The different ways of living with climate change - the region semi-arid - River Basin Bridget - Pernambuco - Brazil

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Abstract – Global warming, caused by increasing temperature of the Earth is a reality. Thus, the objective is to expose and analyze the various forms of cohabitation with in the variability of climates on the river basin Bridget, plus to create an analysis of climate variability and temperature for the year 2020. The analysis area has a semiarid climate and is located in northeastern region of Brazil, in the state of Pernambuco. Recent studies have shown noticeable changes in temperature, rainfall, water resources, surface runoff and agriculture, with severe consequences for populations. However, as water is poorly distributed and the intensification of droughts will worsen the situation increasingly reaching the point of entire families will migrate to other areas. Thus, the region will become an environment highly susceptible to changes in climate. The most vulnerable area of the basin is the northern portion, where the land use occurs in a disorganized and unprepared. While the southern portion is less vulnerable because it is more likely to receive higher rainfall. Thus, living with the climate changes like for example: capturing rainwater and agroecology are required options for the northen region.

Keywords - Global warming, climate variability, cohabitation, semi-arid.

1 INTRODUCTION

In the northeast of Brazil the average annual rainfall reaches 700 billion cubic meters, and of this precipitated volume, only 24 billion cubic meters remain effectively available, the remaining 97% is consumed by the phenomenon of evaporation, on average 2000 mm per year, and runoff {1}et al.

Brito {2}, reveals that the variability in semi-arid climate is more associated with irregularity of scarcity, and this is perhaps the main problem of man does not remain in rural areas, since the existing water does not meet their basic needs or make the proper soil for cultivation.

The waterways - rivers or streams - that flow in the semiarid region of northeastern Brazil are almost all, except for the San Francisco and Parnaiba of temporary character, called also intermittent, remains dry during most of the year {3}et al..

Oliveira {3} et al., recalls that when he leaves the rains, the rivers continue to "run" for some time, fed by water seeping from the ground saturated at higher levels than the main channel or gutter living "river.

Completely ceasing the base flow a river, water continues to drain to the subsurface within the package of detrital sediments (gravel, sand, silt and clay), which together constitute the alluvial or alluvial deposit {4}, when the river ceases to "run"on the surface, this lake will gradually lose its water reserves accumulated and could dry up completely during the drought period.

For acquisition of water reserves in the region built by the Federal Government, several dams to increase the availability of surface water, these works assistance and temporary, at no time has made structures storage of water to meet basic needs and to support of small-scale production.

The basin studied is located in a semi-arid climate and is in the northeastern region of Brazil, in the state of Pernambuco. The region has a dominant rainfall regime marked by extreme irregularity of rainfall in time and space. In this scenario, water scarcity is an important constraint to socioeconomic development and even the livelihood of the population. The cyclical occurrence of drought and

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its catastrophic effects are well known and date back to early history of Brazil {5}.

Studies on the drought in the Northeast show that in this century, there were 14 major droughts, some of which were classified as extreme. Years of drought have in common the fact that the rainfall is located, as a rule, below the historical average. The effects of the drought resulting from the distribution of rainfall, are so intense, that in years of drought, her becomes virtually zero, even in the months typical of rain. Another aspect to highlight is the spatial distribution of drought, as not all sub-areas are affected by lack of rain {6}.

The description of the context in which they occur in the dry semi-arid region shows the natural and institutional difficulties which contribute to the coexistence of the backcountry with this weather phenomenon. Drought remains a scourge for millions of Northeasterners {7}. The lack of land reorganization, availability and proper use of water resources, appropriate technologies for agriculture dependent on rainfall, crops adaptable to climate and soil, causing economic and social effects, thus, widening the sad picture representing the millions of flagellates that periodically resurface in the backwoods of the Northeast.

The Northeastern semi-arid zone, particularly that of Pernambuco is located in a marginal position in relation to climate regions arid and semi-arid tropical and subtropical of the planet.

The rainfall in this region has become quite varied, ranging between 400 and 800 mm and also changing with respect to the times of beginning and end of the rainy season {5}. For these reasons, the semi-arid area is considered especially vulnerable to the effects of climate change.

Surveys suggest scenarios of temperature increase that would result in impact on the semi-arid. Among others: aridization trends with increasing desertification of arable areas; uneven rainfall (decrease of days with rainfall, increased flooding and dry days) with decrease in water availability. Disappearance of plant and animal species of the caatinga biome and more frequently a social crises because of the reduction in carrying capacity of the population in the region {8}.

Hence, the objective is to expose and analyze the various forms of coexistence where the enclaves and changes in climate are caused or intensified by global warming and / or climate change in the watershed of the river environment Brigida in the semi-arid climate. Besides showing average rainfall scenarios and scenarios of increased precipitation in 2020.

2. DESCRIPTION AND LOCATION OF STUDY AREA

The study area is the basin of the River Bridget, located in the hinterland of Pernambuco in the Northeast of Brazil, and is located in the coordinates 7 ° 30 ' to 9 ° 00' south latitude and 39 ° 30' 41° 00' west longitude and altitude of approximately 700m. with source in Araripe and exutório in Rio and San Francisco and an area of 14,366 square kilometers and a length of 160 km.

The Basin has a total of 15 municipalities, among which 6 are fully inserted: Araripina, Bodocó, Granite, Ipubi, Ouricuri and Trinity. The other municipalities that are part of its territory are Cabrobó, Exu Moreilândia, Oroco, Parnamirim, Santa Maria da Boa Vista, Santa Cruz, Sta Filomena and Serrita {9}, Fig. 1.

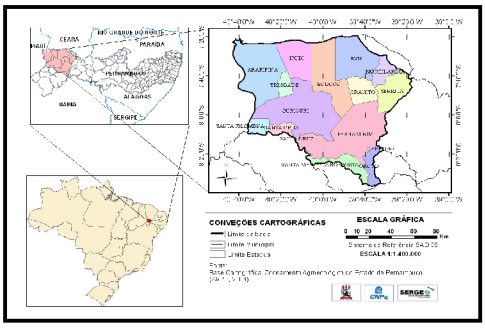

Fig. 1: Spatial of the location of River Basin Bridget with its municipalities - Pernambuco - Brazil.

3. MATERIAL AND METHODS

The hydrological data of the area was provided by the Laboratory of Meteorology and Water Resources of Pernambuco {10}, which organizes, analyzes and disseminates information on the climate Pernambuco. The data is obtained from rain fall and then organized and analyzed at the following locations: Araripina, Ipubi, Bodocó, Feitoria – Bodocó, Estaca – Bodocó, Exu, Moreilândia, Trindade, Granito, Serrita, Ipueira – Serrita, Ouricuri, Santa Filomena - Ouricuri, Santa Cruz - Ouricuri – Anos, Engenho Camacho – Ouricuri, Bezerro – Ouricuri, Parnamirim, Icaiçara – Parnamirim, Matias – Parnamirim, Aboboras – Parnamirim,in order to check variability of the climatological basin.

Then we used the integrated system of regional climate modeling PRECIS (Providing Regional Climates for Impacts Studies), version 1.2 (Jones et al., 2004), developed at the Hadley Centre, England, with the boundary conditions of regional climate model HadRM3P, which was implemented in Brazil by the Center for Weather Forecasting and Climate Studies (CPTEC), National Institute for Space Research (INPE). That is, it is a system of regional climate model, whose regionalization model results in HadCM3 a general atmospheric circulation {11}. Its dynamics are based on HadRM3, which is a newer version of the atmospheric component of HadCM3 the global circulation model {12}.

Thus the CPTEC / INPE has projected temperatures for all Brazil regionalized showing the following scenarios: the optimistic scenario (B2) and pessimistic scenario (A2) for the years 2020, 2030, 2040, 2050, 2060 and 2070. The optimistic scenario (B2), rising temperatures in the Northeast will be 1-3 ° C with 10% to 15% reduction in rainfall. In the pessimistic scenario (A2), the temperature increase will be from 2 to 4 ° C, with a reduction from 15 to 20% in precipitation. Potential impacts are: longer dry spells, and tend to aridization, increased rates of evaporation that can affect the levels of reservoirs and hence the subsistence agriculture; also causing water shortages and migration of man from the countryside to cities (climate refugees). It shows that projections of temperature have a spatial resolution of 0.44x0,44° (latitude x longitude), which corresponds to a grid of approximately 50x50 km for the period 2010 to 2070, as well as reference data.

With these data, we attempted to select those that were located in the basin. Therefore, we chose 20 (twenty) locations of monthly temperatures, with all the data from their geographical references. Then the data was organized and interpolated in Arc GIS 9.3. The method used for the Kriging interpolation was simple. The end result was the construction of monthly maps in scenarios A2 and B2, for the year 2020.

Finally were traced actions in coping with climate changes scenarios. Existing projects in the study area that keeps the backwoodsman in the field, with a view to guide to living with the semi-arid. Were picked potential strategies and exist, in order to advertise that they can serve as support for possible future applications, with a goal of mitigating and coping with the effects of global climate changes / local.

Therefore this article attempts to present the annual variability in rainfall, the scenarios of temperature increase with global warming under, two scenarios, one optimistic and pessimistic emissions of greenhouse gases and then expose and show what are the possible mitigating actions and coexistence with the climate changes in the semi-arid river basin Bridget.

4. RESULTS AND DISCUSSION

4.1 Analysis of mean annual precipitation

Fig. 2, shows the average annual rainfall in the basin. The area Rainier is located in the northern portion of the basin, specifically where are located the municipalities of Exu and Bodocó. The dry season is concentrate in the southern portion, and covers the municipalities of Ouricuri and Parnamirim. Of particular note is that the historical average for the basin was above 400 mm per year, reaching 1000 mm at the top of Araripe near the town of Exu.

The average annual precipitation is about 752 mm, and 70% of the total is concentrated in the months of January, February, March and April in the southern portion. In the northern part are: average annual rainfall of about 585 mm, concentrated during the rainy season from January to April.

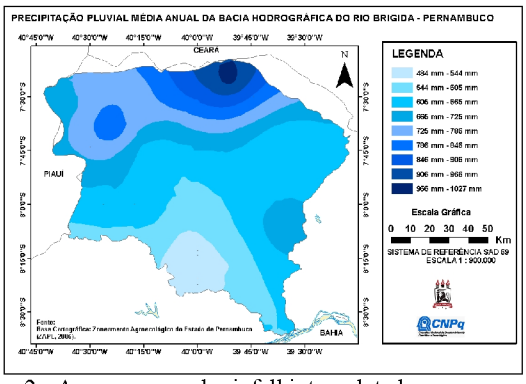

Fig. 2 - Average annual rainfall interpolated.

The annual temperature range of the area is 6 ° C, ranging from 20 to 26 C. The hottest months are October, November and December, and then starts decreasing temperatures. The coldest months occurs in May and runs through August.

4.2 Scenarios monthly temperatures for the year 2020.

This topic examines and exposes monthly maps of temperature in the scenarios A2 and B2, for the year 2020.

4.2.1 A2 scenario for the year 2020

In the Bridget basin were projected temperatures from range 22 to 32 ° C. The hottest months are: September, October, November and December, especially in October and November with temperatures between 28 and 30 degrees C in the area south of the basin. It is also worth mentioning that in the month of January the average temperature is higher than in the subsequent months, mainly in the south. From February to May temperatures are between 22-24 ° C in the north and 24-26 ° C in the south. From the month of June the temperature will be between 26 and 28 ° C, Fig. 3.

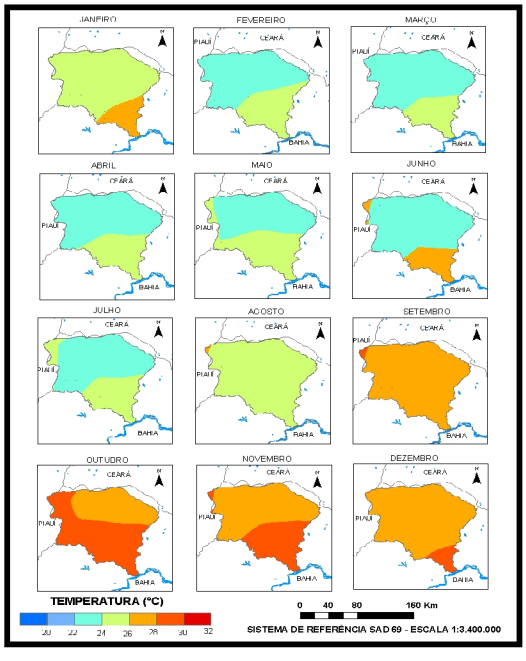

Fig. 3 - Average monthly temperature projected for the year 2020, scenario A2.

4.2.2 Scenario B2 for the year 2020

To this scenario we present average projected temperature of between 22 and 32 ° C. The hottest

months are the months of September, October, November and December, especially the month of October when average temperatures are between 28 and 30 degrees Celsius. As for the months of February to July temperatures are between 24 and 26 degrees Celsius in the southern region and 22-24 ° C in the northern region. From the month of January the temperature is between 24 and 26 in basin, Fig. 4.

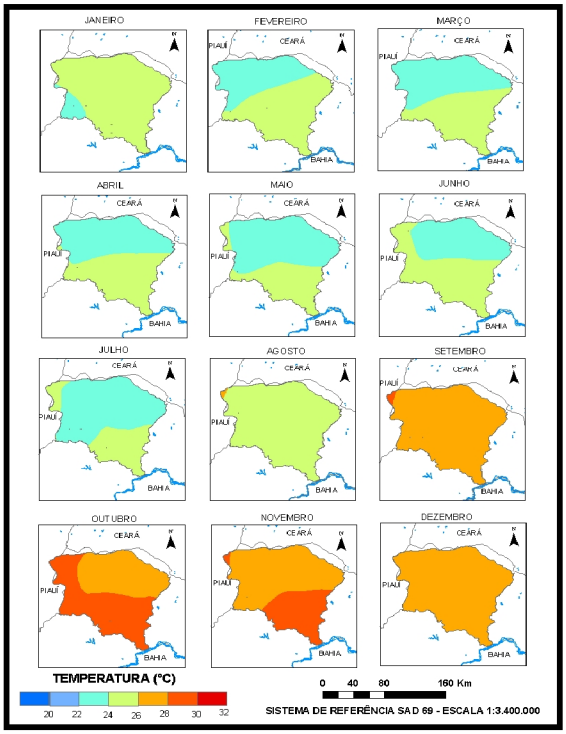

Fig. 4 - Average monthly temperature projected for the year 2020, B2 scenario.

4.3 Scenarios for coping with climate change

In the River Basin Bridget, rain rates are below the average each year. The rainiest months have receded, and the rains have occurred only in two, three, or four months, which actually should happen in five or six months. And years of drought have also increased dramatically.

In the field, investigated whether the rainwater was harnessed in some way. And it was found that the capture of rain water occurs only through dams (fig. 5 a), puddle (fig. 5 b), tanks of the plate (figure 5 c), cisterns (fig. 5 d), these last, devised and implemented by state agencies and organizations (ASA) and ONGs, with several sources of funding. The use of water tanks is only for human consumption, animal, domestic and productive purposes. The water of the dams and puddles are destined for irrigated agriculture, and when good quality to supply some towns. It should also be remembered that the stored water usually comes from the rainy season. Since part of the region's rivers are intermittent.

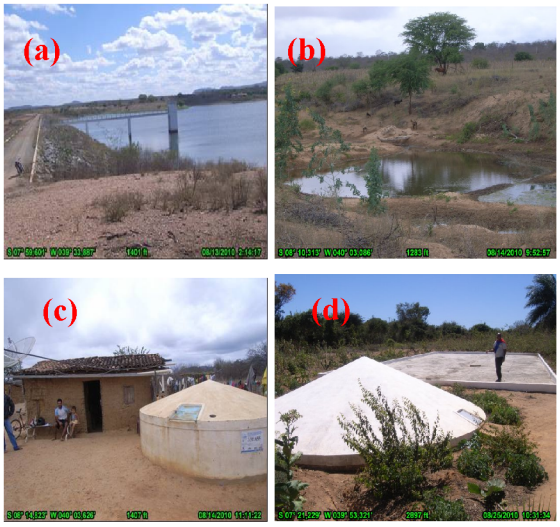

Fig. 5 (a) - dam of the hat in Parnamirim, (b) - puddle, (c) - tank plate, (d) cistern.

The water that supplies part of the urban population is derived from the water network in other regions. Once the water supply in rural communities; happens in several ways: through the rainwater stored in tanks, storage tanks, water and cars powered by animal traction which carry water (Fig. 6), among other ways.

Fig. 6 - Carts water district Matias– Parnamirim.

The basin is heavily dependent on rain water. Deforestation is frequent, due to the archaic

practices of cutting down the forest and subsequent burning. We also have a crystalline structure with geological and shallow soils, which is not conducive to infiltration of rainwater and a fragile plant cover, but very resistant to drought (Caatinga). Evaporation is very high and irregular and poorly distributed rainfall.

The counties are generally insuficentes in the fundraising and depends on additional funding from State and Federal Governments. The source of income of peoples are come from under-employment, public servants and farmer in general. Already the trade is dependent on the incipient and capital. What makes the watershed a place suceptível the bad weather.

Studies by Galvíncio {13} et al., in the study area show that the collection area needed for a tank of 16 m^3 can reach its maximum capacity in dry years, ranges between 29.6 and 49 m^2 on the south and from 10.7 to 29.6 m^2 in the north basin**,** Fig. 7. This data show portions of the basin, less precipitation,must has a larger catchment of rain water, while others do not. But in general, roofs and soils of the region to provide such funding.

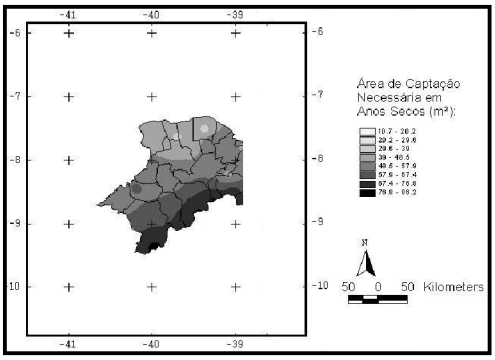

Fig. 7 - Areas of funding required as part of the basin. Source: Galvíncio {13} et al., modified.

Therefore, the projects from the semi-arid the of capture of rainwater is a viable option to minimize / mitigate climate change places, ie, the mean annual rainfall in the basin is around 752 mm , And 70% of that total is concentrated in the months of January, February, March and April, in the southern portion of the basin. In the northern region the average annual rainfall is around 585 mm, concentrated during the rainy season from January to April. Thus, we have 4 (four) months of collecting and 8 (eight) months to cohabit with the stored water.

Another action to minimize / mitigate climate change places, is to stop deforestation and change the way of cultivating the land, using sustainable techniques, which do not harm the environment. Agroecology is an option. Through this instrument, which uses the foundations of sustainable development and using techniques of non-use of pesticides and of not wasting water and inputs, all is produced is harnessed, will help the farmer in order to live with climate change.

In this environment the water is scarce and unpredictable, so it should be well publicized. The waters are captured in tanks, dams and barriers and should be maximized by avoiding waste, in order to bring social returns for communities. Whether for use in agro-ecology, farming, irrigation or agriculture.

The projects developed by NGOs, municipal governments, state and Federal should prioritize human interaction with climate, providing more comprehensive sustainable social technologies in order to keep people in the countryside or in cities.

The projects developed and developing must not be guided by practical assistance and discontinuous as diverse actions of the federal government as it sought to solve the damming water problem in the semi-arid, but that benefited large farms. Another example is the fronts of services in times of drought. In oligarchs hinterland appropriated the manpower paid for with public money to build water reservoirs, recover and opened roads and other works of improvement in their private properties, reinforcing the dominant socio-economic structure.

Another factor that prevented the successful damming of the federal government was that the

semi-arid regions are highly dispersed populations in the immensity of the wilderness, where people spend hours walking to reach the water. And yet how much water evaporates from reservoirs (high evaporation) at the end of summer that is left is a muddy water, which is disputed by people and animals, and therefore transmits numerous diseases, preventing their use.

Therefore, we must consider the possibility of multiple needs and water supply of populations of the semi-arid region, such as the uptake and distribution of rainwater for human consumption and small herds, with the construction and maintenance of dams, wells, tanks and other equipment to use family and community. We need to encourage alternatives to capture, storage and management of rain water for production, especially adequate soil to reduce erosion caused by floods, and techniques that produce wetlands for food production, aiming at food security communities {8}.

There are plans to accelerate sustainable development in semi-arid and that will help keep people in the countryside and cities mitigate and cope with climate change in semi-arid regions. Mainly focused on capturing rainwater. Thus we have as an example: **simple tanks** (reservoirs built next to houses with concrete slabs with coverage to protect the of evaporation. Rainwater that falls on the roofs runs down the tube so that water falls directly into the tank. As the reservoirs are built near the residence, drastically reduces the distances to access water, fig. 8); **cistern** (underground reservoirs built on concrete slabs, above the ground). To capture the water, there is a cement sidewalk, and trenches in sloping ground, where water flows. Not to get pieces of wood and sediment, filter is built at the entrance of the tank fig. 9); **underground dam** (retain rainwater infiltrated into the underground areas of floodplains, valley bottoms and areas of flow of rainwater through dam in a valley bottom in waterproof layer of soil. She has a great impact on the stability of the production system, in supplying water in periods dry, when the area of the dam looks like a green island in the middle of the dry savanna. It guarantees autonomy with regard to food, allows the creation of a larger number of animals and reduces dependence on external inputs, fig. 10); **stone basin or cauldron** (it is possible to store large volumes of water abstracted in flagstones, taking advantage of the natural inclination of ground. In some places, it is necessary to build walls or low walls facilitating containment or directing water to the tanks and therefore a higher accumulation of water. It is one of technical innovation that is based in the value of knowledge of family farmers in the strategies of use and water management. The stone tank stores water for the household expenses for animal feeding and watering a "backyard production" of vegetables, fig. 11); **barrie trench** (deep and narrow ponds are dug into crystalline basement with one or more compartments and more than three feet deep, with a bottom and wall a of stone (gravel), which not leave water to infiltrate, fig. 12); **agroecological** (there are actions for the implementation and development of agroforestry, organic horticulture, honey production, breeding of goats and sheep, poultry, fish farming, expansion and proper management of water infrastructure on the properties and rural communities in a sustainable and permanent. Addition of the preservation of native forests, replanting with native species and erosion controls, fig. 13).

Fig. 8 - Tank plate to capture rainwater that runs off the roof of the house.

Fig. 9 - cisterns to capture rainwater that falls to the ground.

Fig. 10 - Ditch Pit Excavated and Amazon
Source: {14}.

Fig. 11 - Tank natural stone, used for storing rainwater.
Source: {15}

Fig. 12 - barrie trench

Fig. 13 – Agroecology

Other minor works of water infrastructure, improvement and the diversification of production of family, construction, restoration and improvement of teaching thousands of schools located in rural areas should also be prioritized.

These are the actions that should be taken with sustainable ideas, and permanent to the people of these regions. These actions are guides able of help in men to live with changes and / or changes in climate and they do not cause trouble, deaths and climate refugees.

Projects must be permanent, in order to solve the problems of water scarcity and should aim for sustainability based on coexistence rather than the political exploitation of the misery that is the "drought industry" as a thriving business.

In this perspective, it is necessary to seek and / or improve programs / projects existing coping with drought in the sense that a wider range of individuals served. These projects meet must to minimize or mitigate climate changes in the region.

5. CONCLUSIONS

The most vulnerable area of the basin is the northern portion where the land use occurs disorganized, unprepared, because that is where we find the largest areas of exposed soil of the basin. The use of fire and clearing of vegetation is common and a second occupation is installed, eg raising cattle and goats; are practiced extensively.

This is the area where it is observed the greatest variations in temperature, besides being less rainy, which implies a closer monitoring, commitment and actions of the mitigation / control of climate change.

Already the southern portion is less vulnerable because it is more likely to receive larger amounts of precipitation, but it is still prioritized, since the environments; mountain vegetation are the most devastated and in process of devastation and the uncontrolled use of land, where use fire is common.

Water security is a major concern, resulting from frequent droughts that struck the region, water is a major factor limiting the development and how global warming and / or climate change are present is concerned is necessary.

Thus all actions to control / mitigation / to coping with climate change are relevant / urgent and necessary.

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