaras River Sub-basin

Source: CPRM, 2020, IPECE, 2015. Elaboration: Gomes, 2022

In corroboration, Costa (2017) highlighted that geological conditions, together with climatic variables, are relevant variables for understanding the relief and its influence on other landscape components, such as the soil and, consequently, the vegetation. Accordingly, Costa Lima et al., (2007), depending on the type of rock, the soils can be more or less sandy and clayey, and depending on the amount of nutrient elements in each rock, the soils can be fertile or poor.

In this way, the understanding of the configuration of the environmental components in the landscape is an important factor for the incorporation of social technologies of coexistence with the semi-arid region, since the knowledge of the local reality allows the integration of greater Social Technologies with the environment.

The main social technologies present in the semi-arid region of Ceará are the cisterns made of plates and polyethylene for human consumption. These cylindrical reservoirs have the capacity to store 16,000 liters of water, allowing a family to have their needs met during the dry season, which lasts around 7 to 8 months. Around 121 municipalities in the state of Ceará benefited from a total of 184, serving around 175 thousand families (SDA, 2022).

Another program implemented in Ceará was P1 + 2, which, in addition to storing rain for human consumption, aims to ensure access and sustainable management of land and

water, contributing to water, food and nutritional security for families. This program, water for production, also aims to generate income for farming families. According to Andrade and Queiroz, 2009, p. 49 “the one land and two waters program, developed in 26 semi-arid territories, intends to intensify, consolidate and radiate experiences with social technologies of access and productive management of land and water, with the use of existing social dynamics integrated with ASA initiatives”.

Families to benefit from the programs must meet the basic requirements, they are always those included in the single registry for social programs - cadÚnico, or women as head of the family, children from zero to six years of age; children and adolescents attending school and adults aged 65 and over (ASA, 2013). In order to choose the most appropriate technology, some characteristics of the environment in which the families are inserted are taken into account, such as rock formation (geology) and the type of activity to be developed (ASA, 2013).

The municipalities that comprise the Jaibaras River Sub-basin were covered by the programs developed by ASA Brasil, the P1MC, for human consumption and domestic activities and the P1 + 2, for food production, promoting food and nutritional security. and income generation.

However, it was observed that some municipalities had greater investments with the implementation of programs for coexistence with the semi-arid region, through the action of the State Government of Ceará, executed by the Secretariat of Agrarian Development (SDA) and Ematece. The municipalities benefited were Sobral, Reriutaba and Cariré, which were provided with plate cisterns, productive backyards, flood cisterns and underground dams (SDA, 2012).

Figure 5: Social technologies of P1 + 2 in Ceará in 2019

Source: ASA, 2022.

The territorial area that makes up the Jaibaras Sub-basin is located almost entirely in the domain of the flattened surface, under the crystalline basement configured as reliefs that are less resistant to weathering and erosion, giving rise to shallow, shallow and stony soils, with fertility ranging from fertile to non-productive. In this way, considering these

assumptions, an analysis of the relief was carried out, correlating with the social technologies of coexistence with the semi-arid region, in order to propose the most appropriate technologies to be implemented in the study area.

Among the geomorphological units belonging to the Jaibaras River Sub-basin, the Sertaneja Surface has the greatest spatial representation, with an extension of approximately 56 km. The reliefs are under the crystalline basement, presenting rocks belonging to the Alluvial Deposits groups, Serra Grande group, Jaibaras group, Ubajara group, Meruoca Granitoide Suite, Ceará group and Canindé do Ceará Complex. The topography of the compartment consists of flat or slightly undulating reliefs at altitudes around 58 - 350 meters, with slopes below 8% (figure 17), associated with weak to very weak fragilities.

These conditioning elements allow the incorporation of technologies such as Integrated and Sustainable Agroecological Production - PAIS, which has the same structure as the mandala system, but with a difference, instead of the water reservoir, there is a central chicken coop, followed by three circular terraces that prevent soil loss due to erosion, so both vegetables and fruits can be grown. The soils that comprise this compartment have low humidity and low groundwater retention capacity, as well as high susceptibility to soil erosion. . According to Azevedo et al., (2009), these technologies provide a strategy, which enables the integration between agricultural crops and animal husbandry, allowing the recycling of nutrients between soil, animals and plants, in order to balance and increase fertility.

The environment also provides conditions for the implantation of stone cords, which consist of the opening of channels, generally at level, where stones are piled with the objective of also reducing the speed of water flow. In these areas (sertanejo surface) rock outcrops are quite common, ideal for the construction of the stone cord (MACEDO et al., 2009).

Studies such as Almeida (2017), Falcão Sobrinho (2020a), Carvalho and Falcão (2021) and Gomes et al (2021), developed on these types of technologies in the geomorphological compartment of the sertanejo surface, pointed to an improvement in the quality of family food, both for consumption and for marketing. In this way, the success of the technology for substance of the beneficiary families is noted.

The Meruoca Massive Wet Massif geomorphological compartment, also known as wet enclave, comprises altitudes ranging from 400 to 900 meters. This was elaborated on crystalline rocks dating from the Precambrian, represented in geology by the nomenclature “Ey4m”, Granitoid Meruoca, composed of gneiss, migmatites and granite rocks.

The use of the soil in this compartment tends to be concentrated particularly in areas of slopes and mountain tops, it has high agricultural potential, but in some areas it has limitations, mainly when associated with the intense use of inadequate techniques, manifesting itself erosive processes, leading to depletion.

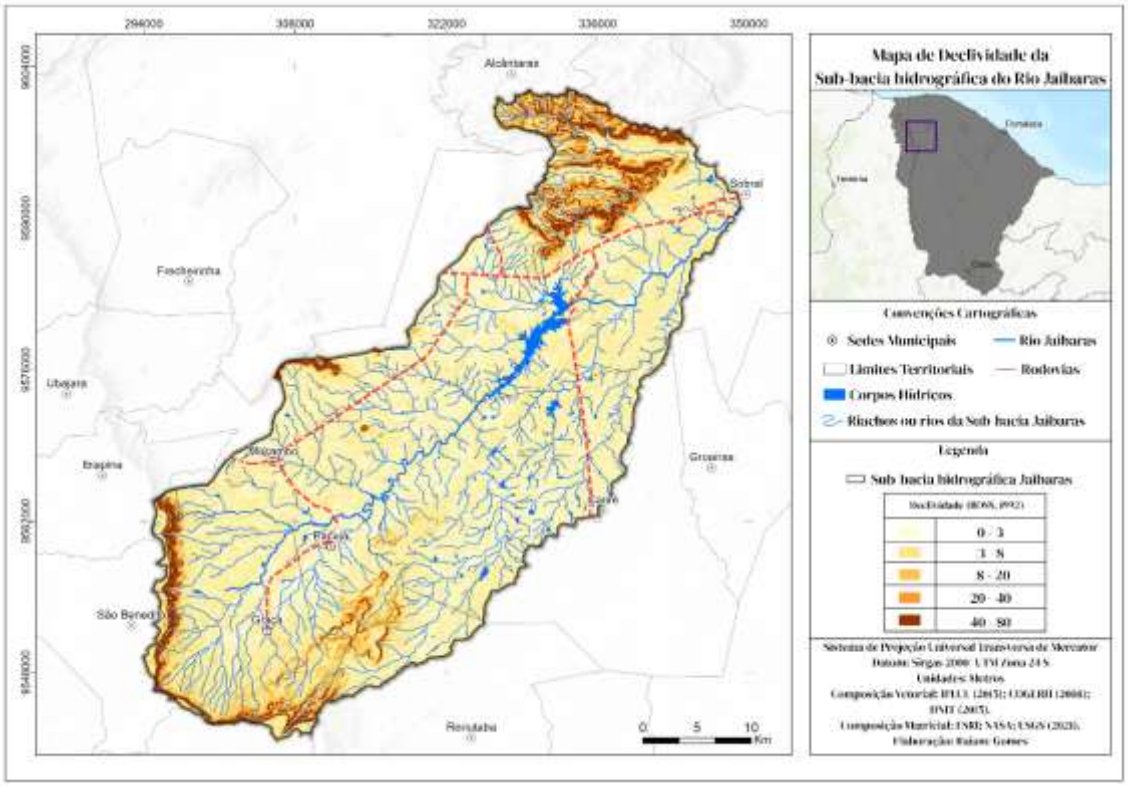
The slope class in this area is greater than 20%, as can be seen in Figure 17, characterized, in relation to the fragility of the relief, as medium to very strong. The particularities of this environment allow a suitable combination for the implementation of certain social technologies such as Cistern-Calçadão, Cistern - runoff, due to the slope of the slopes and stone tank that work to capture rainwater and stone cord, for presenting rocky terrain. and slabs, suitable for construction.

It was observed in the study developed by Gomes et al (2021) on the technologies implemented in the compartment of the Massif Residual da Meruoca, improvements and contribution to family income, however, the number of families benefited are few. It is confirmed that the environment in question provides natural conditions that allow the incorporation of technologies of coexistence that took advantage of the conditions of the relief, providing opportunities for sustainable development.

In the sedimentary environment, corresponding to 8 km of the study area, with altitudes of approximately 900 meters. It presents a large set of environmental riches, particularly correlated to the humid climate, due to the high rainfall between 1,200 and 1,800 mm, properly distributed in time and space of the unit. Due to these favorable climatic conditions, it has very deep, friable, mechanized soils, requiring only correctives and fertilizers for its use (BRANDÃO; FREITAS, 2014). The rugged relief has slope classes greater than 15% as shown in Figure 17, associated with a relief with wavy, mountainous and steep characteristics, with medium to very strong weaknesses.

Due to the characteristics of the relief, the social technologies of coexistence with the semi-arid region most suitable for the region are the Mandalas Systems, characterized as a model organized in the form of concentric circles. In view of the sustainability and active role of the farmer through this system, providing for the cultivation of bananas, vegetables and poultry. The Mandala system format is basically a new form of irrigation. The construction of a reservoir in the middle of the planting in circles in order to make better use of the space, as the project is applied to small rural properties. Food production is diversified, legumes, vegetables, fruits, etc. are planted. (MESIANO; DIAS, 2008). It can also be incorporated the technologies of models Cisterna Calçadão, Underground Dams, Barreiro – Trench, Cisterna de Churrada, PAIS.

Figure 6: Slopes of the Jaibaras River Sub-basin



Source: IPECE, 2015. ESRI, 2021. Elaboration: Gomes, 2022

FINAL CONSIDERATIONS

Social technologies since their implementation in the semiarid region have brought significant changes and improvements, since before families had to travel more than 5 km a day to fetch water for household activities and personal hygiene. The implementation of technologies for coexistence with the semi-arid region facilitated access to water and made it possible to store it throughout the dry season, it is important to highlight the reductions in contamination from water-related diseases.

There are several academic researches pointing out the relevance of the benefits after the implementation of technologies for the population of the semiarid region, such as water independence, supply, livelihood and income of small farmers. However, there is little research that correlates, makes this integration of environmental compartments with social technologies.

In this way, the research sought to evidence through the analysis of the compartments of the Jaibaras Sub-basin, with the aid of the cartographic tool, the most appropriate technologies taking into account the characteristics of the environment. This work also sought to collaborate with bases for future research, as well as for planning and elaboration of public policy actions aimed at fixing man in the countryside through social technologies, which promote sustainability in the semi-arid environment.

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