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Rational use of watershed resources in the Agreste region of the state of Pernambuco - Brazil

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ABSTRACT

It was used a model of development based on the availability of natural resources, to identify the possible options for income generation in the area, and the current infrastructure conditions and of labor qualification. It was drafted a plan to use the watershed centered in man, with the primary concern of protecting the environment of which it is part. This study aimed to establish a development plan, promoting the improvement of quality of life and control of damage to the environment in the watershed of Várzea Grande, located in the city of Belo Jardim - PE. Planning for sustainable use of a basin should involve human and natural resources available, in addition to promoting social welfare and environmental protection. In semi-arid regions occur locations at high altitudes, with less risk of crop loss, representing potential for sustained food production. The planning had as supports an expeditious survey of natural resources, classifications made on the land and socio economic information gathered in the area. It was concluded that in addition to agriculture, there should be encouragement for other activities such as domestic agribusiness, for crafts and even for rural tourism in order to increase earnings and put the population in the market economy.

Keywords: sustainable development, natural resources, erosion

INTRODUCTION

The sustainable development of a region depends on a schedule that takes into account the availability of human and natural resources and proposes activities that promote social welfare and environmental protection.

The areas that take up position in the landscape at high altitudes, located within the semi-arid regions, have significant potential for sustained food production. They can also promote the supply sources, located in the surrounding dry areas. This is because the areas at high altitudes have different climatic conditions, providing greater rainfall and less risk of crop loss.

Unfortunately, throughout the Northeast, parts of these ecosystems are in rapid degradation process. This process is one of the reasons to choose the watershed of Várzea Grande to study, because it is within these areas except in the northeastern semi-arid.

An eminently agricultural region as the area under study, the basis for the development should be agriculture, because it is the most appropriate activity to the educational level and the need for subsistence of the population. However, for the sustainability of the ecosystem it is necessary that this activity is developed rationally. Thus, an efficient planning ecosystem conservation should be established by selecting a group of ideal variables, which differs for each location (Collins & Walling, 2002), in order to diversify activities, inhibiting the excessive use of natural resources. There is urgency in the election of other income-generating activities such as handicrafts, cottage industry and rural tourism, able to promote the access of rural populations to the market and at the same time,

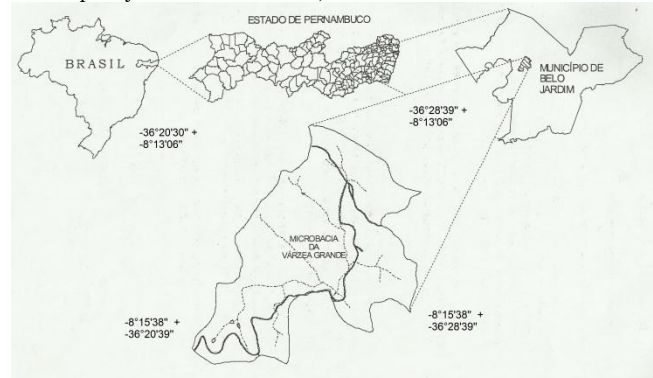
reduce the irrational use and overexploitation of the ecosystem.

This study was conducted in order to determine the potential of natural and human resources, as well as identify current and potential environmental impacts. Based on this knowledge, it is suggested a sustained recovery program based on agriculture, but subsidized by activities that can reduce the threats to the ecosystem and also lead the population to market economy.

MATERIALS AND METHODS

The watershed of Várzea Grande is located in the basin of Bitury River, a tributary of the Rio Ipojuca, in the municipality of Belo Jardim, in the Agreste of Pernambuco (Figure 1), standing between the parallel of $8^{\circ} 13' 06''$ and $8^{\circ} 15' 38''$, south latitude, and between the meridians $36^{\circ} 28' 39''$ and $36^{\circ} 29' 39''$, west of Greenwich. It covers an area of 5,713,600 square meters and has a maximum altitude of 1,086 m and a minimum of 932 m (BOLLINA, 1986a).

Figure 1: Location of the watershed of Várzea Grande, in the municipality of Belo Jardim, in the state of Pernambuco.



In the area of the watershed the climate is influenced by altitude, due to the high position of their land, being classified as As - tropical rainy climate with dry summer, according to the Köppen climate classification, and type 3dTh - warm Mediterranean or northeastern dry sub, according to

the bioclimatic classification of Gaussen (Jacomine et al., 1973). As for the rain, there is an average annual rainfall of 764.5 mm for a period of 26 years (SUDENE, 1990).

The relief in the area varies from flat to mountainous. The plane and undulated reliefs are mainly related to the areas of colluvial and to a lesser extent, to the tops of elevations. The wavy and strong wavy reliefs are the dominant forms in the landscape, while the mountain is mostly restricted to the limits of the east and the north and part of the western boundary (COELHO JUNIOR et al., 2016).

Occur in the study area two main types of plant communities, which are closely associated with relief: the sub-tropical evergreen forest and hygrophilous fields. The sub-tropical evergreen forest covered almost the territory of the watershed, having been reduced to only remaining (REIS, 1999). On rocky outcrops, promoting the weathering of the granite, are observed orchids, bromeliads and grasses, virtually expressionless in territorial terms. The geology of the watershed is related to the Precambrian Undivided (MINISTÉRIO DAS MINAS E ENERGIA, 1973), on virtually its entire surface, and the Quaternary only in the areas of colluvium and alluvium distributed sparsely in foothills elevations and along the streams and are, as a rule, narrow and discontinuous formations.

RESULTS AND DISCUSSION

It became clear that the watershed of Várzea Grande is subject to a model of predatory exploitation of natural resources, including deforestation, soil erosion, siltation and pollution of water sources by sediments dragged by pesticides and fecal coliforms. Furthermore, there is a marked

poverty level which contributes to damage to the environment.

The lush sub-tropical evergreen forest, once arranged throughout the basin, has only remnants. Its deforestation has influenced the water regime of the area by the decrease in infiltration by reducing the supply of groundwater and the consequent increase in flooding in the lower regions.

The resulting erosion, however, is lower than expected, due to the low soil erodibility. Its highest rates are observed in grazing areas, southwest and east of the watershed, in areas of Red-Yellow Argisol and highland regions valleys where there is irrigated agriculture of vegetable crops under Gleysols.

In the southwestern portion of the watershed, in the area occupied by pastures, there are some scattered terraces, which although they were constructed without taking into account the proper distance between them, can be seen that there was a concern with the erosion process.

Mainly in the areas of irrigated agriculture, the intensive use of pesticides without observing any care is harming the health of farmers, determining the pollution of streams and the dams, and consequently, the users of water stored there.

The development model proposed here aims to curb these mistakes and at the same time, propose actions to eradicate poverty or mitigate it and boost healthy economic growth that takes into account the protection of the environment.

The strategy for sustainable development of the watershed requires actions in several segments, through agriculture and other income-generating activities, as well as health, education and infrastructure, all of them imbued with the need to avoid environmental impacts.

Agriculture is the basis of the current economy and also compatible with the farmer's level of education, should constitute a first step, the main activity to be developed within the watershed.

Five types of use should be encouraged, some already established in the area: culture of irrigated vegetables; irrigated floriculture; coffee; banana plantations; grazing and forestry, on the understanding that there must be protection of the remaining forests and reforestation.

These explorations within the extent possible should be conducted on organic farming techniques, promising mode both by the market that is created for the generated products, as well as the tourist possibilities that open up due to the growing interest of visiting the centers of this activity.

All modes of operation should be conducted to avoid overexploitation leading to accelerated erosive wear, whose rate exceeds the natural rate or soil genesis (Gottschalk, 1965), seeking to introduce the biological control of pests and thus minimizing the use of polluting pesticides in the environment.

The adoption of mechanical and vegetative practices to combat erosion during your driving will be required, which, in addition to soil conservation will mean control of silting of watercourses. In this context, Reis (1996) states that soil conservation does not simply mean containment of erosion, it covers a much broader connotation which includes the fertilization, liming, drainage and all procedures able to maintain the productivity of land, preventing its deterioration and / or recovering areas already subject to sterilization processes.

In the irrigated areas, it should be stimulated irrigation efficiency, in order to avoid waste of water, which results in damage to the crop roots or promotes erosion. Furthermore, the erosion results

in reduced production capacity of soils and sediments and transfer of pollutants to rivers, streams, etc. (MERTEN E MINELLA, 2003).

In addition to traditional uses, it can be introduced irrigated cultivation of flowers and herbs, encouraging the use of the latter and, optimistically, the installation of small herbal medicine laboratory to serve the local community and the neighborhood.

Furthermore, the protection of forest remnants of the area is essential. The deforested areas unsuitable for agricultural use should be reforested using native species, and also precocial exotic species to meet the demand for timber in the watershed and round. With the same objective, it is important to plant small domestic forests to meet the community's wood consumption.

According to Salomão (2012), it is important to note that the maintenance of vegetation cover is like the natural defense of the land against erosion. The vegetation protects the soil against the direct impact of rain drops on the surface, increasing infiltration, because the roots of plants produce pores and increases the water retention capability.

There is a significant waste in the area of fruits and vegetables that could be very well used. This waste is more significant in agricultural production. To get a sense of the scale of the problem, these types of losses in Brazil correspond to 7,8% the Brazilian gross domestic product - GDP (JARDINE, 2002), occurring mostly with highly perishable products such as fruits and vegetables.

At the domestic level, it can be cogitated manufacturing sweets in syrup (banana, cashew, jackfruit, soursop, jenipapo and jaboticaba) and shaped fruit (banana and cashew), as well as liqueurs and homemade wines. This idea should not be restricted to the surplus, but extend to the portion

of agricultural production, adding value to those products.

The craft, although on a reduced scale, was identified in the area. It is characterized by making baskets using native vine. In addition to the stimulus to this activity, it is suggested that the IPA - Agricultural Research Institute of Pernambuco and UFRPE - Rural Federal University of Pernambuco seek to domesticate this plant which is already at high risk of extinction, thus ensuring the raw material for the product. It is also important stimulating clay crafts, given the wide availability of suitable material in the region.

The watershed constitutes an excellent example of altitude site, important ecosystem as an exception area in the northeastern semi-arid. Occur notable remaining species of sub-tropical evergreen forest, where are observed many exemplary of species common in humid regions. There are vegetables individuals of high size and timber value, pharmacological and ornamental. These occurrences, properly divulged, can contribute to the development of tourism.

On the other hand, in its eastern and northwestern boundaries, topographic situations occur that allow the practice of certain extreme sports such as hang gliding, and that stimulated may increase the tourist demand.

The divulgation of local crafts, even though incipient at the time, but with prospects for promotion and expansion, can also function as calling visitors. The same can be said with regard to the sources of clear, pure water found there and the mild climate. Once implanted a core of organic farming, it could also serve as a tourist attraction.

As noted, the level of education in the watershed is very low. According to 2010 IBGE sense (IBGE,

2012), Belo Jardim has 78 schools of pre-school, 90 primary schools and only 11 high school and is enrolled 2,232 students in pre-school, 13,647 students in elementary schools and 4,055 students in high school. According to IBGE (2009), there are 13 private schools.

In addition to basic education, it is very important, also, the establishment of an adult literacy program, using as argument matters related to deals in the region. Of course, the creation of a physical space for this purpose will be needed, which could be part of a small group that also meets the needs of other activities proposed in this document.

According to IBGE (2009) there are 21 municipal public health establishments in Belo Jardim. It was found that the main diseases in the area of the watershed are linked to diseases caused by tapeworms. In addition to actions to clarify the population about the prevention of diseases, starting with hygiene measures, construction of septic drains and prophylactic and therapeutic procedures such as boiling water, the use of oral rehydration, etc., must be employed. Diseases caused by poisoning due to the use of pesticides, with all its harmful consequences to organisms, occur acutely and, most commonly, imperceptibly, when the active agents operate continuously. Caring for pregnant women and maternal and child guidance as a whole, should also be addressed, as well as notions of phytotherapy.

For the suggested activities and actions can be optimized, it takes some interventions on infrastructure access, power and communication.

The road network of the watershed is restricted often to bare soil roads with poor maintenance, causing serious traffic problems during the rainy season, especially in steeper stretches northeast of

Boa Vista do Pagão and towards the Alto Bitury and Boqueirão. There is a route that consists of abandoned bare soil roads, but who have significant importance for the socio-economy of the watershed's community and should therefore, as far as possible, be recovered.

To optimize the network, both in terms of production flow, as the resident population transport, the opening of roads is suggested. The aiming is to make it accessible to vehicles to all potential areas for development, even at the time they are not populated, looking the less hilly stretches to facilitate the construction and subsequent population transportation.

However, there are other significant road problems, as or even more important, and related to access to the area due to the high lands, during the rainy season, often making the access impossible. There is most of the agricultural production without irrigation, which justifies importantly the maintenance of roads in the rainy period.

In order to support the implementation of activities and proposed actions, particularly in education and health, building a physical space is required, although rustic and modest, but that could be extended in the future, even to host tourists.

The concern here is to avoid the possible impacts on the environment determined by a number of current activities and those that are being proposed in the sustainable use plan, controlling them and / or preventing them.

The current main environmental impacts observed in the watershed are related to the use of natural resources. The first to be degraded was the forest, remaining only a few covered areas.

Deforestation alone, had already begun to promote soil erosion, but the phenomenon has been

exacerbated by farms that do not consider the support usability and do not use mechanical and vegetative practices control erosion.

This wear has and continues to result in the depletion of the soil, affecting the loss of fertility while promoting the silting of watercourses. In full pikes, the finest sediments can reach weirs and dams located downstream, which supplies the cities.

The degradation of soil by erosion phenomenon is mainly explained by the low level of farmer education and, in some cases, the land use relationship for renting or sharecropping, which does not motivate concern for their protection, which was common since the Middle Ages as related by Kiehl (1985) and also reported by Sousa (1995) for region in the municipality of Serra Talhada in Pernambuco state.

As for pollution by silting, Reis (1998a) states that occur aggression on aquatic biota by increasing turbidity and extinction of the food chain, particularly benton, and also causes the reduction of volumes of water sources. Reis (1998b) states that it is absolutely essential that the management of water resources must begin with the care of the soil and vegetation that it supported. These two elements are the natural apparatus for capture, storage and distribution of water.

The suspended sediments in rivers can be derived from various sources. Identifying these sources is essential for the planning of conservation intervention. Determination of sediment sources can be made by evaluating the chemical and physical characteristics. Through this method, Russell et al. (2001) found that the sources of suspended sediment were from 34-65% of laminar erosion in crops, 27-55% erosion in drains and less than 10% of fluvial erosion.

This same agricultural use, based on the intensive and irrational use of agrochemicals, mainly pesticides, because fertilizers are little used in the watershed, pollutes local water resources, cumulatively compromising water reservoirs and dams downstream. The first application of pesticides occurs, on average, eight days after the planting of the crop and can be repeated every four days. Users, despite being aware of the risks, not have been concerned about the care essential when applying these products. The wind direction is not observed and the application of the product is carried out in many cases by operators with bare feet and wearing shorts.

On a smaller scale, given the low population density of the area, there is the pollution of water resources by fecal coliforms, due to the lack of toilets in various parts of the region and also for solid waste.

With the recovery and expansion of the road network, there may be an exacerbation of threat to plant resources by exposing previously inaccessible areas, as well as the erosion phenomenon determined by this route.

The actions for avoiding these impacts start up by encouraging the diversification of productive activities and are embodied on the rational strategies planned for the various proposed activities and related natural resources. These, in turn, consist primarily of: protection of remaining forest; reforestation of degraded areas; agricultural use according to the use of capacity; use of mechanical and vegetative practices of erosion control; introduction of biological pest control, avoiding the use of pesticides; stimulus to the construction of septic tanks and rational management of waste through screening already in production. Separated at source, the organic fraction

of solid waste can be used as fertilizer, while recyclables such as paper, plastic, metal and glass, can be brought to market, which may be done for future cooperative.

On this subject, Reis (1988), stresses that the success of any environmental wear containment program cannot be achieved through strategies linked to the protection of flora and fauna and the rationalization of agricultural use, if other activities are not considered in use options of natural resources and potential of small industry and handicrafts.

As the mitigation of impacts on water resources, it would be interesting contact with the Department of Water Resources, for, based on the National Plan and State of Water Resources, creating a management council water availability.

For the implementation of the actions described above, it is necessary to create a controlling entity and a physical space where is located the core of its operations. The entity indicated should operate in a cooperative scheme. The space should cover the seat of the cooperative, a school, a warehouse for the storage and marketing of products and in the future, a rustic lodge for tourists. The performance of proposed activities in the area will be advantageously supported by this system, which may provide machinery and inputs for agriculture, handicraft and agro-industry.

Such a system could also facilitate the formation of a management board of water resources of the watershed and also encourage the participation of women in the sustainable development process of the area, particularly in health care, basic and environmental education and resource management vegetables and water which was considered appropriate by the Development and Environment

Commission for Latin America and the Caribbean (1992).

For the sustainable use program proposed in this document can be triggered and implemented it is essential to the support of a public body, and, in this case, the most on the issue, is the Belo Jardim City Hall power.

This entity has already acted in Bitury region, particularly in the Araçá community, together with other organizations, such as IBAMA and SECTMA and also UNDP, FAO and the World Bank, which may contribute to the implementation of the actions physical and social infrastructure and support income-generating activities. Non-governmental organizations, such as NGO SABIÁ may also be driven to the implementation of sustainable use in the watershed.

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